CITY OF TURLOCK
STANISLAUS COUNTY, CALIFORNIA

CONTRACT DOCUMENTS FOR THE CONSTRUCTION OF

TURLOCK REGIONAL WATER QUALITY CONTROL FACILITY

SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION PROJECT

MARCH 2017

VOLUME 1 OF 3 - Specifications
(Divisions 00 through 11)

CITY PROJECT NO. 15-39C

CITY OF TURLOCK
STANISLAUS COUNTY, CALIFORNIA

TURLOCK REGIONAL WATER QUALITY CONTROL FACILITY
SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION PROJECT
LICENSEE RESPONSIBLE FOR SPECIFICATIONS

Contract Documents prepared by or under the direction of the following registered persons:

Digitally signed by James Wickstrom
Contact Info: Carollo Engineers, Inc.
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04/20/2017

James Wickstrom, P.E. California Civil C-57732

CIVIL ENGINEERING
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CITY OF TURLOCK

SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION PROJECT

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ADVERTISEMENT FOR BIDS

CITY OF TURLOCK
DEVELOPMENT SERVICES DEPARTMENT/ ENGINEERING DIVISION
156 SOUTH BROADWAY, SUITE 150
TURLOCK, CA 95380-5454

TURLOCK REGIONAL WATER QUALITY CONTROL FACILITY
SECONDARY CLARIFIER NO. 5 AND
DENITRIFICATION PROJECT
CITY PROJECT NO. 15-39C

ADVERTISEMENT FOR BIDS

Sealed Bids for the construction of the Turlock Regional Water Quality Control Facility Secondary Clarifier No. 5 and Denitrification Project will be received by City of Turlock, at the office of the City Engineer, Engineering Division, 156 South Broadway, Suite 150, Turlock, CA 95380-5454, until 2:00 pm sharp (as determined by computer clock located at the Engineering Division Front Counter) on May 30, 2017 local time, at which time the Bids received will be publicly opened and read. The Project consists of constructing the following components:

1. Secondary Clarifier No. 5.

2. RAS Pump Station No. 2.

3. Mixed Liquor Flume Nos. 5 and 6.

4. Modifications to Aeration Basin Nos. 1 - 7.

5. Modifications to Junction Box No. 1A.

6. Modifications to Biotower Crane.

7. Modifications to Electrical Building No. 7.

8. Additions and modifications to yard piping system.

9. Additions and modifications to electrical systems.

10. Additions and modifications to instrumentation systems.

11. Additions and modifications to grading, paving, and drainage systems.

12. Repair and reconstruction to existing facilities affected by the work and all work necessary to render the facility complete and operational.

BIDDING DOCUMENTS

The Issuing Office for the Bidding Documents is: City of Turlock, Development Services Department/Engineering Division, 156 South Broadway, Suite 150, Turlock, CA 95380 - 5454. The Bidding Documents in PDF format may be downloaded from the City of Turlock's website (www.cityofturlock.org/capitalprojects). Charges for all documents obtained will be made on the following basis: Checks to be made payable to the City of Turlock. Charges are not refundable.

Document Description	Non-Refundable Charges
Complete set of Contract Documents consisting of Volumes 1 through 3 which includes full-size drawings (22" x 34") and specifications.	$ 350
Complete set of Contract Documents consisting of Volumes 1 through 3 which includes reduced-size drawings (11" x 17") and specifications.	$ 175
Mailing	Not included. Must provide UPS, FEDEX or other overnight mail service account number.
Supplemental geotechnical reports listed in Section 00200, Information Available To Bidders, may be obtained by requesting a PDF copy by email to Stephen Fremming (sfremming@turlock.ca.us).	No fee.

Bidding Documents may also be examined at the following locations:

A full set of Bidding Documents is available for examination at the office of the City Engineer of the City of Turlock, Development Services Department/Engineering Division 156 South Broadway, Suite 150, Turlock, CA 95380-5454, and can be viewed at Carollo Engineers, 2700 Ygnacio Valley Road, Suite 300, Walnut Creek, CA 94598.

List of plan holders can be viewed on the Internet at www.cityofturlock.org/capitalprojects. Click on "View Planholders List."

For procedural questions contact:

Stephen Fremming
City of Turlock, Development Services, Engineering Division
(209) 668-5599 ext. 5417
sfremming@turlock.ca.us

Submit all technical questions during the bid period in writing (via email only) to both the primary and secondary contacts listed below:

James Wickstrom, P.E. (primary contact)
Carollo Engineers, Inc. – Walnut Creek, California Office
925-932-1710
jwickstrom@carollo.com

Rob Hunt, P.E. (secondary contact)
Carollo Engineers, Inc. – Walnut Creek, California Office
(925) 932-1710
rhunt@carollo.com

MANDATORY PRE-BID CONFERENCE

A pre-bid conference will be held at 1:00 p.m., local time on May 10, 2017 at the City of Turlock Water Quality Control Facility, 901 South Walnut Road, Turlock, CA, 95380. Attendance at the pre-bid conference is mandatory.

BID SECURITY

Bid security shall be furnished in accordance with Document 00200 - Instructions to Bidders.

CONTRACTOR REGISTRATION

Contractor must provide proof of registration with the California Department of Industrial Relations (DIR) in the form of a PDF extract from DIR Public Works Registration website.

Pursuant to California SB854, Contractor and subcontractor must submit certified payroll records (CPRs) to the Labor Commissioner.

Project is subject to compliance monitoring and enforcement by the DIR.

PREVAILING WAGE RATES

Pursuant to Section 1770 et. seq., California Labor Code, the successful Bidder shall pay not less than the prevailing rate of per diem wages as determined by the Director of California Department of Industrial Relations. A copy of such prevailing rate is on file at the Owner's offices and will be made available for examination during business hours to any party on request. The project is subject to compliance monitoring and enforcement by the California Department of Industrial Relations.

CITY OF TURLOCK

By: _____
Michael G. Pitcock, P.E.
Director of Development Services/
City Engineer

Date: 4-21-2017
Date of Initial Publication of Advertisement

END OF SECTION

DOCUMENT 00200

INSTRUCTIONS TO BIDDERS

ARTICLE 1 - DEFINED TERMS

1.01 Terms used in this Document will have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in this Document have the meanings indicated below:

A. Issuing Office - The office from which the Bidding Documents are to be issued.

B. Successful Bidder - The lowest responsible Bidder submitting a responsive Bid to whom Owner (on the basis of Owner's evaluation as hereinafter provided) makes an award.

C. Responsive Bidder - Means a Bidder who has submitted a Bid which conforms in all material respects to the Bidding Documents.

D. Responsible Bidder - Means a Bidder who has the capacity and capability in all respects to perform fully the contract requirements and who has the integrity and reliability to assure good faith performance.

ARTICLE 2 - COPIES OF BIDDING DOCUMENTS

2.01 Complete sets of the Bidding Documents may be obtained from the Issuing Office in the number and format stated in the advertisement or invitation to bid.

2.02 Complete sets of Bidding Documents shall be used in preparing Bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.03 Owner and Engineer, in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining Bids for the Work and do not authorize or confer a license for any other use.

ARTICLE 3 - QUALIFICATIONS OF BIDDERS

3.01 More than 1 Bid from an individual, firm, partnership, corporation, or association under the same or different names will not be considered. If the Owner believes that any Bidder submits more than 1 Bid for the Work contemplated, all Bids in which such Bidder is interested will be rejected. If the Owner believes that collusion exists among the Bidders, all Bids will be rejected.

3.02 Provide proof of registration with the California Department of Industrial Relations (DIR) in the form of a PDF extract from DIR Public Works Registration website.

3.03 Pursuant to Section 4105, California Public Contract Code, Bidder may not circumvent the requirement to list subcontractors by the device of listing 1 subcontractor, who in turn sublets portions constituting the majority of the work covered by the contract.

3.04 No Contractor or Subcontractor may submit a Bid or perform Work on this Project who is found in violation of California Labor Code Division 2, Part 7, Chapter 1 by the Labor Commissioner. Subcontractors who have been disbarred may not receive public funds pursuant to California Public Contract Code §6109.

3.05 To demonstrate Bidder's qualifications to perform the Work**,** Bidder shall submit written evidence establishing its qualifications such as financial data, previous experience, present commitments by submitting Document 00451A - Construction Contractor's Qualification Statement For Engineered Construction.

3.06 A Bidder's failure to submit required qualification information within the times indicated may disqualify Bidder from receiving an award of the Contract.

3.07 No requirement in this Article 3 to submit information will prejudice the right of Owner to seek additional pertinent information regarding Bidder's qualifications.

3.08 Bidder is advised to carefully review those portions of the Bid Form requiring Bidder's representations and certifications.

ARTICLE 4 - SITE AND OTHER AREAS; EXISTING SITE CONDITIONS; EXAMINATION OF SITE; OWNER'S SAFETY PROGRAM; OTHER WORK AT THE SITE

4.01 Site and Other Areas:

A. The Site is identified in the Bidding Documents. By definition, the Site includes rights-of-way, easements, and other lands furnished by Owner for the use of the Contractor. Any additional lands required for temporary construction facilities, construction equipment, or storage of materials and equipment, and any access needed for such additional lands, are to be obtained and paid for by Contractor.

4.02 Existing Site Conditions:

A. Subsurface and Physical Conditions; Hazardous Environmental Conditions:
   1. The Supplementary Conditions identify:
      a. Those reports known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site.
      b. Those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).
      c. Reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site.
      d. Technical Data contained in such reports and drawings.

2. Owner will make copies of reports and drawings referenced above available at the cost of reproduction to any Bidder on request. These reports and drawings are not part of the Contract Documents, but the Technical Data contained therein upon whose accuracy Bidder is entitled to rely, as provided in the General Conditions, has been identified and established in the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any Technical Data or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings.
3. If the Supplementary Conditions do not identify Technical Data, the default definition of Technical Data set forth in Article 1 of the General Conditions will apply.

B. Underground Facilities: Information and data shown or indicated in the Bidding Documents with respect to existing Underground Facilities at or contiguous to the Site are set forth in the Contract Documents and are based upon information and data furnished to Owner and Engineer by owners of such Underground Facilities, including Owner, or others.

C. Adequacy of Data: Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated subsurface or physical conditions appear in Paragraphs 5.03, 5.04, and 5.05 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work, appear in Paragraph 5.06 of the General Conditions.

4.03 Site Visit and Testing by Bidders:

A. Bidder is not required to conduct any subsurface testing, or exhaustive investigations of Site conditions.

B. On request, and to the extent Owner has control over the Site, and schedule permitting, the Owner will provide Bidder access to the Site to conduct such additional examinations, investigations, explorations, tests, and studies as Bidder deems necessary for preparing and submitting a successful Bid. Owner will not have any obligation to grant such access if doing so is not practical because of existing operations, security or safety concerns, or restraints on Owner's authority regarding the Site.

C. Bidder shall comply with all applicable Laws and Regulations regarding excavation and location of utilities, obtain all permits, and comply with all terms and conditions established by Owner or by property owners or other entities controlling the Site with respect to schedule, access, existing operations, security, liability insurance, and applicable safety programs.

D. Bidder shall fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies.

4.04 Owner's Safety Program:

A. Site visits and work at the Site may be governed by an Owner safety program. As the General Conditions indicate, if an Owner safety program exists, it will be noted in the Supplementary Conditions.

4.05 Other Work at the Site:

A. Reference is made to Article 8 of the Supplementary Conditions for the identification of the general nature of other work of which Owner is aware (if any) that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) and relates to the Work contemplated by these Bidding Documents. If Owner is party to a written contract for such other work, then on request, Owner will provide to each Bidder access to examine such contracts (other than portions thereof related to price and other confidential matters), if any.

ARTICLE 5 - BIDDER'S REPRESENTATIONS

5.01 It is the responsibility of each Bidder before submitting a Bid to:

A. Examine and carefully study the Bidding Documents, and any data and reference items identified in the Bidding Documents.

B. Visit the Site, conduct a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfy itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Become familiar with and satisfy itself as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Carefully study all:
   1. Reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings.
   2. Reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawing.

E. Consider the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on:
   1. The cost, progress, and performance of the Work.
   2. The means, methods, techniques, sequences, and procedures of construction to be employed by Bidder.
   3. Bidder's safety precautions and programs.

F. Agree, based on the information and observations referred to in the preceding paragraph, that at the time of submitting its Bid no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

G. Become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

H. Promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder.

I. Determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing of the Work.

J. Agree that the submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article, that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

ARTICLE 6 - PRE-BID CONFERENCE

6.01 A mandatory pre-Bid conference will be held at the time and location stated in the invitation or advertisement to bid. Representatives of Owner and Engineer will be present to discuss the Project. Bidders are required to attend and participate in the conference. Engineer will transmit to all prospective Bidders of record such Addenda as Engineer considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

ARTICLE 7 - INTERPRETATIONS AND ADDENDA

7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to Engineer in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda delivered to all parties recorded as having received the Bidding Documents. Questions received less than 5 days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

7.02 Addenda may be issued to clarify, correct, supplement, or change the Bidding Documents.

ARTICLE 8 - BID SECURITY

8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of 10 percent of Bidder's maximum Bid price (determined by adding the base bid and all alternates) and in the form of a certified check, bank money order, or Document 00432 - Bid Bond issued by a surety meeting the requirements of Paragraphs 6.01 and 6.02 of the General Conditions.

8.02 The Bid security of the apparent Successful Bidder will be retained until Owner awards the contract to such Bidder, and such Bidder has executed the Contract Documents, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid security will be released:

A. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within 15 days after the Notice of Award, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited. Such forfeiture shall be Owner’s exclusive remedy if Bidder defaults.

8.03 The Bid security of other Bidders that Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of seven days after the Effective Date of the Contract or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be released.

8.04 Bid security of other Bidders that Owner believes do not have a reasonable chance of receiving the award will be released within seven days after the Bid opening.

ARTICLE 9 - CONTRACT TIMES

9.01 The number of days within which, or the dates by which, the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

ARTICLE 10 - DELAY DAMAGES

10.01 Provisions for delay damages for failure to timely attain a Milestone, Substantial Completion, or completion of the Work in readiness for final payment, are set forth in Document 00520 - Agreement.

ARTICLE 11 - SUBSTITUTE AND "OR-EQUAL" ITEMS

11.01 The Contract for the Work, as awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration during the bidding and Contract award process of possible substitute or “or-equal” items:

A. In cases in which the Contract allows the Contractor to request that Engineer authorize the use of a substitute or “or-equal” item of material or equipment, application for such acceptance may not be made to and will not be considered by Engineer until after the Effective Date of the Contract.

11.02 In accordance with Section 3400 of the California Public Contract Code, the successful Bidder is permitted a period of 30 days after the award of contract for submission of data substantiating a request for a substitution of an “or equal” item.

11.03 Prices that Bidder sets forth in its Bid shall be based on the presumption that the Contractor will furnish the materials and equipment specified or described in the Bidding Documents, as amended by Addenda:

A. Any assumptions regarding the possibility of post-Bid approvals of “or-equal” or substitution requests are made at Bidder’s sole risk.

ARTICLE 12 - SUBCONTRACTORS, SUPPLIERS, AND OTHERS

12.01 A Bidder shall be prepared to retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of the Work if required by the Bidding Documents (most commonly in the Specifications) to do so. If a prospective Bidder objects to retaining any such Subcontractor, Supplier, or other individual or entity, and the concern is not relieved by an Addendum, then the prospective Bidder should refrain from submitting a Bid.

12.02 Subsequent to the submittal of the Bid, Owner may not require the Successful Bidder or Contractor to retain any Subcontractor, Supplier, or other individual or entity against which Contractor has reasonable objection.

12.03 Pursuant to California Public Contract Code §4106, Document 00434 - Proposed Subcontractors List shall list the Subcontractors or Suppliers proposed who will perform work or labor or render services in an amount in excess of 1/2 of 1 percent of Contractor’s total bid. The apparent Successful Bidder, and any other Bidder pursuant to California Public Contract Code §4104 so requested, shall within twenty-four hours after Bid opening, submit to Owner any additional information requested by Owner in Document 00434 - Proposed Subcontractors Form, other than: 1) the name, 2) the location of the business, 3) the California contractor license number, and 4) the Department of Industrial Relations registration number of each proposed subcontractor. The information in items 1) through 4) above must be set forth on Document 00434 - Proposed Subcontractors List, and attached to Document 00410 - Bid Form.

A. If requested by Owner, such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, or other individual or entity. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit an acceptable substitute, in which case apparent Successful Bidder shall submit a substitute, Bidder’s Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and Owner may consider such price adjustment in evaluating Bids and making the Contract award.

12.04 If apparent Successful Bidder declines to make any such substitution, Owner may award the Contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers, or other individuals or entities. Declining to make requested substitutions will constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which Owner or Engineer makes no written objection prior to the giving of the Notice of Award will be deemed acceptable to Owner and Engineer subject to subsequent revocation of such acceptance as provided in Paragraph 7.06 of the General Conditions.

ARTICLE 13 - PREPARATION OF BID

13.01 Document 00410 - Bid Form is included with the Bidding Documents.

A. Complete each blank on Document 00410 - Bid Form in ink and the Bid Form signed in ink.

B. The person signing the Bid Form must initial in ink erasures or alterations.

C. Indicate Bid Price for each section, Bid item, alternative, adjustment unit price item, and unit price item listed therein.

D. If the Bid Form expressly indicates that submitting pricing on a specific alternate item is optional, and Bidder elects to not furnish pricing for such optional alternate item, then Bidder may enter the words “No Bid” or “Not Applicable.”

13.02 A Bid by a corporation shall be executed in the corporate name by a corporate officer (whose title must appear under the signature), accompanied by evidence of authority to sign. The corporate address and state of incorporation must be shown.

13.03 A Bid by a limited liability company shall be executed in the name of the firm by a member or other authorized person and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm must be shown.

13.04 A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be shown.

13.05 A Bid by an individual shall show the Bidder's name and official address.

13.06 A Bid by a joint venture shall be executed by an authorized representative of each joint venturer in the manner indicated on Document 00410 - Bid Form. The official address of the joint venture shall be shown.

13.07 All names shall be printed in ink below the signatures.

13.08 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on Document 00410 - Bid Form.

13.09 Postal and e-mail addresses and telephone number for communications regarding the Bid shall be shown.

13.10 The Bid shall contain evidence of Bidder's authority and qualification to do business in California, or Bidder shall covenant in writing to obtain such authority and qualification prior to award of the Contract and attach such covenant to the Bid. Bidder's state contractor license number, if any, shall also be shown on Document 00410 - Bid Form. Questions concerning a contractor may be referred to the Registrar, Contractors' State License Board, P.O. Box 26000, Sacramento, CA 95826.

13.11 Pursuant to the provisions of Section 6707, California Labor Code, Bids shall contain, as a Bid item, the cost for adequate sheeting, shoring and bracing, or equivalent method, for the protection of life and limb in trenches and open excavation, which shall conform to applicable safety orders.

13.12 Pursuant to the provisions of Section 7106 of the California Public Contract Code, Bidders shall submit with their Bids, a Non-Collusion Affidavit, Document 00456 - Non-Collusion Affidavit.

13.13 Pursuant to Section 7105, California Public Contract Code, Bidder shall indicate, in the appropriate space provided in Document 00410 - Bid Forms, the cost of insurance premiums for earthquake and tidal wave to indemnify Owner for damage to the Work caused by earthquake or tidal wave in an amount of at least 50 percent of the contract price. The determination of whether to require earthquake and tidal wave insurance will be made by Owner prior to award of contract.

ARTICLE 14 - BASIS OF BID

14.01 Base Bid with Alternates:

A. Bidders shall submit a Bid on a lump sum basis for the base Bid and include a separate price for each alternate described in the Bidding Documents and as provided for in Document 00410 - Bid Form. The price for each alternate will be the amount added to or deleted from the base Bid if Owner selects the alternate.

14.02 Unit Price:

A. Bidders shall submit a Bid on a unit price basis for each item of Work listed in the unit price section of Document 00410 - Bid Form.

B. The "Bid Price" (sometimes referred to as the extended price) for each unit price Bid item will be the product of the "Estimated Quantity" (which Owner or its representative has set forth in the Bid Form) for the item and the corresponding "Bid Unit Price" offered by the Bidder. The total of all unit price Bid items will be the sum of these "Bid Prices"; such total will be used by Owner for Bid comparison purposes. The quantities of work or material stated in unit price items of the Bid are supplied only to give an indication of the general scope of the Work; the Owner does not expressly or by implication agree that the actual amount of work or material will correspond therewith. The final quantities and Contract Price will be determined in accordance with Paragraph 13.03 of the General Conditions.

C. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

14.03 Allowances:

A. For cash allowances the Bid price shall include such amounts as the Bidder deems proper for Contractor's overhead, costs, profit, and other expenses on account of cash allowances, if any, named in the Contract Documents, in accordance with Paragraph 13.02.B of the General Conditions.

14.04 Evaluation of bids containing alternates:

A. In the evaluation of Bids, the lowest Bid shall be the lowest Bid price on the Base Bid without consideration of the Bid Alternates additive or deductive items.

ARTICLE 15 - SUBMITTAL OF BID

15.01 With each copy of the Bidding Documents, a Bidder is furnished one separate unbound copy of the Bid Form, and, if required, the Bid Bond Form. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the other documents required to be submitted under the terms of Article 7 of the Bid Form.

15.02 A Bid shall be received no later than the date and time prescribed and at the place indicated in the Document 00100 – Advertisement for Bids and shall be enclosed in a plainly marked package with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted), the name and address of Bidder, and shall be accompanied by the Bid security and other required documents.

A. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate package plainly marked on the outside with the notation “BID ENCLOSED.” A mailed Bid shall be addressed to City of Turlock Engineering Division, 156 S. Broadway, Suite 150, Turlock, CA 95380.

15.03 Bids received after the date and time prescribed for the opening of bids, or not submitted at the correct location or in the designated manner, will not be accepted and will be returned to the Bidder unopened.

ARTICLE 16 - MODIFICATION AND WITHDRAWAL OF BID

16.01 A Bid may be withdrawn by an appropriate document duly executed in the same manner that a Bid must be executed and delivered to the place where Bids are to be submitted prior to the date and time for the opening of Bids. Upon receipt of such notice, the unopened Bid will be returned to the Bidder.

16.02 If a Bidder wishes to modify its Bid prior to Bid opening, Bidder must withdraw its initial Bid in the manner specified in Paragraph 16.01 and submit a new Bid prior to the date and time for the opening of Bids.

16.03 Unauthorized conditions, limitations, or modifications attached to the Bid will render it informal and may cause its rejection as being non-responsive. The completed Document 00410 - Bid Forms shall be without interlineations, alterations, or erasures. Any changes or corrections shall be initialed by the Bidder. Alternative Bids will not be considered unless expressly called for in Document 00100 - Invitation to Bid. Oral, telegraphic, faxed or telephone Bids or modifications will not be considered.

16.04 In accordance with Sections 5101 and 5103, California Public Contract Code, withdrawal of Bids may be permitted for mistakes made in filling out the Bid but will not be permitted for mistakes resulting from errors in judgment or carelessness in inspecting the site of the work or in reading the drawings, specifications, and other Contracts Documents.

16.05 In the event Bidder alleges that a clerical error has been made in the list of subcontractors, the procedures for substitution shall be provided in accordance with Section 4107.5, California Public Contract Code.

ARTICLE 17 - OPENING OF BIDS

17.01 Bids will be opened at the time and place indicated in Document 00100 - Advertisement for Bids and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the base Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

17.02 The 3 lowest Bidders shall submit within 72 hours of the Bid opening, 1 copy of all documentary information generated in preparation of Bid prices for this Project, pursuant to Document 00823 - Escrow Bid Documents.

ARTICLE 18 - BIDS TO REMAIN SUBJECT TO ACCEPTANCE

18.01 All Bids will remain subject to acceptance for the period of time stated in Document 00410 - Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

ARTICLE 19 - EVALUATION OF BIDS AND AWARD OF CONTRACT

19.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner will reject the Bid of any Bidder that Owner finds, after reasonable inquiry and evaluation, to not be responsible. If Bidder purports to add terms or conditions to its Bid, takes exception to any provision of the Bidding Documents, or attempts to alter the contents of the Contract Documents for purposes of the Bid, then the Owner will reject the Bid as nonresponsive; provided that Owner also reserves the right to waive all minor informalities not involving price, time, or changes in the Work. Owner may also reject the Bid of any Bidder if Owner believes that it would not be in the best interest of the Project to make an award to that Bidder.

19.02 If Owner awards the contract for the Work, such award shall be to the responsible Bidder submitting the lowest responsive Bid.

19.03 More than 1 Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than 1 Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.

19.04 Evaluation of Bids:

A. In evaluating Bids, Owner will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data, as may be requested in Document 00410 - Bid Form or prior to Document 00510 - Notice of Award.

B. For the determination of the apparent low Bidder when unit price bids are submitted, Bids will be compared on the basis of the total of the products of the estimated quantity of each item and unit price Bid for that item, together with any lump sum items.

19.05 In evaluating whether a Bidder is responsible, Owner will consider the qualifications of Bidder and may consider the qualifications and experience of Subcontractors and Suppliers proposed for those portions of the Work for which the identity of Subcontractors and Suppliers must be submitted as provided in the Bidding Documents.

19.06 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders and any proposed Subcontractors or Suppliers.

19.07 If the Contract is to be awarded, Owner will award the Contract to the Bidder whose Bid is in the best interests of the Project.

ARTICLE 20 - BONDS AND INSURANCE

20.01 Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the Agreement (executed by Successful Bidder) to Owner, it shall be accompanied by required bonds and insurance documentation.

ARTICLE 21 - SIGNING OF AGREEMENT

21.01 When Owner issues a Notice of Award to the Successful Bidder, it shall be accompanied by the unexecuted counterparts of the Agreement along with the other Contract Documents as identified in the Agreement. Within 15 days thereafter, Successful Bidder shall execute and deliver the required number of counterparts of the Agreement (and any bonds and insurance documentation required to be delivered by the Contract Documents) to Owner. Within ten days thereafter, Owner shall deliver one fully executed counterpart of the Agreement to Successful Bidder, together with printed and electronic copies of the Contract Documents as stated in Paragraph 2.02 of the General Conditions.

ARTICLE 22 - SALES AND USE TAXES

22.01 Contractor shall pay all sales, use and other taxes as specified in paragraph 6.10 of the General Conditions.

ARTICLE 23 - CONTRACTS TO BE ASSIGNED

Not Used.

ARTICLE 24 - RETAINAGE

24.01 Provisions concerning Contractor's rights to deposit securities in lieu of retainage are set forth in Document 00520 - Agreement.

ARTICLE 25 - PARTNERING

Not Used.

ARTICLE 26 - LAWS AND REGULATIONS

26.01 Prevailing Wage Rates: Pursuant to Section 1770 et seq., California Labor Code, the successful Bidder shall pay not less than the prevailing rate of per diem wages as determined by the Director of California Department of Industrial Relations. A copy of such prevailing rate is on file at the offices of the City Clerk, Turlock, California where copy will be made available for examination during business hours to any party on request.

A. Pursuant to California SB854, Contractor and subcontractor must submit certified payroll records (CPRs) to the Labor Commissioner.

26.02 Contractor's License Classification: In accordance with the provisions of California Business and Professions Code, Section 7028, Owner has determined that Contractor shall possess a valid Class A Contractor License at the time of Bid and for the duration of the contract. Failure to possess the specified license shall render the Bid as non-responsive and shall act as a bar to award of the contract to any Bidder not possessing said license at the time of Bid opening.

26.03 The Contractors' State License Board may be contacted at 9821 Business Park Drive, Sacramento, CA 95827; P.O. Box 26000, Sacramento, CA 95826; (800) 321-2752.

26.04 In accordance with California Civil Code, Section 3247, a payment bond is required.

26.05 In accordance with California Public Contract Code, Section 22300, Contractor may substitute securities in place of retained funds, as provided in Document 0062B - Escrow Agreement for Security Deposits in Lieu of Retention.

ARTICLE 27 - PREVAILING WAGE RATES

27.01 Pursuant to Section 1770 et. seq., California Labor Code, the successful Bidder shall pay not less than the prevailing rate of per diem wages as determined by the Director of California Department of Industrial Relations.

27.02 A copy of such prevailing rate is on file at the Owner's offices:

A. A copy will be made available for examination during business hours to any party on request.

27.03 The project is subject to compliance monitoring and enforcement by the California Department of Industrial Relations.

END OF DOCUMENT

DOCUMENT 00410

BID FORM

ARTICLE 1 - BID RECIPIENT

1.01 Project Identification:

City of Turlock
Development Services Department/Engineering Division
Turlock Regional Water Quality Control Facility
Secondary Clarifier No. 5 and Denitrification Project
City of Turlock Project No. 15-39C

1.02 This Bid is submitted to:

City of Turlock
Development Services Department/Engineering Division
156 South Broadway, Suite 150
Turlock, CA 95380 - 5454

1.03 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents within the specified time and for the price indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 - BIDDER'S ACKNOWLEDGMENT

2.01 Bidder accepts all of the terms and conditions of Document 00200 - Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. The Bid will remain subject to acceptance for 90 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

ARTICLE 3 - BIDDER'S REPRESENTATIONS

3.01 In submitting this Bid, Bidder represents that:

A. Bidder has examined and carefully studied the Bidding Documents, and any data and reference items identified in the Bidding Documents, and hereby acknowledges receipt of the following Addenda:

Addendum No.	Addendum Date
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

B. Bidder has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and satisfied itself as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Bidder is familiar with and has satisfied itself as to all Federal, state, and local Laws and Regulations and Permits that may affect cost, progress, and performance of the Work.

D. Bidder has carefully studied all:
   1. reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings.
   2. reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings.

E. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and any Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on:
   1. The cost, progress, and performance of the Work.
   2. The means, methods, techniques, sequences, and procedures of construction to be employed by Bidder.
   3. Bidder's safety precautions and programs.

F. Bidder agrees, based on the information and observations referred to in the preceding paragraph, that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

G. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

H. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and confirms that the written resolution thereof by Engineer is acceptable to Bidder.

I. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance and furnishing the Work required by the Bidding Documents.

J. In accordance with Section 1861, California Labor Code, the Bidder states the following as its certification.

K. "I am aware of the provisions of Section 3700 of the California Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the Work."

ARTICLE 4 - BIDDER'S CERTIFICATION

4.01 Bidder further represents:

A. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation.

B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham bid.

C. Bidder has not solicited or induced any individual or entity to refrain from bidding.

D. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this paragraph:
   1. "Corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process.
   2. "Fraudulent practice" means an intentional misrepresentation of facts made:
      a. to influence the bidding process to the Owner's detriment,
      b. to establish bid prices at artificial non-competitive levels, or
      c. to deprive Owner of the benefits of free and competitive bidding process.
   3. "Collusive practice" means a scheme or arrangement between two or more Bidders with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels.
   4. "Coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.
   5. Pursuant to California Public Contract Code Section 7103.5(b), Contractor or Subcontractor shall offer and agree to assign to the awarding body all rights, title, and interest in and to all causes of action it may have under Section 4 of the Clayton Act (15 U.S.C. Sec. 15) or under the Cartwright Act (Chapter 2 (commencing with Section 16700) of Part 2 of Division 7 of the Business and Professions Code).

ARTICLE 5 - ASSIGNMENTS AND ALLOWANCES

5.01 No assignments are used on this project.

5.02 Bidder shall provide the Owner with an allowance for work associated with locating unanticipated existing underground utilities and yard piping of $25,000. The Owner, at Owner's option, will use this allowance for locating unanticipated existing underground utilities and yard piping. The Contractor will submit the appropriate invoices to the Owner with pay requests. The $25,000 allowance shall be included in the Lump Sum Bid in addition to the cost of the Work in accordance with Section 01210 - Allowances of the General Requirements.

ARTICLE 6 - BASIS OF BID

6.01 Bidder will complete the Work in accordance with the Contract Documents for the Lump Sum Bid Price of:

BASE BID		
Item Number	Lump Sum Item Description	Lump Sum Amount
1	Sheeting, shoring, and bracing, or equivalent method for protection of life and limb in trenches and open excavations.	$ (In figures)
2	Preparation and submittal of a written geotechnical report as specified in Section 02260, including field investigations, soil sampling, laboratory testing, and interpretation of the data by a register geotechnical engineer in the State of California for the purpose of shoring design, dewatering and other temporary facilities.	$ (In figures)
3	RTU and SCADA work performed by HSQ Technology described by HSQ Quote No. 1610-0019-SC-B dated April 18, 2017 attached to Section 17050.	$ 360,170
4	Bid allowances for locating unanticipated existing underground utilities and yard piping.	$ 25,000
5	Completion of all Work associated with the Contract Documents excluding all work listed on other bid items in this table.	$ (In figures)
	TOTAL LUMP SUM BID PRICE (BID ITEMS 1 - 5) (In words)	$ (In figures)

6.02 Bid Alternatives

A. Bidder offers to make, at the bid alternate prices following, the changes in the Work covered by the Lump Sum Bid Price that are specified in the bid alternates priced below.

B. It is understood that:
   1. All bid alternate prices must be filled in.
   2. The acceptance or rejection of any or all of these bid alternates is at the option of Owner.
   3. Acceptance or rejection of bid alternates will not necessarily be made on the basis of price alone.
   4. The acceptance or rejection of one or more bid alternates will not affect the Lump Sum Bid Price, nor other conditions of this Bid, nor the price of other accepted bid alternates.
   5. The addition or deduction shown herein for each bid alternate is the net addition or net deduction that is to be applied to the Lump Sum Bid Price of the undersigned if the bid alternate is accepted by Owner.
   6. The Contract Price shall be the net amount determined by applying the bid alternate prices of all accepted bid alternates to the Lump Sum Bid Price.

C. Bid Alternate A (add): Bidder agrees to add to the total Lump Sum Bid Price the amount shown below for insurance coverage in the amount of fifty (50) percent of the Lump Sum Bid Price against the risk of tidal wave and earthquake of any magnitude, deemed an act of God as provided in Section 7104 of California Public Contract Code:

$ (in figures) _____

dollars (in words) _____

D. Bid Alternate B (deduct): Bidder agrees to deduct from the total Lump Sum Bid Price the amount shown below if the Owner chooses to allow excess screened and segregated soils to be stockpiled on the project site as described in Section 02300:

$ (in figures) _____

dollars (in words) _____

ARTICLE 7 - TIME OF COMPLETION

7.01 Bidder agrees that the Work will be substantially completed, and, completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before the dates or within the number of calendar days as specified in Document 00520 - Agreement.

7.02 Bidder accepts the provisions of the Agreement as to delay damages in the event of failure to complete the Work within the times specified above, which shall be as specified in Document 00520 - Agreement.

ARTICLE 8 - ATTACHMENTS TO THIS BID

8.01 The following documents are attached to and made a condition of this Bid:

A. Document 00432 - Bid Bond. Provide required Bid security in the form of cash, a certified or bank check, or a Bid Bond as specified in this document.

B. Document 00434 - Proposed Subcontractors Form.

C. Document 00436 - List of Equipment Manufacturers.

D. Document 00451A - Construction Contractor's Qualification Statement with supporting data.

E. Document 00452 - Affirmative Action Program Certificate.

F. Document 00456 - Non-Collusion Affidavit.

G. Document 00458 - Certification of Drug-Free Workplace Requirements.

ARTICLE 9 - DEFINED TERMS

9.01 The terms used in this Bid with initial capital letters or all capital letters have the meanings as specified in Document 00200 - Instructions to Bidders, General Conditions, and Supplementary Conditions.

ARTICLE 10 - BID SUBMITTAL

SUBMITTED on _____, 2017.

State Contractor License Number _____. (If applicable)

If Bidder is:

An Individual

Name (typed or printed): _____

By: _____
(Individual's signature)

Doing business as: _____

Business address: _____

Phone Number: (___)_____ FAX Number: (___)_____

A Partnership

Partnership Name: _____

By: _____
(Signature of general partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Business address: _____

Phone Number: (___)_____ FAX Number: (___)_____

A Corporation

Corporation Name: _____

State of Incorporation: _____

Type (General Business, Professional, Service, Limited Liability):_____

By: _____
(Signature -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Attest: _____
(Signature of Corporate Secretary, Acting Secretary or other officer)

Business address: _____

Phone Number: (___)_____ FAX Number: (___)_____

Date of Qualification to do business is _____

A Joint Venture

Joint Venturer Name: _____

By: _____
(Signature of joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

Phone Number: (___)_____ FAX Number: (___)_____

Joint Venturer Name: _____

By: _____
(Signature of joint venture partner -- attach evidence of authority to sign)

Name (typed or printed): _____

Title: _____

Business address: _____

Phone Number: (___)_____ FAX Number: (___)_____

Phone and FAX Number, and Address for receipt of official communications:

_____

(Each joint venturer must sign. The manner of signing for each individual, partnership, and corporation that is a party to the joint venture should be in the manner indicated above.)

END OF DOCUMENT

DOCUMENT 00432

BID BOND

PENAL SUM FORM

Any singular reference to Bidder, Surety, Owner, or other party shall be considered plural where applicable.

BIDDER *(Name and Address)*:

_____

_____

_____

SURETY *(Name and Address of Principal Place of Business)*:

_____

_____

_____

OWNER *(Name and Address)*:

_____

_____

_____

BID

Bid Due Date:_____

Description *(Project Name and Include Location)*:

_____

_____

_____

BOND

Bond Number:_____

Date: *(Not earlier than Bid Due Date)*:_____

Penal Sum: $_____

(Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Bid Bond to be duly executed by an authorized officer, agent, or representative.

BIDDER	SURETY
_____ (Bidder's Name)	_____ (SEAL) (Surety's Name and Corporate Seal)
By: _____ Signature	By: _____ Signature (Attach Power of Attorney)
_____ Print Name	_____ Print Name
_____ Title	_____ Title
Attest: _____ Signature	Attest: _____ Signature
_____ Title	_____ Title

Note: Above addresses are to be used for giving required notice. Provide execution by any additional parties, such as joint venturers, if necessary.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to pay to Owner upon default of Bidder the penal sum set forth on the face of this Bond. Payment of the penal sum is the extent of Bidder's and Surety's liability. Recovery of such penal sum under the terms of this Bond shall be Owner's sole and exclusive remedy upon default of Bidder.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Procurement Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Procurement Documents and any performance and payment bonds, insurance, and preliminary schedule required by the Procurement Documents.

3. This obligation shall be null and void if:

    a. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Procurement Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Procurement Documents and any performance and payment bonds, insurance, and preliminary schedule required by the Procurement Documents, or

    b. All Bids are rejected by Owner, or

    c. Owner fails to issue a Document 00510 - Notice of Award to Bidder within the time specified in the Procurement Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required).

        1. Surety waives notice of and any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

4. Payment under this Bond will be due and payable upon default of Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

    a. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required is received by Bidder and Surety and in no case later than 1 year after Bid due date.

5. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state in which the Project is located.

6. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

7. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

8. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included in this Document as if set forth at length. If any provision of the Bond conflicts with any applicable provision of any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

9. The term "Bid" as used in this Document includes a Bid, offer, or proposal as applicable.

END OF DOCUMENT

DOCUMENT 00434

PROPOSED SUBCONTRACTORS FORM

Pursuant to California Public Contract Code §4100, the Bidder shall list below the names, location of place of business and California contractor license number of each subcontractor who will perform Work or labor or who will render service to the prime Contractor in or about the construction of the Work or improvement, or a subcontractor duly licensed who, under subcontract to the prime Contractor, specially fabricates and installs a portion of the Work or improvement according to detailed Drawings contained in the Contract Documents, in an amount in excess of 1/2 of 1 percent of the prime Contractor's total Bid or, in the case of Bids or offers for the construction of streets or highways, including bridges, in excess of 1/2 of 1 percent of the prime Contractor's total Bid or $10,000, whichever is greater. After the opening of Bids, no changes or substitutions will be allowed except as otherwise provided by law. The listing of more than one subcontractor for each item of Work to be performed with the words "and/or" will not be permitted. The Bidder's attention is directed to the provisions of paragraph 7.06.B.1 of the Supplementary Conditions, which stipulates the percent of the Work to be performed with the Bidder's own forces. Failure to comply with this requirement may render the Bid as non-responsive and may cause its rejection.

Pursuant to California Labor Code §1725.5, this project is subject to compliance monitoring and enforcement by the Department of Industrial Relations. No contractor or subcontractor may be listed on a bid proposal for a public works project and no contractor or subcontractor may be awarded a contract for public work on a public works project unless registered with the Department of Industrial Relations (DIR). Each bidder is responsible to list their registered information with the DIR in the space below provided and sign below.

Work to be Performed	Percent of Total Contract	Subcontractor's Name, Address, and Contact Person	Contractor License Type/ Number	Contractor License Expiration Date	DIR Registration Number	DIR Classifications to be Employed
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						

The Contractor is responsible to list the information for their proposed Project Manager, responsible for DIR compliance, in the space below provided and sign below.

Contractor Project Manager Name	Title	E-mail address	Work phone number

Add additional sheets, if necessary.

BIDDER

_____

(Signature)

_____

(Date)

END OF DOCUMENT

DOCUMENT 00436

LIST OF EQUIPMENT MANUFACTURERS

ARTICLE 1 - SELECTED MANUFACTURER/SUPPLIER

1.01 Bidder shall circle the manufacturer/supplier that will furnish the respective item of equipment for the Work in the following table.

1.02 Bidder shall circle only one manufacturer or supplier for each piece of equipment identified.

A. If Bidder fails to indicate which manufacturer/supplier their Bid is based on, or circles more than one listed manufacturer/supplier per equipment item, the Bidder shall provide the first listed ("A") manufacturer/supplier for its Bid for the amount included in the Total Bid at no increase in the Contract amount.

ARTICLE 2 - SUBMITTAL REQUIREMENTS

2.01 Acceptance of a manufacturer or supplier listed by the Bidder shall not constitute a waiver of any provision of the Contract Documents.

2.02 Where manufacturer's or supplier's names are listed by the Bidder next to the specific item of equipment listed, this shall be interpreted to mean that such manufacturers and suppliers shall not be changed by the Bidder after the Bid opening, except as follows.

2.03 Failure by Bidder to list names of manufacturers or suppliers for every item of equipment in the space provided may be cause for rejection of the Bid.

2.04 Detailed shop drawings shall be required for equipment as specified in the Contract Documents:

Section	Equipment	Manufacturer/Supplier
11292A	Flap Gates	Waterman Industries Whipps Inc.
11294B	Heavy-Duty Fabricated Stainless Steel Slide Gates	Golden Harvest Waterman Industries Whipps Inc.
11312G	Submersible Large Capacity Centrifugal Pumps	ITT Flygt
11312J	Submersible Process Liquid Sump Pumps	Barnes ITT Goulds Pumps Hydromatic Sulzer

Section	Equipment	Manufacturer/Supplier
11312K	Submersible Medium Capacity Centrifugal Pumps	ITT Flygt
11312P	Submersible Axial Flow Propeller Pumps	ITT Flygt
11317	Submersible Mixers: High Speed	ITT Flygt
11353B	Circular Secondary Clarifier Equipment	Ovivo USA Evoqua Inc. WesTech, Inc. Kuesters Water
11378A	Fine Bubble Diffused Aeration System - Disk	Sanitaire
13443	Electro Hydraulic Actuators	Rexa Inc.
13447	Electric Actuators	Rotork Controls Inc. Limitorque Corporation
16262	Variable Frequency Drives 0.50 - 50 Horsepower	Eaton/Cutler-Hammer Allen-Bradley Toshiba Siemens-Robicon Schneider Electric/Square D General Electric
16444	Low Voltage Motor Control Centers	Eaton/Cutler-Hammer (to match existing)

ARTICLE 3 - PROPOSED SUBSTITUTIONS

3.01 Bidder may propose a manufacturer/supplier substitution for any major piece of equipment specified in this Section:

A. Prices listed in the following tabulation are “installed prices and include any costs associated with changes that may be required to the original design to accommodate the proposed substitution.

3.02 Proposed substitutions do not affect the bid price or bid award.

3.03 Bidder agrees to follow the requirements for formal substitution request requirements as specified in Section 01600 - Product Requirements after bid award.

3.04 If the Engineer determines that the substitute equipment cannot be used, the original Base Bid equipment shall be provided.

3.05 Owner may, at its sole discretion, select items of any of the approved substitutions listed in this Section:

A. Contractor agrees to furnish and install selected approved substitutions for the price indicated in this Section.

B. The Contract price will be adjusted by Change Order.

Section	Equipment	Substituted Manufacturer/Supplier	Add (Deduct) From Base Bid

BIDDER

_____

(Signature)

_____

(Date)

END OF DOCUMENT

DOCUMENT 00451A

CONSTRUCTION CONTRACTOR'S QUALIFICATION STATEMENT FOR ENGINEERED CONSTRUCTION

Issue Date:		**Effective Date:**	
Owner:	City of Turlock	**Owner's Contract No.:**	15-39C
Contractor:			
Project:	Turlock Water Quality Control Facility, SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION PROJECT		
Contract Name:			

Qualifications Statement

THE INFORMATION SUPPLIED IN THIS DOCUMENT IS CONFIDENTIAL TO THE EXTENT PERMITTED BY LAWS AND REGULATIONS

1. FIRM INFORMATION:

Official Name of Firm: _____

Address: _____

2. TYPE OF WORK: _____

3. CONTRACTOR'S CONTACT INFORMATION

Contact Person; _____

Title: _____

Phone: _____

Email:

4. AFFILIATED COMPANIES:

Name: _____

Address: _____

5. TYPE OF ORGANIZATION:

☐ SOLE PROPRIETORSHIP

Name of Owner: _____

Doing Business As: _____

Date of Organization:

Qualifications Statement

☐ PARTNERSHIP

Date of Organization: _____

Type of Partnership: _____

Name of General Partner(s): _____

_____

_____

☐ CORPORATION

State of Organization: _____

Date of Organization: _____

Executive Officers:

President: _____

Vice President(s): _____

_____

_____

Treasurer: _____

Secretary: _____

☐ LIMITED LIABILITY COMPANY

State of Organization: _____

Date of Organization: _____

Members: _____

_____

_____

Qualifications Statement	
☐ JOINT VENTURE	
State of Organization:	_____
Date of Organization:	_____
Form of Organization:	_____
JV Managing Partner:	_____
Name:	_____
Address:	_____
JV Managing Partner:	_____
Name:	_____
Address:	

6. LICENSING:

Jurisdiction:	_____
Type of License:	_____
License Number:	_____
Jurisdiction:	_____
Type of License:	_____
License Number:	

7. CERTIFICATIONS **CERTIFIED BY:**

Disadvantaged Business Enterprise:	_____
Minority Business Enterprise:	_____
Woman Owned Business Enterprise:	_____
Small Business Enterprise:	_____
Other: (_____):	_____

Qualifications Statement

8. BONDING INFORMATION

Bonding Company: _____

Address: _____

Bonding Agent: _____

Address: _____

Contact Name: _____

Phone: _____

Aggregate Bonding Capacity: _____

Available Bonding Capacity as of date of this submittal: _____

9. FINANCIAL INFORMATION

Financial Institution: _____

Address: _____

Account Manager: _____

Phone: _____

INCLUDE AS AN ATTACHMENT AN AUDITED BALANCE SHEET FOR EACH OF THE LAST 3 YEARS.

10. CONSTRUCTION EXPERIENCE

Current Experience:

List on a **Schedule A** all uncompleted projects currently under contract (If Joint Venture, list each participant's projects separately).

Bidder authorizes Owner's representative to verify any and all information contained in the Qualification Statement from references contained herein and hereby releases all those concerned providing information as a reference from any liability in connection with any information they give.

Qualifications Statement

Previous Experience:

List on **Schedule B** all projects completed within the last 5 years (If Joint Venture, list each participant's projects separately).

Bidder authorizes Owner's representative to verify any and all information contained in the Qualification Statement from references contained herein and hereby releases all those concerned providing information as a reference from any liability in connection with any information they give.

Key Personnel:

List on **Schedule C** qualifications and experience of Bidder's key personnel who will be directly involved in this project (If Joint Venture, list each participant's projects separately).

Bidder authorizes Owner's representative to verify any and all information contained in the Qualification Statement from references contained herein and hereby releases all those concerned providing information as a reference from any liability in connection with any information they give.

Has firm listed in Section 1 ever failed to complete a construction contract awarded to it?

☐ Yes ☐ No

If YES, attach as an Attachment details including Project Owner's contact information.

Has any Corporate Officer, Partner, Joint Venture participant or Proprietor ever failed to complete a construction contract awarded to them in their name or when acting as a principal of another entity?

☐ Yes ☐ No

If YES, attach as an Attachment details including Project Owner's contact information.

Are there any judgments, claims, disputes or litigation pending or outstanding involving the firm listed in Section 1 or any of its officers (or any of its partners if a partnership or any of the individual entities if a joint venture)?

☐ Yes ☐ No

If YES, attach as an Attachment details including Project Owner's contact information.

11. SAFETY PROGRAM

Name of Contractor's Safety Officer: _____

Include the following as attachments:

Provide as an Attachment Contractor's (and Contractor's proposed Subcontractors and Suppliers furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) OSHA No. 300- Log of Work-Related Injuries and Illnesses for the past 5 years.

Provide as an Attachment Contractor's (and Contractor's proposed Subcontractors and Suppliers furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) list of all OSHA Citations & Notifications of Penalty (monetary or other) received within the last 5 years (indicate disposition as applicable) - IF NONE SO STATE.

Provide as an Attachment Contractor's (and Contractor's proposed Subcontractors and Suppliers furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) list of all safety citations or violations under any state all received within the last 5 years (indicate disposition as applicable) - IF NONE SO STATE.

Qualifications Statement

Provide the following for the firm listed in Section V (and for each proposed Subcontractor furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) the following (attach additional sheets as necessary):

Workers' compensation Experience Modification Rate (EMR) for the last 5 years:

Year	_____	EMR	_____
Year	_____	EMR	_____
Year	_____	EMR	_____
Year	_____	EMR	_____
Year	_____	EMR	_____

Total Recordable Frequency Rate (TRFR) for the last 5 years.

Year	_____	TRFR	_____
Year	_____	TRFR	_____
Year	_____	TRFR	_____
Year	_____	TRFR	_____
Year	_____	TRFR	_____

Total number of man hours worked for the last 5 years.

Year	_____	TOTAL NUMBER OF MAN HOURS	_____
Year	_____	TOTAL NUMBER OF MAN HOURS	_____
Year	_____	TOTAL NUMBER OF MAN HOURS	_____
Year	_____	TOTAL NUMBER OF MAN HOURS	_____

Provide Contractor's (and Contractor's proposed Subcontractors and Suppliers furnishing or performing Work having a value in excess of 10 percent of the total amount of the Bid) Days Away From Work, Days of Restricted Work Activity or Job Transfer (DART) incidence rate for the particular industry or type of Work to be performed by Contractor and each of Contractor's proposed Subcontractors and Suppliers) for the last 5 years:

Year	_____	DART	_____
Year	_____	DART	_____
Year	_____	DART	_____
Year	_____	DART	_____

12. EQUIPMENT:

MAJOR EQUIPMENT

List on **Schedule D** all pieces of major equipment available for use on Owner's Project.

Qualifications Statement

I HEREBY CERTIFY THAT THE INFORMATION SUBMITTED HEREWITH, INCLUDING ANY ATTACHMENTS, IS TRUE TO THE BEST OF MY KNOWLEDGE AND BELIEF.

NAME OF ORGANIZATION: _____

BY: _____

TITLE: _____

DATED: _____

NOTARY ATTEST:

SUBSCRIBED AND SWORN TO BEFORE ME:

THIS _____ DAY OF _____ , 20

NOTARY PUBLIC – STATE OF _____

MY COMMISSION EXPIRES: _____

REQUIRED ATTACHMENTS

1. Schedule A (Current Experience).
2. Schedule B (Previous Experience).
3. Schedule C (Major Equipment).
4. Audited balance sheet for each of the last 3 years for firm named in Section 1.
5. Evidence of authority for individuals listed in Section 5 to bind organization to an agreement.
6. Resumes of officers and key individuals (including Safety Officer) of firm named in Section 1.
7. Required safety program submittals listed in Section 11.
8. Additional items as pertinent.

SCHEDULE A CURRENT EXPERIENCE (UNCOMPLETED PROJECTS)

Project Name	Owner's Contact Person	Design Engineer	Contract Dates	Type of Work	Status	Cost of Work	Liquidated Damages (yes/no)
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				

SCHEDULE B PREVIOUS EXPERIENCE (Include ALL Projects Completed Within Last 5 Years)							
Project Name	**Owner's Contact Person**	**Design Engineer**	**Contract Dates**	**Type of Work**	**Status**	**Cost of Work**	**Liquidated Damages (yes/no)**
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				

SCHEDULE B PREVIOUS EXPERIENCE (Include ALL Projects Completed Within Last 5 Years)							
Project Name	**Owner's Contact Person**	**Design Engineer**	**Contract Dates**	**Type of Work**	**Status**	**Cost of Work**	**Liquidated Damages (yes/no)**
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				
	Name: Address: Phone:	Name: Address: Phone:	Start: Stop:				

SCHEDULE C – PROJECT KEY PERSONNEL				
NAME	**POSITION**	**NUMBER OF YEARS OF CONSTRUCTION EXPERIENCE ON SIMILAR CONSTRUCTION PROJECTS**	**DATE STARTED WITH THIS ORGANIZATION**	**EXPERIENCE ON SIMILAR CONSTRUCTION PROJECTS (Name the projects)**
	Project Manager			
	Project Superintendent			
	Quality Control Manager			
	Scheduler			

SCHEDULE D – LIST OF MAJOR EQUIPMENT AVAILABLE			
ITEM	**PURCHASE DATE**	**CONDITION**	**ACQUIRED VALUE**

DOCUMENT 00452

AFFIRMATIVE ACTION PROGRAM CERTIFICATE

The Bidder hereby certifies that Bidder is in compliance with the Civil Rights Act of 1964, Executive Order No. 11246, and all other applicable Federal and State laws and regulations relating to equal opportunity employment.

BIDDER

_____
(Signature)

_____
(Date)

Bidder's Name: _____

Address: _____

_____

_____

(The above certification of the Bidder regarding its affirmative action program shall be filled out completely, signed, and submitted by each Bidder and shall be a part of the Contract Documents.)

END OF DOCUMENT

DOCUMENT 00456

NON-COLLUSION AFFIDAVIT

State of California)
ss.
County of_____)

The undersigned declares that this Bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the Bid is genuine and not collusive or sham; that the Bidder has not directly or indirectly induced or solicited any other Bidder to put in a false or sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any Bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the Bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the Bidder or any other Bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other Bidder, or to secure any advantage against the public body awarding the contract of anyone interested in the proposed contract; that all statements contained in the Bid are true; and, further, that the Bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or data relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid.

Any person executing this declaration on behalf of a Bidder that is a corporation, partnership, joint venture, limited liability company, limited liability partnership, or any other entity herby represents that they have full power to execute, and does execute, this declaration on behalf of the Bidder.

I declare under penalty of perjury under state laws that the foregoing is true and correct.

BIDDER

_____
(Signature)

_____
(Date)

Subscribed and sworn to before me on _____(date) at _____(location).

_____ (seal)
(Signature of Notary Public)

END OF DOCUMENT

DOCUMENT 00458

CERTIFICATION OF DRUG-FREE WORKPLACE REQUIREMENTS

ARTICLE 1 - BIDDER CERTIFICATIONS

1.01 The Bidder certifies that it will or will continue to provide a drug-free work place by:

A. Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the Bidder's work place and specifying the actions that will be taken against employees for violation of such prohibition:
   1. Making it a requirement that each employee to be engaged in the performance of the contract be given a copy of the statement.
   2. Notifying the employee in the statement that, as a condition of employment under the Contract, the employee will:
      a. Abide by the terms of the statement.
      b. Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the work place no later than 5 calendar days after such conviction:
         1) Notifying the Owner in writing within 10 calendar days after receiving notice from an employee or otherwise receiving actual notice of such conviction.
         2) Taking 1 of the following actions, within 30 calendar days of receiving notice, with respect to any employee who is so convicted:
            a) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of Federal and State law.
            b) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purpose by a Federal, State or local health, law enforcement, or other appropriate agency.
      c. Notify the employee that in the event of a major accident/incident resulting in loss of life, injury or damage to the facility, or equipment, all personnel involved shall be required to submit to substance testing as soon as possible after the incident, but not more than 4 hours after the incident.

B. Establishing an ongoing drug-free awareness program to inform employees about:
   1. The dangers of drug abuse in the work place.
   2. The Bidder's policy of maintaining a drug-free work place.
   3. Any available drug counseling, rehabilitation, and employee assistance programs.
   4. The penalties that may be imposed upon employees for drug abuse violations occurring in the work place.

C. Making a good faith effort to continue to maintain a drug-free work place through implementation of the requirements stated in this Document.

ARTICLE 2 - WORK LOCATIONS

2.01 The Bidder may insert in the space provided below the site(s) for the performance of work done in connection with this Contract:

A. Place(s) of Performance: (Street address, city, county, state, zip code):

_____

_____

_____

BIDDER

_____
(Signature)

_____
(Date)

END OF DOCUMENT

SECTION 00510

NOTICE OF AWARD

YOLANDA A. GARDINI
SENIOR SECRETARY
ygardini@turlock.ca.us

DEVELOPMENT SERVICES DEPARTMENT
ENGINEERING DIVISION
209-668-5520

156 S. BROADWAY, SUITE 150| TURLOCK, CALIFORNIA 95380 | PHONE 209-668-6033| FAX 209-668-5563| TDD 1-800-735-2929

Date_____, 2017

To:_____

Address:_____
_____

Project: Regional Water Quality Control Facility Secondary Clarifier No. 5 and Denitrification

Project No.: 15-39

RE: Notice of Award

The City of Turlock is pleased to notify you that the City Manager has been authorized by the City Council on _____ to enter into an agreement with your company for a contract amount of $_____.

Enclosed please see the Agreements for signatures to be signed in blue ink. Please return all three (3) agreements with required insurance documentation, their endorsements, and your W-9 to City of Turlock, Engineering Division, 156 S. Broadway, Suite 150, Turlock, CA 95380. The City Attorney approves all required insurance documents. I will let you know if there is anything missing. A completely executed document will be returned for your records.

If you have any questions please call our office at (209) 668-6033 and ask for Yolanda Gardini. I would like to thank you in advance for expediting the return of these agreements.

Sincerely,

Yolanda A. Gardini
Senior Secretary

Enclosures
Agreements (3 copies)

DOCUMENT 00520

AGREEMENT

THIS AGREEMENT is by and between City of Turlock (Owner) and_____(Contractor). Owner and Contractor hereby agree as follows:

ARTICLE 1 - WORK

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents for completion of the Project.

ARTICLE 2 - THE PROJECT

2.01 The Project, of which the Work under the Contract Documents is a part, is generally described as follows:

1. Secondary Clarifier No. 5.
2. RAS Pump Station No. 2.
3. Mixed Liquor Flume Nos. 5 and 6.
4. Modifications to Aeration Basin Nos. 1 - 7.
5. Modifications to Junction Box No. 1A.
6. Modifications to Biotower Crane.
7. Modifications to Electrical Building No. 7.
8. Additions and modifications to yard piping system.
9. Additions and modifications to electrical system.
10. Additions and modifications to instrumentation systems.
11. Additions and modifications to grading, paving, and drainage systems.
12. Repair and reconstruction to existing facilities affected by the work and all work necessary to render the facility complete and operational.

ARTICLE 3 - ENGINEER

3.01 The Project has been designed by Carollo Engineers, Inc. ("Design Engineer").

3.02 The Owner will retain a construction manager ("Construction Manager" or "CM") to act as Owner's representative.

3.03 The term "Engineer shall refer to either the Construction Manager or Design Engineer based on their roles as defined in Section 00800, SUPPLEMENTARY CONDITIONS, and their separate contracts with the Owner.

ARTICLE 4 - CONTRACT TIMES

4.01 Time of the essence:

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 Contract Times: Days:

A. The Work will be substantially completed within 660 calendar days after the date when the Contract Times commence to run as provided in paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with paragraph 15.06 of the General Conditions within 690 calendar days after the date when the Contract Times commence to run.

B. Parts of the Work shall be substantially completed on or before the following Milestones:
   1. Milestone 1: Within 420 calendar days after the date when Contract times commence to run.

4.03 Delay damages:

A. Contractor and Owner recognize that time is of the essence as stated above and that Owner will suffer financial and other losses if the Work is not completed and Milestones not achieved within the times specified in Paragraph 4.02 above, plus any extensions thereof allowed in accordance with the Contract. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as damages for delay (but not as a penalty):
   1. Substantial Completion: Contractor shall pay Owner $5,000 for each day that expires after the time (as duly adjusted pursuant to the Contract) specified in this Agreement for Substantial Completion until the Work is substantially complete.
   2. Completion of Remaining Work: After substantial completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Time (as duly adjusted pursuant to the Contract) for completion and readiness for final payment, Contractor shall pay Owner $1,500 for each day that expires after such time until the Work is completed and ready for final payment.
   3. Delay damages for failing to timely attain Substantial Completion and final completion are not additive and will not be imposed concurrently.
   4. Milestones: Contractor shall pay Owner $5,000 for each day that expires after the time (as duly adjusted to the Contract) specified above for achievement of Milestones, until that Milestone is achieved.

4.04 Special Damages:

A. In addition to the amount provided for liquidated damages, Contractor shall reimburse Owner:
   1. for any fines or penalties imposed on Owner as a direct result of the Contractor's failure to attain Substantial Completion according to the Contract Times, and
   2. for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time

specified in this Agreement for Substantial Completion (as duly adjusted pursuant to the Contract), until the Work is substantially complete.

B. After Contractor achieves Substantial Completion, if Contractor shall neglect, refuse, or fail to complete the remaining Work within the Contract Times, Contractor shall reimburse Owner for the actual costs reasonably incurred by Owner for engineering, construction observation, inspection, and administrative services needed after the time specified in this Agreement for Work to be completed and ready for final payment (as duly adjusted pursuant to the Contract), until the Work is completed and ready for final payment.

ARTICLE 5 - CONTRACT PRICE

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents the amounts that follow, subject to adjustment under the Contract:

A. For all Work, a lump sum of:

$ _____

_____ _____

(in words) **(figure)**

1. All specific cash allowances are included in the above price and have been computed in accordance with paragraph 13.02 of the General Conditions.

B. For all Work, at the prices stated by Contractor's Bid, Document 00410 - Bid Form is attached hereto as an exhibit.

ARTICLE 6 - PAYMENT PROCEDURES

6.01 Submittal and processing of payments:

A. Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.02 Progress payments; retainage:

A. Pursuant to Section 20104.50 of California Public Contract Code, Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment within 30 days after receipt during performance of the Work as provided in paragraphs below, provided that such Applications for Payment have been submitted in a timely manner and otherwise meet the requirements of the Contract. All such payments will be measured by the Schedule of Values established as provided in the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided elsewhere in the Contract:

1. Pursuant to Section 22300 of California Public Contract Code, Contractor has the option to deposit securities with an Escrow Agent as a substitute for retention of

earnings required to be withheld by Owner. For Escrow Agreement see Document 00602B Agreement §2230.

2. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Owner may withhold, including but not limited to delay damages, in accordance with the Contract:
   a. 95 percent of Work completed (with the balance being retainage), pursuant to California Public Contract Code §7201. Release of all retention withheld shall occur within thirty five (35) to sixty (60) days after the Notice of Completion has been recorded in compliance with the Code of Civil Procedure of the State of California.

6.03 Final Payment:

A. Upon final completion and acceptance of the Work, in accordance with paragraph 15.06 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer.

ARTICLE 7 - INTEREST

7.01 All amounts not paid when due shall bear interest at the legal rate unless otherwise specified according to California law.

ARTICLE 8 - CONTRACTOR'S REPRESENTATIONS

8.01 In order to induce Owner to enter into this Agreement, Contractor makes the following representations:

A. Contractor has examined and carefully studied the Contract Documents and any data and reference items identified in the Bidding Documents.

B. Contractor has visited the Site, conducted a thorough, alert visual examination of the Site and adjacent areas, and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Contractor has carefully studied all:
   1. Reports of explorations and tests of subsurface conditions at or adjacent to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at the Site that have been identified in the Supplementary Conditions, especially with respect to Technical Data in such reports and drawings, and
   2. Reports and drawings relating to Hazardous Environmental Condition, if any, at or adjacent to the Site which has been identified in the Supplementary Conditions especially with respect to Technical Data in such reports and drawings.

E. Contractor has considered the information known to Contractor itself; information commonly known to contractors doing business in the locality of the Site; information

and observations obtained from visits to the Site; the Contract Documents; and the Site-related reports and drawings identified in the Contract Documents, with respect to the effect of such information, observations, and documents on:

1. The cost, progress, and performance of the Work.
2. The means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and
3. Contractor's safety precautions and programs.

F. Based on the information and observations referred to in the preceding paragraph, Contractor agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.

G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

H. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

I. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

J. Contractor's entry into this Contract constitutes an incontrovertible representation by Contractor that without exception, all prices in the Agreement are premised upon performing and furnishing the Work required by the Contract Documents.

ARTICLE 9 - CONTRACT DOCUMENTS

9.01 Contents:

A. The Contract Documents consist of the following:

1. Document 00100 - Advertisement for Bids.
2. Document 00200 - Instructions to Bidders.
3. Document 00520 - Agreement.
4. Document 00612 - Performance Bond.
5. Document 00614 - Payment Bond.
6. Document 00700 - General Conditions.
7. Document 00800 - Supplementary Conditions.
8. Specifications as listed in the table of contents of the Project Manual.
9. Drawings as listed on the sheet index.
10. Addenda (numbers ____ to ____, inclusive).
11. City Standard Drawings and Specifications.

12. Exhibits to this Agreement (enumerated as follows):
    a. Document 00410 - Bid Form completed by the Contractor.
    b. Document 00451A - Construction Contractor's Qualification Statement For Engineered Construction.
    c. Document 00823 - Escrow Bid Documents.
    d. Conformed Bid.
13. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:
    a. Document 00550 - Notice to Proceed.
    b. Executed change orders.

B. There are no Contract Documents other than those listed in this Document.

C. The Contract Documents may only be amended, modified, or supplemented as provided in paragraph 3.04 of the General Conditions.

ARTICLE 10 - MISCELLANEOUS

10.01 Terms:

A. Terms used in this Agreement will have the meanings indicated in the General Conditions and the Supplementary Conditions.

10.02 Assignment of Contract:

A. No assignment by a party hereto of any rights under or interests in the Contract will be binding on another party hereto without the written consent of the party sought to be bound; and, specifically but without limitation, money that may become due and money that is due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

10.03 Successors and Assigns:

A. Owner and Contractor each binds itself, its successors, assigns, and legal representatives to the other party hereto, its successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

10.04 Severability:

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

10.05 Procurement contract(s):

None.

10.06 Contractor's Certifications:

A. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract:
   1. "Corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in the Contract execution;
   2. "Fraudulent practice" means an intentional misrepresentation of facts made:
      a. To influence the bidding process or the execution of the Contract to the detriment of Owner.
      b. To establish Bid or Contract prices at artificial non-competitive levels.
      c. To deprive Owner of the benefits of free and open competition.
   3. "Collusive practice" means a scheme or arrangement between 2 or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, non-competitive levels.
   4. "Coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

10.07 In accordance with Section 1775, California Labor Code, Contractor shall forfeit to Owner, as a penalty, not more than $50 for each calendar day, or portion thereof, for each worker paid, either by Contractor or any subcontractor, less than the prevailing rates as determined by the Director of California Department of Industrial Relations for the Work.

10.08 In the performance of the Work, a day's work shall be 8 hours of labor in any workday and 40 hours in any work week and any other work as required by Section 510, California Labor Code, and Contractor shall further conform to the requirements of Section 1813, California Labor Code, or forfeit to Owner, as a penalty, the sum of $25 for each worker employed in the execution of the Work by Contractor or any subcontractor, for each day during which any worker is required or permitted to labor more than 8 hours in any workday or more than 40 hours in any 1 calendar week in violation of Section 510.

10.09 Contractor shall carry workers' compensation insurance and require subcontractors to carry workers' compensation insurance as required by Section 3700, California Labor Code.

10.10 Pursuant to California Labor Code Section 6705, excavation of any trench or trenches 5 feet or more in depth, involving estimated expenditures in excess of $25,000 shall require, in advance of excavation, a detailed plan showing the design of shoring, bracing, sloping or other provisions to be made for worker protection prepared by a registered civil or structural engineer.

10.11 Contractor registration:

A. Project is subject to compliance monitoring and enforcement by the California Department of Industrial Relations (DIR).

10.12 Pursuant to Section 1770 et seq., California Labor Code, the successful Bidder shall pay not less than the prevailing rate of per diem wages as determined by the Director of California Department of Industrial Relations. A copy of such prevailing rate is on file at the offices of the City of Turlock, California which copy will be made available for examination during business hours to any party on request.

10.13 Contractor, by signing this Agreement, certifies the following: "I am aware of the provisions of Section 3700 of the Labor Code which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the Work of this Contract."

10.14 Nothing in this Agreement shall prevent Contractor or any Subcontractor from employing properly registered apprentices in the execution of the Agreement. Contractor shall have responsibility for compliance with California Labor Code Section 1777.5 for all apprenticeable occupations.

10.15 Other Provisions:

A. Owner stipulates that if the General Conditions that are made a part of this Contract are based on EJCDC® C-700, Standard General Conditions for the Construction Contract, published by the Engineers Joint Contract Documents Committee®, and if Owner is the party that has furnished said General Conditions, then Owner has plainly shown all modifications to the standard wording of such published document to the Contractor, in the Supplementary Conditions.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement in duplicate. One counterpart each has been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or identified by Owner and Contractor or on their behalf.

This Agreement will be effective on _____, 2017 (which is the Effective Date of the Agreement).

CONTRACTOR:

By: _____

_____
Print Name

Address: _____

_____

_____

Phone: _____

Date: _____

Federal Tax ID or Social Security No.

_____

(Attach Contractor Seal Here)

OWNER:
CITY OF TURLOCK, a municipal corporation

By: _____
Gary Soiseth, Mayor

or

By: _____
Gary Hampton, City Manager

Date: _____

APPROVED AS TO SUFFICIENCY:

By: _____
Michael G. Pitcock, Development Services Director / City Engineer

APPROVED AS TO FORM:

By: _____
Phaedra A. Norton, City Attorney

ATTEST:

By: _____
Jennifer Land, City Clerk

END OF DOCUMENT

DOCUMENT 00550

NOTICE TO PROCEED

To: _____

Project: Turlock Regional Water Quality Control Facility Secondary Clarifier No. 5 and Denitrification Project

Procurement Contract Number: 15-39C

Amount of Contract: _____

You are hereby notified to commence work on the referenced Contract on or before _____, 2017, and shall complete all of the work of said Contract within _____ consecutive calendar days thereafter. Your final completion date is therefore _____, 2017.

Document 00520 - Agreement Forms, provides for an assessment of delay damages for each consecutive calendar day after the date for final acceptance as indicated in the Procurement Documents.

Owner

_____
(Signature)

_____
(Date)

ACCEPTANCE OF NOTICE

Receipt of the foregoing Notice to Proceed is hereby acknowledged by this _____day of _____, 2017.

_____
(Signature)

_____
(Date)

END OF DOCUMENT

DOCUMENT 00602B

ESCROW AGREEMENT FOR
SECURITY DEPOSITS IN LIEU OF RETENTION - CALIFORNIA,
PUBLIC CONTRACT CODE §22300

This escrow agreement is made and entered into by and between _____ whose address is _____ hereinafter called "Owner," _____ whose address is _____ hereinafter called "Contractor," and _____ _____ whose address is _____ hereinafter called "Escrow Agent."

For the consideration hereinafter set forth, the Owner, Contractor, and Escrow Agent agree as follows:

1. Pursuant to Section 22300 of the Public Contract Code of the State of California, the Contractor has the option to deposit securities with the Escrow Agent as a substitute for retention earnings required to be withheld by the Owner pursuant to the construction contract entered into between the Owner and Contractor for _____ in the amount of _____ dated _____ (hereafter referred to as the "contract"). Alternatively, on written request of the Contractor, the Owner shall make payments of the retention earnings directly to the Escrow Agent. When the Contractor deposits the securities as a substitute for the contract earnings, the Escrow Agent shall notify the Owner within ten days of the deposit. The market value of the securities at the time of the substitution shall be at least equal to the cash amount then required to be withheld as retention under the terms of the contract between the Owner and Contractor. Securities shall be held in the name of the _____ and shall designate the Contractor as the beneficial owner.

2. The Owner shall make progress payments to the Contractor for those funds which otherwise would be withheld from progress payments pursuant to the contract provisions, provided that the Escrow Agent holds securities in the form and amount specified above.

3. When the Owner makes payment of retentions earned directly to the Escrow Agent, the Escrow Agent shall hold them for the benefit of the Contractor until such time as the escrow created under this contract is terminated. The Contractor may direct the investment of the payments into securities. All terms and conditions of this Agreement and the rights and responsibilities of the parties shall be equally applicable and binding when the Owner pays the Escrow Agent directly.

4. Contractor shall be responsible for paying all fees for the expenses incurred by the Escrow Agent in administering the escrow account and all expenses of the Owner. These expenses and payment terms shall be determined by the Owner, Contractor, and Escrow Agent.

5. The interest earned on the securities or the money market accounts held in escrow and all interest earned on that interest shall be for the sole account of Contractor and shall be subject to withdrawal by Contractor at any time and from time to time without notice to the Owner.

6. Contractor shall have the right to withdraw all or any part of the principal in the escrow account only by written notice to Escrow Agent accompanied by written authorization from the Owner to the Escrow Agent that the Owner consents to the withdrawal of the amount sought to be withdrawn by Contractor.

7. The Owner shall have a right to draw upon the securities in the event of default by the Contractor. Upon seven days' written notice to the Escrow Agent from the Owner of the default, the Escrow Agent shall immediately convert the securities to cash and shall distribute the cash as instructed by the Owner.

8. Upon receipt of written notification from the Owner certifying that the contract is final and complete, and that the Contractor has complied with all requirements and procedures applicable to the contract, the Escrow Agent shall release to the Contractor all securities and interest on deposit less escrow fees and charges of the escrow account. The escrow shall be closed immediately upon disbursement of all moneys and securities on deposit and payments of fees and charges.

9. Escrow Agent shall rely on the written notifications from the Owner and the Contractor pursuant to Sections (5) to (8), inclusive, of this Agreement and the Owner and Contractor shall hold Escrow Agent harmless from the Escrow Agent's release, and disbursement of the securities and interest as set forth above.

10. The names of the persons who are authorized to give written notice or to receive written notice on behalf of the Owner and on behalf of the Contractor in connection with the foregoing, and exemplars of their respective signatures are as follows:

On behalf of the Owner:	On behalf of the Contractor:
Title	Title
Name	Name
Signature	Signature
Address	Address
On behalf of the Escrow Agent:	
Title	
Name	

Signature

Address

At the time the escrow account is opened, the Owner and Contractor shall deliver to the Escrow Agent a fully executed counterpart of this Agreement.

IN WITNESS WHEREOF, the parties have executed this Agreement by their proper officers on the date first set forth above.

Owner	Contractor
Title	Title
Name	Name
Signature	Signature

END OF DOCUMENT

DOCUMENT 00612

CONTRACTOR (*Name and Address*):

SURETY (*Name and Address of Principal Place of Business*):

OWNER (*Name and Address*):

CONSTRUCTION CONTRACT

Effective Date of Agreement:
Amount:
Description (*Name and Location*):

BOND

Bond Number:
Date (*Not earlier than Effective Date of Agreement)*:
Amount:
Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL	SURETY
_____	_____ (SEAL)
Contractor's Name	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	Attest: _____
Signature	Signature
_____	_____
Title	Title

Notes: (1) Provide execution by any additional parties, such as joint venturers, if necessary.
(2) Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

Whereas, the City Council of the City of Turlock, State of California, and _____ (hereinafter designated as "Principal") have entered into an Agreement whereby Principal agrees to install and complete certain designated public improvements, which said Agreement, dated _____, 2017, and identified as Project No. 15-39C, is hereby referred to and made a part hereof; and

Whereas, said Principal is required under the terms of said Agreement to furnish a bond for the faithful performance of said Agreement.

Now, therefore, we, the Principal and _____, as Surety, are held and firmly bound unto City of Turlock (hereinafter called "City"), in the penal sum of _____ dollars ($____) lawful money of the United States, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, successors, executors and administrators, jointly and severally, firmly by these presents.

The condition of this obligation is such that if the above bounded Principal, his or its heirs, executors, administrators, successors or assigns, shall in all things stand to and abide by, and well and truly keep and perform the covenants, conditions and provisions in the said Agreement and any alteration thereof made as therein provided, on his or their part, to be kept and performed at the time and in the manner therein specified, and in all respects according to their true intent and meaning, and shall indemnify and save harmless _____, its officers, agents, employees, and professional consultants, as therein stipulated, then this obligation shall become null and void; otherwise it shall be and remain in full force and effect.

As a part of the obligation secured hereby and in addition to the face amount specified therefor, there shall be included costs and reasonable expenses and fees, including reasonable attorney's fees, incurred by City in successfully enforcing such obligation, all to be taxed as costs and included in any judgment rendered, including a sum to complete construction according to the Contract Documents.

The Surety hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Agreement or to the Work to be performed thereunder or the Specifications accompanying the same shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the Agreement or to the Work or to the Specifications.

In witness whereof, this instrument has been duly executed by the Principal and Surety above named, on _____, 2017.

FOR INFORMATION ONLY — (*Name, Address and Telephone*)
Surety Agency or Broker:
Owner's Representative (*Engineer or other party*):

END OF SECTION

DOCUMENT 00614

PAYMENT BOND

CONTRACTOR (*Name and Address*):

_____
_____
_____

SURETY (*Name and Address of Principal Place of Business*):

_____
_____
_____

OWNER (*Name and Address*):

_____
_____
_____

CONTRACT

Effective Date of Agreement: _____
Amount: _____
Description (*Name and Location*): _____
_____
_____
_____

BOND

Bond Number: _____
Date (*Not earlier than Effective Date of Agreement)*: _____
Amount: _____
Modifications to this Bond Form: _____
_____
_____

Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth below, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.

CONTRACTOR AS PRINCIPAL	SURETY
_____	_____ (SEAL)
Contractor's Name	Surety's Name and Corporate Seal
By: _____	By: _____
Signature	Signature (Attach Power of Attorney)
_____	_____
Print Name	Print Name
_____	_____
Title	Title
Attest: _____	Attest: _____
Signature	Signature
_____	_____
Title	Title

Notes: (1) Provide execution by any additional parties, such as joint venturers, if necessary.
(2) *Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.*

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.

2. With respect to Owner, this obligation shall be null and void if Contractor:

    2.1 Promptly makes payment, directly or indirectly, for all sums due Claimants, and

    2.2 Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the address described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.

3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.

4. Surety shall have no obligation to Claimants under this Bond until:

    4.1 Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.

    4.2 Claimants who do not have a direct contract with Contractor:

        1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and

        2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor has indicated the claim will be paid directly or indirectly; and

        3. Not having been paid within the above 30 days, have sent a written notice to Surety (at the address described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.

5. If a notice by Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.

6. Reserved.

7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.

8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By

Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.

9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.

10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related subcontracts, purchase orders, and other obligations.

11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone or the last materials or equipment were furnished by anyone under the Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

12. Notice to Surety, Owner or Contractor shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Owner or Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.

13. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.

14. Upon request by any person or entity appearing to be a potential beneficiary of this Bond, Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.

15. Definitions.

    15.1 Claimant: An individual or entity having a direct contract with Contractor or with a first-tier subcontractor of Contractor to furnish labor, materials, or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms “labor, materials or equipment” that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of Contractor and Contractor's subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.

    15.2 Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

15.3 Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or otherwise comply with the other terms thereof.

FOR INFORMATION ONLY — (*Name, Address, and Telephone*)
Surety Agency or Broker:
Owner's Representative (*Engineer or other*):

END OF SECTION

DOCUMENT 00700

GENERAL CONDITIONS

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

EJCDC®
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

Issued and Published Jointly by

ACEC
AMERICAN COUNCIL OF ENGINEERING COMPANIES

ASCE
AMERICAN SOCIETY OF CIVIL ENGINEERS

National Society of Professional Engineers®

These General Conditions have been prepared for use with the Agreement Between Owner and Contractor for Construction Contract (EJCDC® C-520, Stipulated Sum, or C-525, Cost-Plus, 2013 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other.

To prepare supplementary conditions that are coordinated with the General Conditions, use EJCDC's Guide to the Preparation of Supplementary Conditions (EJCDC® C-800, 2013 Edition). The full EJCDC Construction series of documents is discussed in the Commentary on the 2013 EJCDC Construction Documents (EJCDC® C-001, 2013 Edition).

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

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ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

1.01 Defined Terms

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.
3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
5. *Bidder*—An individual or entity that submits a Bid to Owner.
6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.
7. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.
8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.
9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
10. *Claim*—(a) A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein: seeking an adjustment of Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract; or (b) a demand or assertion by Contactor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal; or seeking resolution of a contractual issue that Engineer has declined to address. A demand for money or services by a third party is not a Claim.

11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to (a) the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§9601 et seq. ("CERCLA"); (b) the Hazardous Materials Transportation Act, 49 U.S.C. §§5501 et seq.; (c) the Resource Conservation and Recovery Act, 42 U.S.C. §§6901 et seq. ("RCRA"); (d) the Toxic Substances Control Act, 15 U.S.C. §§2601 et seq.; (e) the Clean Water Act, 33 U.S.C. §§1251 et seq.; (f) the Clean Air Act, 42 U.S.C. §§7401 et seq.; or (g) any other federal, state, or local statute, law, rule, regulation, ordinance, resolution, code, order, or decree regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
12. *Contract*—The entire and integrated written contract between the Owner and Contractor concerning the Work.
13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.
14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents. .
15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.
16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.
17. *Cost of the Work*—See Paragraph 13.01 for definition.
18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.
19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.
20. *Engineer*—The individual or entity named as such in the Agreement.
21. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
22. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated in the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, does not establish a Hazardous Environmental Condition.
23. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
24. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
25. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date or by a time prior to Substantial Completion of all the Work.
26. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.
27. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.

28. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
29. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.
30. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.
31. *Project Manual*—The written documents prepared for, or made available for, procuring and constructing the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.
32. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or "RPR" includes any assistants or field staff of Resident Project Representative.
33. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.
34. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer's review of the submittals and the performance of related construction activities.
35. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.
36. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
37. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands furnished by Owner which are designated for the use of Contractor.
38. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
39. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.
40. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

41. *Successful Bidder*—The Bidder whose Bid the Owner accepts, and to which the Owner makes an award of contract, subject to stated conditions.
42. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
43. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.
44. *Technical Data*—Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (a) subsurface conditions at the Site, or physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) or (b) Hazardous Environmental Conditions at the Site. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then the data contained in boring logs, recorded measurements of subsurface water levels, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical or environmental report prepared for the Project and made available to Contractor are hereby defined as Technical Data with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06.
45. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including but not limited to those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, fiber optic transmissions, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.
46. *Unit Price Work*—Work to be paid for on the basis of unit prices.
47. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.
48. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 Terminology

A. The words and terms discussed in the following paragraphs are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. Intent of Certain Terms or Adjectives:
   1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. Day:
   1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.

D. Defective:
   1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
   2. does not conform to the Contract Documents; or
   3. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
   4. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or 15.04).

E. Furnish, Install, Perform, Provide:
   1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
   2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
   3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
   4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words “furnish,” “install,” “perform,” or “provide,” then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.

F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 - PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

A. *Bonds*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. *Evidence of Contractor's Insurance*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract), the certificates and other evidence of insurance required to be provided by Contractor in accordance with Article 6.

C. *Evidence of Owner's Insurance*: After receipt of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or otherwise), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 Copies of Documents

A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 Before Starting Construction

A. Preliminary Schedules: Within 10 days after the Effective Date of the Contract (or as otherwise specifically required by the Contract Documents), Contractor shall submit to Engineer for timely review:
   1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;
   2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 Preconstruction Conference; Designation of Authorized Representatives

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 Initial Acceptance of Schedules

A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.03.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer:
   1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
   2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
   3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.

2.06 Electronic Transmittals

A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may transmit, and shall accept, Project-related correspondence, text, data, documents, drawings, information, and graphics, including but not limited to Shop Drawings and other submittals, in electronic media or digital format, either directly, or through access to a secure Project website.

B. If the Contract does not establish protocols for electronic or digital transmittals, then Owner, Engineer, and Contractor shall jointly develop such protocols.

C. When transmitting items in electronic media or digital format, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the items, or from those established in applicable transmittal protocols.

ARTICLE 3 - DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 Intent

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents.

C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic or digital versions of the Contract Documents (including any printed copies derived from such electronic or digital versions) and the printed record version, the printed record version shall govern.

D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.

E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.

3.02 Reference Standards

A. Standards Specifications, Codes, Laws and Regulations:
   1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard specification, manual, reference standard, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 Reporting and Resolving Discrepancies

A. Reporting Discrepancies:
   1. *Contractor's Verification of Figures and Field Measurements*: Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.
   2. *Contractor's Review of Contract Documents*: If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.
   3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. Resolving Discrepancies:
   1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:
      a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or
      b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 Requirements of the Contract Documents

A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work thereunder.

B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.

C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Owner and Contractor that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 Reuse of Documents

A. Contractor and its Subcontractors and Suppliers shall not:
   1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or
   2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4 - COMMENCEMENT AND PROGRESS OF THE WORK

4.01 Commencement of Contract Times; Notice to Proceed

A. The Contract Times will commence to run on the thirtieth day after the Effective Date of the Contract or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within 30 days after the Effective Date of the Contract. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Contract, whichever date is earlier.

4.02 Starting the Work

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to such date.

4.03 Reference Points

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment are necessary to enable Contractor to proceed with the Work. Contractor shall be responsible for laying out the Work, shall protect and preserve the established reference points and property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points or property monuments by professionally qualified personnel.

4.04 Progress Schedule

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below:
   1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.
   2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 11.

B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 Delays in Contractor's Progress

A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Times and Contract Price. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.

C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:
   1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
   2. abnormal weather conditions;
   3. acts or failures to act of utility owners (other than those performing other work at or adjacent to the Site by arrangement with the Owner, as contemplated in Article 8); and
   4. acts of war or terrorism.

D. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5.

E. Paragraph 8.03 governs delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.

F. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor.

G. Contractor must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under this paragraph within 30 days of the commencement of the delaying, disrupting, or interfering event.

ARTICLE 5 - AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 Availability of Lands

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.

B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 Use of Site and Other Areas

A. Limitation on Use of Site and Other Areas:
   1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.
   2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.12, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or at law; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

B. *Removal of Debris During Performance of the Work*: During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning*: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading of Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 Subsurface and Physical Conditions

A. *Reports and Drawings*: The Supplementary Conditions identify:
   1. those reports known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site;
   2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities); and
   3. Technical Data contained in such reports and drawings.

B. Reliance by Contractor on Technical Data Authorized: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:
   1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or
   2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or
   3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions, or information.

5.04 Differing Subsurface or Physical Conditions

A. *Notice by Contractor*: If Contractor believes that any subsurface or physical condition that is uncovered or revealed at the Site either:
   1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate; or
   2. is of such a nature as to require a change in the Drawings or Specifications; or
   3. differs materially from that shown or indicated in the Contract Documents; or
   4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

   then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. *Engineer's Review*: After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine the necessity of Owner's obtaining additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A above; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.

C. *Owner's Statement to Contractor Regarding Site Condition*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.

D. *Possible Price and Times Adjustments*:
   1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, or both, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
      a. such condition must fall within any one or more of the categories described in Paragraph 5.04.A;
      b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,
      c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
    a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise; or
    b. the existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or
    c. Contractor failed to give the written notice as required by Paragraph 5.04.A.
3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.
4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

5.05 Underground Facilities

A. *Contractor's Responsibilities*: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or adjacent to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:
    1. Owner and Engineer do not warrant or guarantee the accuracy or completeness of any such information or data provided by others; and
    2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
        a. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
        b. locating all Underground Facilities shown or indicated in the Contract Documents as being at the Site;
        c. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
        d. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.

B. *Notice by Contractor*: If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.

C. *Engineer's Review*: Engineer will promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the Underground Facility in question; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and advise Owner in writing of Engineer's findings, conclusions, and recommendations. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

D. *Owner's Statement to Contractor Regarding Underground Facility*: After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question, addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.

E. *Possible Price and Times Adjustments*:
   1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, or both, to the extent that any existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
      a. Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Underground Facility in question;
      b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
      c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times; and
      d. Contractor gave the notice required in Paragraph 5.05.B.
   2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.
   3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

5.06 Hazardous Environmental Conditions at Site

A. *Reports and Drawings*: The Supplementary Conditions identify:
   1. those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
   2. Technical Data contained in such reports and drawings.

B. Reliance by Contractor on Technical Data Authorized: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:
   1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or
   2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or
   3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.

D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.

E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.

G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off.

H. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.

I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.H shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6 - BONDS AND INSURANCE

6.01 Performance, Payment, and Other Bonds

A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of Contractor's obligations under the Contract. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the Supplementary Conditions, or other specific provisions of the Contract. Contractor shall also furnish such other bonds as are required by the Supplementary Conditions or other specific provisions of the Contract.

B. All bonds shall be in the form prescribed by the Contract except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (as amended and supplemented) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.

C. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds in the required amounts.

D. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state or jurisdiction where any part of the Project is located, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements above.

E. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.

F. Upon request, Owner shall provide a copy of the payment bond to any Subcontractor, Supplier, or other person or entity claiming to have furnished labor or materials used in the performance of the Work.

6.02 Insurance—General Provisions

A. Owner and Contractor shall obtain and maintain insurance as required in this Article and in the Supplementary Conditions.

B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.

C. Contractor shall deliver to Owner, with copies to each named insured and additional insured (as identified in this Article, in the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Contractor has obtained and is maintaining the policies, coverages, and endorsements required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

D. Owner shall deliver to Contractor, with copies to each named insured and additional insured (as identified in this Article, the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Owner has obtained and is maintaining the policies, coverages, and endorsements required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

E. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, shall not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.

F. If either party does not purchase or maintain all of the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.

G. If Contractor has failed to obtain and maintain required insurance, Owner may exclude the Contractor from the Site, impose an appropriate set-off against payment, and exercise Owner's termination rights under Article 16.

H. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price shall be adjusted accordingly.

I. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests.

J. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner and other individuals and entities in the Contract.

6.03 Contractor's Insurance

A. *Workers' Compensation*: Contractor shall purchase and maintain workers' compensation and employer's liability insurance for:
   1. claims under workers' compensation, disability benefits, and other similar employee benefit acts.
   2. United States Longshoreman and Harbor Workers' Compensation Act and Jones Act coverage (if applicable).
   3. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees (by stop-gap endorsement in monopolist worker's compensation states).
   4. Foreign voluntary worker compensation (if applicable).

B. Commercial General Liability—Claims Covered: Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against:
   1. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees.
   2. claims for damages insured by reasonably available personal injury liability coverage.
   3. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.

C. Commercial General Liability—Form and Content: Contractor's commercial liability policy shall be written on a 1996 (or later) ISO commercial general liability form (occurrence form) and include the following coverages and endorsements:
   1. Products and completed operations coverage:
      a. Such insurance shall be maintained for three years after final payment.
      b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.
   2. Blanket contractual liability coverage, to the extent permitted by law, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
   3. Broad form property damage coverage.
   4. Severability of interest.
   5. Underground, explosion, and collapse coverage.
   6. Personal injury coverage.
   7. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.
   8. For design professional additional insureds, ISO Endorsement CG 20 32 07 04, "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.

D. *Automobile liability*: Contractor shall purchase and maintain automobile liability insurance against claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy shall be written on an occurrence basis.

E. *Umbrella or excess liability*: Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the paragraphs above. Subject to industry-standard exclusions, the coverage afforded shall follow form as to each and every one of the underlying policies.

F. *Contractor's pollution liability insurance*: Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance shall be maintained for no less than three years after final completion.

G. *Additional insureds*: The Contractor's commercial general liability, automobile liability, umbrella or excess, and pollution liability policies shall include and list as additional insureds Owner and Engineer, and any individuals or entities identified in the Supplementary Conditions; include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds; and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Contractor shall obtain all necessary endorsements to support these requirements.

H. *Contractor's professional liability insurance*: If Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance shall provide protection against claims arising out of performance of professional design or related services, and caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by Contractor itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.

I. *General provisions*: The policies of insurance required by this Paragraph 6.03 shall:
   1. include at least the specific coverages provided in this Article.
   2. be written for not less than the limits of liability provided in this Article and in the Supplementary Conditions, or required by Laws or Regulations, whichever is greater.
   3. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 10 days prior written notice has been given to Contractor. Within three days of receipt of any such written notice, Contractor shall provide a copy of the notice to Owner, Engineer, and each other insured under the policy.
   4. remain in effect at least until final payment (and longer if expressly required in this Article) and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract Documents.

5. be appropriate for the Work being performed and provide protection from claims that may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable.

J. The coverage requirements for specific policies of insurance must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

6.04 Owner's Liability Insurance

A. In addition to the insurance required to be provided by Contractor under Paragraph 6.03, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

B. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

6.05 Property Insurance

A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the full insurable replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:
   1. include the Owner and Contractor as named insureds, and all Subcontractors, and any individuals or entities required by the Supplementary Conditions to be insured under such builder's risk policy, as insureds or named insureds. For purposes of the remainder of this Paragraph 6.05, Paragraphs 6.06 and 6.07, and any corresponding Supplementary Conditions, the parties required to be insured shall collectively be referred to as "insureds."
   2. be written on a builder's risk "all risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire; lightning; windstorm; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; flood; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; water damage (other than that caused by flood); and such other perils or causes of loss as may be specifically required by the Supplementary Conditions. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise, such insurance may be provided through other insurance policies acceptable to Owner and Contractor.

3. cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.
4. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects).
5. extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier).
6. extend to cover damage or loss to insured property while in transit.
7. allow for partial occupation or use of the Work by Owner, such that those portions of the Work that are not yet occupied or used by Owner shall remain covered by the builder's risk insurance.
8. allow for the waiver of the insurer's subrogation rights, as set forth below.
9. provide primary coverage for all losses and damages caused by the perils or causes of loss covered.
10. not include a co-insurance clause.
11. include an exception for ensuing losses from physical damage or loss with respect to any defective workmanship, design, or materials exclusions.
12. include performance/hot testing and start-up.
13. be maintained in effect, subject to the provisions herein regarding Substantial Completion and partial occupancy or use of the Work by Owner, until the Work is complete.

B. *Notice of Cancellation or Change*: All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 6.05 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured.

C. *Deductibles*: The purchaser of any required builder's risk or property insurance shall pay for costs not covered because of the application of a policy deductible.

D. *Partial Occupancy or Use by Owner*: If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide notice of such occupancy or use to the builder's risk insurer. The builder's risk insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy; rather, those portions of the Work that are occupied or used by Owner may come off the builder's risk policy, while those portions of the Work not yet occupied or used by Owner shall remain covered by the builder's risk insurance.

E. *Additional Insurance*: If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.05, it may do so at Contractor's expense.

F. *Insurance of Other Property*: If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, such as tools, construction equipment, or other personal property owned by Contractor, a Subcontractor, or an employee of Contractor or a Subcontractor, then the entity or individual owning such property item will be responsible for deciding whether to insure it, and if so in what amount.

6.06 Waiver of Rights

A. All policies purchased in accordance with Paragraph 6.05, expressly including the builder's risk policy, shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all Subcontractors, all individuals or entities identified in the Supplementary Conditions as insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for:
   1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and
   2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 6.06.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them.

D. Contractor shall be responsible for assuring that the agreement under which a Subcontractor performs a portion of the Work contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by builder's risk insurance and any other property insurance applicable to the Work.

6.07 Receipt and Application of Property Insurance Proceeds

A. Any insured loss under the builder's risk and other policies of insurance required by Paragraph 6.05 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.05 shall distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

C. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the money so received applied on account thereof, and the Work and the cost thereof covered by Change Order, if needed.

ARTICLE 7 - CONTRACTOR'S RESPONSIBILITIES

7.01 Supervision and Superintendence

A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.02 Labor; Working Hours

A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.03 Services, Materials, and Equipment

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.

B. All materials and equipment incorporated into the Work shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.04 "Or Equals"

A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment, or items from other proposed suppliers under the circumstances described below:
   1. If Engineer in its sole discretion determines that an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer shall deem it an "or equal" item. For the purposes of this paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:
      a. in the exercise of reasonable judgment Engineer determines that:
         1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
         2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;

3) it has a proven record of performance and availability of responsive service; and
4) it is not objectionable to Owner.

b. Contractor certifies that, if approved and incorporated into the Work:
1) there will be no increase in cost to the Owner or increase in Contract Times; and
2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

B. *Contractor's Expense*: Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.

C. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal", which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

D. *Effect of Engineer's Determination*: Neither approval nor denial of an "or-equal" request shall result in any change in Contract Price. The Engineer's denial of an "or-equal" request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents.

E. *Treatment as a Substitution Request*: If Engineer determines that an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer considered the proposed item as a substitute pursuant to Paragraph 7.05.

7.05 Substitutes

A. Unless the specification or description of an item of material or equipment required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment under the circumstances described below. To the extent possible such requests shall be made before commencement of related construction at the Site:
1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of material or equipment from anyone other than Contractor.
2. The requirements for review by Engineer will be as set forth in Paragraph 7.05.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.

3. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:
    a. shall certify that the proposed substitute item will:
        1) perform adequately the functions and achieve the results called for by the general design,
        2) be similar in substance to that specified, and
        3) be suited to the same use as that specified.
    b. will state:
        1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times,
        2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and
        3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.
    c. will identify:
        1) all variations of the proposed substitute item from that specified, and
        2) available engineering, sales, maintenance, repair, and replacement services.
    d. shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.

B. *Engineer's Evaluation and Determination*: Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.

C. *Special Guarantee*: Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

D. *Reimbursement of Engineer's Cost*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

E. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute at Contractor's expense.

F. *Effect of Engineer's Determination*: If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.05.D, by timely submittal of a Change Proposal.

7.06 Concerning Subcontractors, Suppliers, and Others

A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner.

B. Contractor shall retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of designated parts of the Work if required by the Contract to do so.

C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against which Contractor has reasonable objection.

D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable, during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within five days.

E. Owner may require the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors, Suppliers, or other individuals or entities for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor, Supplier, or other individual or entity so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity.

F. If Owner requires the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, or both, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.

G. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.

H. On a monthly basis Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.

I. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions.

J. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors, Suppliers, and all other individuals or entities performing or furnishing any of the Work.

K. Contractor shall restrict all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed herein.

L. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

M. All Work performed for Contractor by a Subcontractor or Supplier shall be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer.

N. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor on account of Work performed for Contractor by the particular Subcontractor or Supplier.

O. Nothing in the Contract Documents:
   1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier, or other individual or entity; nor
   2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

7.07 Patent Fees and Royalties

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.08 Permits

A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of utility owners for connections for providing permanent service to the Work

7.09 Taxes

A. Contractor shall pay all sales, consumer, use, and other similar taxes required to be paid by Contractor in accordance with the Laws and Regulations of the place of the Project which are applicable during the performance of the Work.

7.10 Laws and Regulations

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.

B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It shall not be Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

C. Owner or Contractor may give notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.11 Record Documents

A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.12 Safety and Protection

A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:
   1. all persons on the Site or who may be affected by the Work;
   2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
   3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site, when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.

C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.

D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

E. All damage, injury, or loss to any property referred to in Paragraph 7.12.A.2 or 7.12.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

F. Contractor's duties and responsibilities for safety and protection shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 15.06.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

G. Contractor's duties and responsibilities for safety and protection shall resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.13 Safety Representative

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

7.14 Hazard Communication Programs

A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 Emergencies

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor is obligated to act to prevent threatened damage, injury, or loss. Contractor shall give Engineer prompt written notice if Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby or are required as a result thereof. If Engineer determines that a change in the Contract Documents is required because of the action taken by Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

7.16 Shop Drawings, Samples, and Other Submittals

A. Shop Drawing and Sample Submittal Requirements:
   1. Before submitting a Shop Drawing or Sample, Contractor shall have:
      a. reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
      b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
      c. determined and verified the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
      d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.
   2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that submittal, and that Contractor approves the submittal.
   3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Engineer for review and approval of each such variation.

B. Submittal Procedures for Shop Drawings and Samples: Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals. Each submittal will be identified as Engineer may require:
   1. Shop Drawings:
      a. Contractor shall submit the number of copies required in the Specifications.
      b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.D.

2. Samples:
    a. Contractor shall submit the number of Samples required in the Specifications.
    b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 7.16.D.
3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Other Submittals*: Contractor shall submit other submittals to Engineer in accordance with the accepted Schedule of Submittals, and pursuant to the applicable terms of the Specifications.

D. Engineer's Review:
1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.
3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
4. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Contract Documents in a Field Order.
5. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 7.16.A and B.
6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, shall not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.
7. Neither Engineer's receipt, review, acceptance or approval of a Shop Drawing, Sample, or other submittal shall result in such item becoming a Contract Document.
8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.D.4.

E. Resubmittal Procedures:
   1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.
   2. Contractor shall furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.
   3. If Contractor requests a change of a previously approved submittal item, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

7.17 Contractor's General Warranty and Guarantee

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
   1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
   2. normal wear and tear under normal usage.

C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:
   1. observations by Engineer;
   2. recommendation by Engineer or payment by Owner of any progress or final payment;
   3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
   4. use or occupancy of the Work or any part thereof by Owner;
   5. any review and approval of a Shop Drawing or Sample submittal;
   6. the issuance of a notice of acceptability by Engineer;
   7. any inspection, test, or approval by others; or
   8. any correction of defective Work by Owner.

D. If the Contract requires the Contractor to accept the assignment of a contract entered into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract shall govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 Indemnification

A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 7.18.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:
   1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or
   2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

7.19 Delegation of Professional Design Services

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable Laws and Regulations.

B. If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this paragraph, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 7.16.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria specified by Owner or Engineer.

ARTICLE 8 - OTHER WORK AT THE SITE

8.01 Other Work

A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.

B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any utility work at or adjacent to the Site, Owner shall provide such information to Contractor.

C. Contractor shall afford each other contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.

D. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 8, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

8.02 Coordination

A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:
   1. the identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;
   2. an itemization of the specific matters to be covered by such authority and responsibility; and
   3. the extent of such authority and responsibilities.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 Legal Relationships

A. If, in the course of performing other work at or adjacent to the Site for Owner, the Owner's employees, any other contractor working for Owner, or any utility owner causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment shall take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract. When applicable, any such equitable adjustment in Contract Price shall be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due to Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this paragraph.

C. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due to Contractor.

D. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9 - OWNER'S RESPONSIBILITIES

9.01 Communications to Contractor

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

9.02 Replacement of Engineer

A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer's status under the Contract Documents shall be that of the former Engineer.

9.03 Furnish Data

A. Owner shall promptly furnish the data required of Owner under the Contract Documents.

9.04 Pay When Due

A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 Lands and Easements; Reports, Tests, and Drawings

A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.

B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.

C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 Insurance

A. Owner's responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 Change Orders

A. Owner's responsibilities with respect to Change Orders are set forth in Article 11.

9.08 Inspections, Tests, and Approvals

A. Owner's responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 Limitations on Owner's Responsibilities

A. The Owner shall not supervise, direct, or have control or authority over, nor be responsible for, Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Owner will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

9.10 Undisclosed Hazardous Environmental Condition

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 Evidence of Financial Arrangements

A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents (including obligations under proposed changes in the Work).

9.12 Safety Programs

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed.

B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10 - ENGINEER'S STATUS DURING CONSTRUCTION

10.01 Owner's Representative

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract.

10.02 Visits to Site

A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.08. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 Project Representative

A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 10.08. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent, or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

10.04 Rejecting Defective Work

A. Engineer has the authority to reject Work in accordance with Article 14.

10.05 Shop Drawings, Change Orders and Payments

A. Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, are set forth in Paragraph 7.16.

B. Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, are set forth in Paragraph 7.19.

C. Engineer's authority as to Change Orders is set forth in Article 11.

D. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.06 Determinations for Unit Price Work

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.07 Decisions on Requirements of Contract Documents and Acceptability of Work

A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.08 Limitations on Engineer's Authority and Responsibilities

A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 15.06.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 10.08 shall also apply to the Resident Project Representative, if any.

10.09 Compliance with Safety Program

A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs (if any) of which Engineer has been informed.

ARTICLE 11 - AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

11.01 Amending and Supplementing Contract Documents

A. The Contract Documents may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order:
   1. Change Orders:
      a. If an amendment or supplement to the Contract Documents includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order. A Change Order also may be used to establish amendments and supplements of the Contract Documents that do not affect the Contract Price or Contract Times.
      b. Owner and Contractor may amend those terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, without the recommendation of the Engineer. Such an amendment shall be set forth in a Change Order.
   2. *Work Change Directives*: A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.04 regarding change of Contract Price. Contractor must submit any Change Proposal seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 30 days after the completion of the Work set out in the Work Change Directive. Owner must submit any Claim seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 60 days after issuance of the Work Change Directive.

3. *Field Orders*: Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly. If Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.02 Owner-Authorized Changes in the Work

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Such changes shall be supported by Engineer's recommendation, to the extent the change involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters. Such changes may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work shall be performed under the applicable conditions of the Contract Documents. Nothing in this paragraph shall obligate Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.03 Unauthorized Changes in the Work

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.

11.04 Change of Contract Price

A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment of Contract Price shall comply with the provisions of Article 12.

B. An adjustment in the Contract Price will be determined as follows:
   1. where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03); or
   2. where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.04.C.2); or

3. where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.04.C).

C. *Contractor's Fee*: When applicable, the Contractor's fee for overhead and profit shall be determined as follows:
   1. a mutually acceptable fixed fee; or
   2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
      a. for costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee shall be 15 percent;
      b. for costs incurred under Paragraph 13.01.B.3, the Contractor's fee shall be five percent;
      c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.01.C.2.a and 11.01.C.2.b is that the Contractor's fee shall be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.A.1 and 13.01.A.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of five percent of the amount (fee plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted work the maximum total fee to be paid by Owner shall be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the work;
      d. no fee shall be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;
      e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and
      f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 11.04.C.2.a through 11.04.C.2.e, inclusive.

11.05 Change of Contract Times

A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of Article 12.

B. An adjustment of the Contract Times shall be subject to the limitations set forth in Paragraph 4.05, concerning delays in Contractor's progress.

11.06 Change Proposals

A. Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; appeal an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract. The Change Proposal shall specify any proposed change in Contract Times or Contract Price, or both, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents:
   1. *Procedures*: Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 30 days) after the start of the event giving rise thereto, or after such initial decision. The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal. The supporting data shall be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event. Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal.
   2. *Engineer's Action*: Engineer will review each Change Proposal and, within 30 days after receipt of the Contractor's supporting data, either deny the Change Proposal in whole, approve it in whole, or deny it in part and approve it in part. Such actions shall be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.
   3. *Binding Decision*: Engineer's decision will be final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

B. *Resolution of Certain Change Proposals*: If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice shall be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

11.07 Execution of Change Orders

A. Owner and Contractor shall execute appropriate Change Orders covering:
   1. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
   2. changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;

3. changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.02, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters; and
4. changes in the Contract Price or Contract Times, or other changes, which embody the substance of any final and binding results under Paragraph 11.06, or Article 12.

B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of this Paragraph 11.07, it shall be deemed to be of full force and effect, as if fully executed.

11.08 Notification to Surety

A. If the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

ARTICLE 12 - CLAIMS

12.01 Claims

A. *Claims Process*: The following disputes between Owner and Contractor shall be submitted to the Claims process set forth in this Article:
1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents; and
3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters.

B. *Submittal of Claim*: The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim shall rest with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, or both, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.

C. *Review and Resolution*: The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim shall be stated in writing and submitted to the other party, with a copy to Engineer.

D. *Mediation*:
   1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate shall stay the Claim submittal and response process.
   2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process shall resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process shall resume as of the date of the conclusion of the mediation, as determined by the mediator.
   3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.

E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action shall be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.

F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim shall be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.

G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim shall be incorporated in a Change Order to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13 - COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 Cost of the Work

A. Purposes for Determination of Cost of the Work: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:
   1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or

2. To determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.

B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 13.01.C, and shall include only the following items:
   1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.
   2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.
   3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.
   4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.
   5. Supplemental costs including the following:
      a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
      b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.
      c. Rentals of all construction equipment and machinery, and the parts thereof, whether rented from Contractor or others in accordance with rental

agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 6.05), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.
g. The cost of utilities, fuel, and sanitary facilities at the Site.
h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded*: The term Cost of the Work shall not include any of the following items:
1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.
2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee*: When the Work as a whole is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 11.04.C.

E. *Documentation*: Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

13.02 Allowances

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances*: Contractor agrees that:
   1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
   2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. *Contingency Allowance*: Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

13.03 Unit Price Work

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.

C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of the following paragraph.

E. Within 30 days of Engineer's written decision under the preceding paragraph, Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price if:
   1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement;
   2. there is no corresponding adjustment with respect to any other item of Work; and
   3. Contractor believes that it is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price, and the parties are unable to agree as to the amount of any such increase or decrease.

ARTICLE 14 - TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

14.01 Access to Work

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

14.02 Tests, Inspections, and Approvals

A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.

B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work shall be governed by the provisions of Paragraph 14.05.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:
   1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;
   2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;
   3. by manufacturers of equipment furnished under the Contract Documents;
   4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and
   5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

   Such inspections and tests shall be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.

F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering shall be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 Defective Work

A. *Contractor's Obligation*: It is Contractor's obligation to assure that the Work is not defective.

B. *Engineer's Authority*: Engineer has the authority to determine whether Work is defective, and to reject defective Work.

C. *Notice of Defects*: Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.

D. *Correction, or Removal and Replacement*: Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.

E. *Preservation of Warranties*: When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

F. *Costs and Damages*: In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 Acceptance of Defective Work

A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work shall be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 Uncovering Work

A. Engineer has the authority to require special inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.

B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.

C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.
   1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.

2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 Owner May Stop the Work

A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 Owner May Correct Defective Work

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, then Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.

C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15 - PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 Progress Payments

A. *Basis for Progress Payments*: The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.

B. Applications for Payments:
   1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens, and evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.
   2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
   3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. Review of Applications:
   1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
   2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:
      a. the Work has progressed to the point indicated;
      b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called

for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and

c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
   b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.
4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
   a. to supervise, direct, or control the Work, or
   b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
   c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
   d. to make any examination to ascertain how or for what purposes Contractor has used the money paid on account of the Contract Price, or
   e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.
6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:
   a. the Work is defective, requiring correction or replacement;
   b. the Contract Price has been reduced by Change Orders;
   c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
   d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or
   e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. Payment Becomes Due:
   1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

E. Reductions in Payment by Owner:
   1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:
      a. claims have been made against Owner on account of Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages on account of Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;
      b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
      c. Contractor has failed to provide and maintain required bonds or insurance;
      d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
      e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;
      f. the Work is defective, requiring correction or replacement;
      g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
      h. the Contract Price has been reduced by Change Orders;
      i. an event that would constitute a default by Contractor and therefore justify a termination for cause has occurred;
      j. liquidated damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
      k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;
      l. there are other items entitling Owner to a set off against the amount recommended.
   2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed shall be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.
   3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 15.01.C.1 and subject to interest as provided in the Agreement.

15.02 Contractor's Warranty of Title

A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than seven days after the time of payment by Owner.

15.03 Substantial Completion

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which shall fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.

F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 Partial Use or Occupancy

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:
   1. At any time Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through E for that part of the Work.
   2. At any time Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
   3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.
   4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.05 regarding builder's risk or other property insurance.

15.05 Final Inspection

A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 Final Payment

A. Application for Payment:
   1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.11), and other documents, Contractor may make application for final payment.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:
    a. all documentation called for in the Contract Documents;
    b. consent of the surety, if any, to final payment;
    c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.
    d. a list of all disputes that Contractor believes are unsettled; and
    e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.
3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.

B. Engineer's Review of Application and Acceptance:
    1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the Application for Payment to Owner for payment. Such recommendation shall account for any set-offs against payment that are necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to the provisions of Paragraph 15.07. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment.

D. *Payment Becomes Due*: Thirty days after the presentation to Owner of the final Application for Payment and accompanying documentation, the amount recommended by Engineer (less any further sum Owner is entitled to set off against Engineer's recommendation, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions above with respect to progress payments) will become due and shall be paid by Owner to Contractor.

15.07 Waiver of Claims

A. The making of final payment will not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 15.05, from Contractor's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, from outstanding Claims by Owner, or from Contractor's continuing obligations under the Contract Documents.

B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted or appealed under the provisions of Article 17.

15.08 Correction Period

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents), any Work is found to be defective, or if the repair of any damages to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas used by Contractor as permitted by Laws and Regulations, is found to be defective, then Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
   1. correct the defective repairs to the Site or such other adjacent areas;
   2. correct such defective Work;
   3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
   4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others).

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor's obligations under this paragraph are in addition to all other obligations and warranties. The provisions of this paragraph shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16 - SUSPENSION OF WORK AND TERMINATION

16.01 Owner May Suspend Work

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension. Any Change Proposal seeking such adjustments shall be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 Owner May Terminate for Cause

A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:
   1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule);
   2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
   3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or
   4. Contractor's repeated disregard of the authority of Owner or Engineer.

B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) ten days written notice that Owner is considering a declaration that Contractor is in default and termination of the contract, Owner may proceed to:
   1. declare Contractor to be in default, and give Contractor (and any surety) notice that the Contract is terminated; and
   2. enforce the rights available to Owner under any applicable performance bond.

C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.

D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within seven days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.

E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.

G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond shall govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 Owner May Terminate For Convenience

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
   1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
   2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and
   3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.

B. Contractor shall not be paid on account of loss of anticipated overhead, profits, or revenue, or other economic loss arising out of or resulting from such termination.

16.04 Contractor May Stop Work or Terminate

A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17 - FINAL RESOLUTION OF DISPUTES

17.01 Methods and Procedures

A. Disputes Subject to Final Resolution: The following disputed matters are subject to final resolution under the provisions of this Article:
   1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full; and
   2. Disputes between Owner and Contractor concerning the Work or obligations under the Contract Documents, and arising after final payment has been made.

B. *Final Resolution of Disputes*: For any dispute subject to resolution under this Article, Owner or Contractor may:
   1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions; or
   2. agree with the other party to submit the dispute to another dispute resolution process; or
   3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18 - MISCELLANEOUS

18.01 Giving Notice

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:
   1. delivered in person, by a commercial courier service or otherwise, to the individual or to a member of the firm or to an officer of the corporation for which it is intended; or
   2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the sender of the notice.

18.02 Computation of Times

A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 Cumulative Remedies

A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 Limitation of Damages

A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 No Waiver

A. A party's non-enforcement of any provision shall not constitute a waiver of that provision, nor shall it affect the enforceability of that provision or of the remainder of this Contract.

18.06 Survival of Obligations

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

18.07 Controlling Law

A. This Contract is to be governed by the law of the state in which the Project is located.

18.08 Headings

A. Article and paragraph headings are inserted for convenience only and do not constitute parts of these General Conditions.

END OF DOCUMENT

DOCUMENT 00800

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement Document 00700 - General Conditions. All provisions, which are not so amended or supplemented, remain in full force and effect.

The terms used in these Supplementary Conditions will have the meanings indicated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings indicated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added thereto.

ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

SC-1.01 Defined Terms

SC-1.01 Add to the list of definitions in Paragraph 1.01.A by inserting the following as numbered items in their proper alphabetical positions:

Construction Manager - Person or entity designated by the Owner to provide construction management services for the Project.

Design Engineer - Carollo Engineers, Inc.

Final Completion - The Work is complete when it is ready for final payment as established by the Engineer's written recommendation of final payment as set forth in Paragraph 15.06.

ARTICLE 2 - PRELIMINARY MATTERS

SC-2.01 Delivery of Bonds and Evidence of Insurance

SC-2.01 Delete Paragraphs 2.01 B. and C. in their entirety and insert the following in their place:

B. Evidence of Contractor's Insurance: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner copies of the policies of insurance (including all endorsements, and identification of applicable self-insured retentions and deductibles) required to be provided by Contractor in Article 6. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

C. Evidence of Owner's Insurance: After receipt from Contractor of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor copies of the policies of insurance to be provided by Owner under Article 6 (if any). Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

SC-2.02 Copies of Documents

SC-2.02 Delete Paragraph 2.02.A. in its entirety and insert the following in its place:

A. Owner shall furnish Contractor up to 5 printed copies of the Contract Conformed Documents (including 1 fully executed counterpart of the Agreement), and 1 copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.

SC-2.04 Preconstruction Conference; Designation of Authorized Representative

SC-2.04 Delete Paragraph 2.04.B. in its entirety.

ARTICLE 4 - COMMENCEMENT AND PROGRESS OF THE WORK

SC-4.01 Commencement of Contract Times; Notice to Proceed

SC-4.01 Delete Paragraph 4.01.A. in its entirety and insert the following in its place:

A. The time fixed for the commencement of such work is within (10) working days after the "Notice to Proceed" has been issued.

ARTICLE 5 - AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS

SC-5.01 Availability of Lands

SC-5.01 Add the following new paragraph immediately after Paragraph 5.01.C:

D. Any Work performed in public rights-of-way, in addition to conforming to the Contract Documents, shall be done in accordance with the requirements of the permit issued by the public agency in whose right-of-way the Work is located.

SC-5.03 Subsurface and Physical Conditions

SC-5.03 Add the following new paragraphs immediately after Paragraph 5.03.B:

C. The following reports of explorations and tests of subsurface conditions at or adjacent to the Site are known to Owner:

1. Report dated January 25, 2017, by Kleinfelder, Inc., entitled "Addendum to Geotechnical Services Reports, Secondary Clarifier No. 5 and

Denitrification Improvement Projects, Turlock Water Quality Control Plant, Turlock, California."

2. Report dated July 24, 2014, by Kleinfelder, Inc., entitled "Report Update Geotechnical Services Report and Geologic/Seismic Hazards Assessment for the Proposed Secondary Clarifier, Turlock Water Quality Control Facility, Turlock, California."

3. Report dated August 10, 2011, by Kleinfelder, Inc., entitled "Report Update Geotechnical Services Report and Geologic/Seismic Hazards Assessment for the Proposed Headworks and Secondary Expansion, Turlock Water Quality Control Facility, Turlock, California."

4. Report dated December 21, 2007, by Kleinfelder, Inc., entitled "Geotechnical Services Report", Proposed Headworks and Secondary Expansion, Turlock Water Quality Control Facility, Turlock, California.

D. The following drawings of physical conditions relating to existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities) are known to Owner:

1. Drawings dated January 1971, prepared by Jenks & Adamson entitled, "City of Turlock, CA Sewerage Works Improvements, Plans for the Construction of Wastewater Treatment Plan Enlargement" consisting of Sheets 1 through 66, inclusive.

2. Drawings dated March 1977, prepared by CH2M Hill entitled, "City of Turlock Wastewater Treatment Plant" consisting of Sheets 1 through 76, inclusive.

3. Drawings dated October 1994, prepared by John Carollo Engineers, entitled: "Water Quality Control Facility Expansion Program Stage 1," consisting of Sheets 1 through 31, inclusive.

4. Drawings dated July 1995, prepared by HDR Engineering, Inc., entitled: "Water Quality Control Facility Expansion Phase II," consisting of Sheets 1 through 50, inclusive.

5. Drawings dated June 2000, prepared by Carollo Engineers, entitled: "Water Quality Control Facility Expansion Program – Nitrification Facilities Project," consisting of Sheets 1 through 68, inclusive.

6. Drawings dated September 2003, prepared by Carollo Engineers, entitled: "Water Quality Control Facility Treatment Facilities Improvement Project," consisting of Sheets 1 through 397, inclusive.

7. Drawings dated March 2012, prepared by Carollo Engineers, entitled "Headworks And Secondary Treatment Capacity Expansion Project - Phase I," consisting of Sheets 1 through 259, inclusive.

E. Contractor may examine copies of reports and drawings identified in Document 00800 Supplementary Conditions that were not included with the Bidding Documents at 156 S. Broadway, Suite 150,Turlock, CA during regular business hours, or may request copies of PFD documents by requesting them from Stephen Fremming, phone 209-668-5417, sfremming@turlock.ca.us.

SC-5.06 Hazardous Environmental Conditions at Site

SC-5.06 Delete Paragraphs 5.06.A and 5.06.B in their entirety and insert the following:

A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner.

B. Not Used.

ARTICLE 6 - BONDS AND INSURANCE

SC-6.03 Contractor's Insurance

SC-6.03 Add the following new paragraph immediately after Paragraph 6.03.J:

K. The limits of liability for the insurance required by Paragraph 6.03 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

1. Workers' Compensation, and related coverages under Paragraphs 6.03.A.1 and A.2 of the General Conditions:

State:		Statutory
Federal, if applicable (e.g., Longshoreman's):		Statutory
Employer's Liability:		
Bodily injury, each accident	$	1,000,000
Bodily injury aggregate	$	1,000,000
Foreign voluntary worker compensation		Statutory

2. Contractor's Commercial General Liability under Paragraphs 6.03.B and 6.03.C of the General Conditions:

General Aggregate	$ 5,000,000
Products - Completed Operations Aggregate	$ 5,000,000
Personal and Advertising Injury	$ 1,000,000
Each Occurrence (Bodily Injury and Property Damage)	$ 1,000,000

3. Automobile Liability under Paragraph 6.03.D. of the General Conditions:

Bodily Injury:	
Each person	$ 1,000,000
Each accident	$ 1,000,000
Property Damage:	
Combined Single Limit of	$ 1,000,000

4. Excess or Umbrella Liability:

Per Occurrence	$ 5,000,000
General Aggregate	$ 5,000,000

5. Contractor's Pollution Liability:

Each Occurrence	$ 1,000,000
General Aggregate	$ 2,000,000

☐ If box is checked, Contractor is not required to provide Contractor's Pollution Liability insurance under this Contract

6. Contractor's Professional Liability:

Each Claim	$ 1,000,000
Annual Aggregate	$ 1,000,000

7. Additional Insureds: In addition to Owner and Engineer, include as additional insureds the following: Design Engineer and Construction Manager.

L. Each policy shall contain a cross liability or severability of interest clause or endorsement. Insurance covering the specified additional insureds shall be primary insurance, and all other insurance carried by the additional insureds shall be excess insurance; and with respect to workers' compensation and employer's liability, comprehensive automobile liability, commercial general liability, and umbrella liability insurance, Contractor shall require Contractor's insurance carriers to waive all rights of subrogation against Owner, Engineer, Design Engineer and Construction Manager and their respective officers, directors, partners, employees, subconsultants, and agents.

SC-6.05 Property Insurance

SC-6.05 Add the following new subparagraph after subparagraph 6.05.A.1:

a. In addition to Owner, Contractor, and all Subcontractors, include as insureds the following: Engineer, Design Engineer and Construction Manager.

SC-6.05 Amend the first sentence of Paragraph 6.05.B to read as follows:

All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 6.05 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to the purchasing policyholder.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

SC-7.02 Labor; Working Hours

SC-7.02 Add the following new subparagraphs immediately after Paragraph 7.02.B:

1. Regular working hours will be 7:00 a.m. to 5:00 p.m.
2. Owner's legal holidays are New Year's Day, Martin Luther King, Jr. Day, President's Birthday, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans Day, Thanksgiving/Day After Thanksgiving, Christmas Day.

SC-7.06 Concerning Subcontractors, Suppliers, and Others

SC-7.06 Add the following subparagraph immediately after 7.06.B:

1. Subcontracting: Contractor shall perform with Contractor's own organization work amounting to not less than 40 percent of the combined value of all items of the Work covered by the Contract.

SC-7.09 Taxes

SC-7.09 Add the following new sentence and subparagraphs immediately after the last sentence of paragraph 7.09.A:

Contractor shall cooperate with City to the full extent possible to maximize the local allocation of California sales and use tax to the City. Such cooperation shall include but not be limited to:

1. Use Tax Direct Payment Permits. Contractor shall apply for, obtain and utilize, to the maximum extent reasonable, a California Use Tax Direct Payment Permit.
2. Purchases of $500,000 or More. Contractor shall require vendors and suppliers located outside California from whom Contractor makes purchase of $500,000 or more to allocate the use tax to the City.

Additional information regarding use tax and the Permit can be found in the State of California Board of Equalization, Sales and Use Tax Regulations, Regulation 1699.6, Use Tax Direct Payment Permits, or on the web site for the Board of Equalization at http://www.boe.ca.gov/sutax/sutprograms.htm

SC-7.12 Safety and Protection

SC-7.12 Insert the following new sentence immediately after the second sentence of Paragraph 7.12.C:

The following Owner safety programs are applicable to the Work: Contractor's Safety Program.

SC-7.14 Hazard Communication Programs:

SC-7.14.B Add the following paragraphs immediately after 6.15.A:

B. Contractor shall promptly, and before the following conditions are disturbed, notify Owner and Engineer, in writing, of any:
   1. Material that Contractor believes may be material that is hazardous waste, as defined in Section 25117, California Health & Safety Code, that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with provisions of existing law.
   2. Subsurface or latent physical conditions at the site differing from those indicated in the Contract Documents.
   3. Unknown physical conditions at the site of any unusual nature, different materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents.

C. Owner will promptly investigate the conditions, and where Owner finds the conditions do materially so differ, or do involve hazardous waste, and cause a decrease or increase in the Contract Price, or in the Contract Time, or both, a Change Order will be issued in accordance with Document 00700, General Conditions.

D. In the event a dispute arises as to whether the conditions materially differ, or involve hazardous waste, or cause a decrease or increase in the Contract Price, Contract Time, or both, Contractor shall not be excused from any scheduled completion date provided in the Contract Documents, but shall proceed with the Work.

SC-7.16 Shop Drawings, Samples, and Other Submittals

SC-7.16 Delete the Paragraph 7.16.E.2 in its entirely and insert the following in its place:

2. Contractor shall furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than

two submittals. Engineer will record Engineer's time for reviewing a third or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.

SC-7.20 Add the following paragraph immediately after Article 7.19

SC-7.20 City Business License

E. Contractor shall obtain a City of Turlock business license prior to issuance of the Notice to Proceed. The cost of the business license is fifty cents per thousand dollars in revenue. Business Licenses are obtained through the Finance Division at Turlock City Hall, 156 S. Broadway, Suite 114. Additional information can be found on the City's website at http://ci.turlock.ca.us/doingbusinessinturlock/businesslicenses/newbusinesslicense.asp

F. Full compensation for obtaining a business license as specified above shall be considered as included in the prices paid for the various contract items of work and no additional compensation will be allowed therefore.

ARTICLE 9 - OWNER'S RESPONSIBILITIES

SC-9.01 Communications to Contractor

SC-9.01 Amend the first sentence of paragraph 9.01.A to read as follows:

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Construction Manager.

SC-9.01 Add paragraph 9.01.B to read as follows:

B. Construction Manager will establish and implement procedures including testing, reviewing and processing requests for clarifications and interpretations of the Contract Documents; Shop Drawings, samples, and other submittals; schedule adjustments; Change Order proposals; written proposals for substitutions; payment applications; and maintenance of logs.

SC-9.02 Replacement of Engineer

SC-9.02 Amend the first sentence of paragraph 9.02.A to read as follows:

Owner may at its discretion appoint an engineer to replace Engineer.

ARTICLE 10 - ENGINEER'S STATUS DURING CONSTRUCTION

SC-10.03 Project Representative

SC-10.03 Delete Paragraph 10.03 in its entirety.

ARTICLE 11 - AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

SC-11.01 Amending and Supplementing Contract Documents

SC-11.01 Insert the following subparagraphs immediately following 11.02.A.1.b:

c. In signing a Change Order, the Owner and Contractor acknowledge and agree that:

1) the stipulated compensation (Contract Price or Contract Times, or both) set forth in the Change Order includes not only all direct costs of Contractor such as labor, material, job overhead, and profit markup, but also includes any costs for modifications or changes in sequence of work to be performed, delays, rescheduling, disruptions, extended direct overhead or general overhead, acceleration, material or other escalation which includes wages and other impact costs. This document will become a supplement to the Contract and all Contract provisions will apply hereto. It is understood that this Change Order shall be effective on the date approved by the Owner's Representative.

2) the Change Order constitutes full mutual accord and satisfaction for the change to the Work;

3) no reservation of rights to pursue subsequent claims on the Change Order will be made by either party; and

4) no subsequent claim or amendment of the Contract Documents will arise out of or as a result of the Change Order.

SC-11.04 Change of Contract Price

SC-11.04 Delete the Paragraph 11.04.B.3 in its entirely and insert the following in its place:

3. where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor markup percentage for overhead and profit as provided below:
   a. Labor markup: Labor markup applies to the direct performance of the work and equals 5 percent. In addition to the 5 percent markup, Contractor shall receive the labor surcharge percentage published in the current edition of the Caltrans Labor Surcharge and Equipment Rental Rates book.
   b. Materials markup: Material markup applies to materials furnished and consumed on the extra work and equals 5 percent of the direct cost to the Contractor.
   c. Equipment markup: Equipment markup is applied to all equipment utilized on the extra work and equals 5 percent.
   d. Subcontractor markup: If a subcontractor performs work on the basis of the Cost of the Work, accept an additional 2 percent markup to the total cost of that work paid at the basis of the Cost of the Work, including markups specified above, as reimbursement for additional administrative costs.

SC-11.05 Change of Contract Times

SC-11.05 Add the following new paragraphs immediately after 11.05.B:

C. Use of Float:

1. A request for adjustment of Contract Times (or Milestones), otherwise allowable under the Contract Documents, shall be granted only when the time lost or gained exceeds the float for the activity at the time of the event giving rise to the claim. Float, the amount of time between the early start date and the late start date, or the early finish date and the late finish date, is jointly owned by both Owner and Contractor whether expressly disclosed or implied in any manner.

2. Contractor shall not use float suppression techniques (including, but not limited to, preferential sequencing caused by late starts of follow-up trades, unreasonably small crews, extended durations, or imposed dates) in information provided to Engineer.

D. Weather Days:

1. The Contract Time includes a weather day allowance of 20 working days. No extension in Contract Time will be allowed for the first 20 working days lost due to weather conditions.

SC-11.06 Change Proposals

SC-11.06 Delete Paragraph 11.06.a.1 in its entirety and insert the following in its place:

1. *Procedures*: Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 15 days) after the start of the event giving rise thereto, or after such initial decision. The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal. The supporting data shall be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event. Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal.

ARTICLE 12 - CLAIMS

SC-12.01 Delete Paragraph 12.01 in its entirely and insert the following in its place:

12.01. Claims Process*:*

Claims between the Owner and Contractor shall be addressed as provided by California Public Contract Code Section 9204, which is set forth in its entirety:

Legislative findings and declarations regarding timely and complete payment of contractors for public works projects; claims process.

(a) The Legislature finds and declares that it is in the best interests of the state and its citizens to ensure that all construction business performed on a public works project in the state that is complete and not in dispute is paid in full and in a timely manner.

(b) Notwithstanding any other law, including, but not limited to, Article 7.1 (commencing with Section 10240) of Chapter 1 of Part 2, Chapter 10 (commencing with Section 19100) of Part 2, and Article 1.5 (commencing with Section 20104) of Chapter 1 of Part 3, this section shall apply to any claim by a contractor in connection with a public works project.

(c) For purposes of this section:

(1) "Claim" means a separate demand by a contractor sent by registered mail or certified mail with return receipt requested, for one or more of the following:

(A) A time extension, including, without limitation, for relief from damages or penalties for delay assessed by a public entity under a contract for a public works project.

(B) Payment by the public entity of money or damages arising from work done by, or on behalf of, the contractor pursuant to the contract for a public works project and payment for which is not otherwise expressly provided or to which the claimant is not otherwise entitled.

(C) Payment of an amount that is disputed by the public entity.

(2) "Contractor" means any type of contractor within the meaning of Chapter 9 (commencing with Section 7000) of Division 3 of the Business and Professions Code who has entered into a direct contract with a public entity for a public works project.

(3) Public entity definition

(A) "Public entity" means, without limitation, except as provided in subparagraph (B), a state agency, department, office, division, bureau, board, or commission, the California State University, the University of California, a city, including a charter city, county, including a charter county, city and county, including a charter city and county, district, special district, public authority, political subdivision, public corporation, or nonprofit transit corporation wholly owned by a public agency and formed to carry out the purposes of the public agency.

(B) "Public entity" shall not include the following:

(i) The Department of Water Resources as to any project under the jurisdiction of that department.

(ii) The Department of Transportation as to any project under the jurisdiction of that department.

(iii) The Department of Parks and Recreation as to any project under the jurisdiction of that department.

(iv) The Department of Corrections and Rehabilitation with respect to any project under its jurisdiction pursuant to Chapter 11 (commencing with Section 7000) of Title 7 of Part 3 of the Penal Code.

(v) The Military Department as to any project under the jurisdiction of that department.

(vi) The Department of General Services as to all other projects.

(vii) The High-Speed Rail Authority.

(4) “Public works project” means the erection, construction, alteration, repair, or improvement of any public structure, building, road, or other public improvement of any kind.

(5) “Subcontractor” means any type of contractor within the meaning of Chapter 9 (commencing with Section 7000) of Division 3 of the Business and Professions Code who either is in direct contract with a contractor or is a lower tier subcontractor.

(d) Claims process:

(1) Claims review and response

(A) Upon receipt of a claim pursuant to this section, the public entity to which the claim applies shall conduct a reasonable review of the claim and, within a period not to exceed 45 days, shall provide the claimant a written statement identifying what portion of the claim is disputed and what portion is undisputed. Upon receipt of a claim, a public entity and a contractor may, by mutual agreement, extend the time period provided in this subdivision.

(B) The claimant shall furnish reasonable documentation to support the claim.

(C) If the public entity needs approval from its governing body to provide the claimant a written statement identifying the disputed portion and the undisputed portion of the claim, and the governing body does not meet within the 45 days or within the mutually agreed to extension of time following receipt of a claim sent by registered mail or certified mail, return receipt requested, the public entity shall have up to three days following the next duly publicly noticed meeting of the governing body after the 45-day period, or extension, expires to provide the claimant a written statement identifying the disputed portion and the undisputed portion.

(D) Any payment due on an undisputed portion of the claim shall be processed and made within 60 days after the public entity issues its written statement. If the public entity fails to issue a written statement, paragraph (3) shall apply.

(2) Claims dispute

(A) If the claimant disputes the public entity’s written response, or if the public entity fails to respond to a claim issued pursuant to this section within the time prescribed, the claimant may demand in writing an informal conference to meet and confer for settlement of the issues in dispute. Upon receipt of a demand in writing sent by registered mail or certified mail, return receipt requested, the public entity shall schedule a meet and confer conference within 30 days for settlement of the dispute.

(B) Within 10 business days following the conclusion of the meet and confer conference, if the claim or any portion of the claim remains in dispute, the public entity shall provide the claimant a written statement identifying the portion of the claim that remains in dispute and the portion that is undisputed. Any payment due on an undisputed portion of the claim shall be processed and made within 60 days after the public entity issues its written statement. Any disputed portion of the claim, as identified by the contractor in writing, shall be submitted to nonbinding mediation, with the public entity and the claimant sharing the associated costs equally. The public entity and claimant shall mutually agree to a mediator within 10 business days after the disputed portion of the claim has been identified in writing. If the parties cannot agree upon a mediator,

each party shall select a mediator and those mediators shall select a qualified neutral third party to mediate with regard to the disputed portion of the claim. Each party shall bear the fees and costs charged by its respective mediator in connection with the selection of the neutral mediator. If mediation is unsuccessful, the parts of the claim remaining in dispute shall be subject to applicable procedures outside this section.

(C) For purposes of this section, mediation includes any nonbinding process, including, but not limited to, neutral evaluation or a dispute review board, in which an independent third party or board assists the parties in dispute resolution through negotiation or by issuance of an evaluation. Any mediation utilized shall conform to the timeframes in this section.

(D) Unless otherwise agreed to by the public entity and the contractor in writing, the mediation conducted pursuant to this section shall excuse any further obligation under Section 20104.4 to mediate after litigation has been commenced.

(E) This section does not preclude a public entity from requiring arbitration of disputes under private arbitration or the Public Works Contract Arbitration Program, if mediation under this section does not resolve the parties' dispute.

(3) Failure by the public entity to respond to a claim from a contractor within the time periods described in this subdivision or to otherwise meet the time requirements of this section shall result in the claim being deemed rejected in its entirety. A claim that is denied by reason of the public entity's failure to have responded to a claim, or its failure to otherwise meet the time requirements of this section, shall not constitute an adverse finding with regard to the merits of the claim or the responsibility or qualifications of the claimant.

(4) Amounts not paid in a timely manner as required by this section shall bear interest at 7 percent per annum.

(5) If a subcontractor or a lower tier subcontractor lacks legal standing to assert a claim against a public entity because privity of contract does not exist, the contractor may present to the public entity a claim on behalf of a subcontractor or lower tier subcontractor. A subcontractor may request in writing, either on his or her own behalf or on behalf of a lower tier subcontractor, that the contractor present a claim for work which was performed by the subcontractor or by a lower tier subcontractor on behalf of the subcontractor. The subcontractor requesting that the claim be presented to the public entity shall furnish reasonable documentation to support the claim. Within 45 days of receipt of this written request, the contractor shall notify the subcontractor in writing as to whether the contractor presented the claim to the public entity and, if the original contractor did not present the claim, provide the subcontractor with a statement of the reasons for not having done so.

(e) The text of this section or a summary of it shall be set forth in the plans or specifications for any public works project that may give rise to a claim under this section.

(f) A waiver of the rights granted by this section is void and contrary to public policy, provided, however, that (1) upon receipt of a claim, the parties may mutually agree to waive, in writing, mediation and proceed directly to the commencement of a civil action or binding arbitration, as applicable; and (2) a public entity may prescribe reasonable change order, claim, and dispute resolution procedures and requirements in addition to

the provisions of this section, so long as the contractual provisions do not conflict with or otherwise impair the timeframes and procedures set forth in this section.

(g) This section applies to contracts entered into on or after January 1, 2017.

(h) Nothing in this section shall impose liability upon a public entity that makes loans or grants available through a competitive application process, for the failure of an awardee to meet its contractual obligations.

(i) This section shall remain in effect only until January 1, 2020, and as of that date is repealed, unless a later enacted statute, that is enacted before January 1, 2020, deletes or extends that date.

(j)* Claims Process additional requirements*:

(1) Claims asserted by the Owner against the Contractor shall be submitted according to the procedures set forth above.

(2) In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, or both, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled. Such a claim shall be submitted promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal.

(3) The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. All actions taken on a Claim shall be stated in writing and submitted to the other party, with a copy to Engineer..

(4) Mediation:

(A) If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process shall resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision.

SC-12.01 Add the following subparagraph immediately following Paragraph 12.01.A:

B. Claims over $375,000 or less shall be resolved pursuant to California Public Contract Code Section 20104 et seq. unless Owner elects to resolve the dispute pursuant to California Public Contract Code Section 10240 et seq.

ARTICLE 13 - COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

SC-13.01 Cost of Work

SC-13.01 Delete Paragraph 13.01.B.5.c in its entirety and insert the following in its place:

c. Construction Equipment and Machinery

Equipment rental payment is full compensation for:

1. Rental equipment costs, including moving rental equipment to and from the change order work site using its own power.
2. Transport equipment costs for rental equipment that cannot be transported economically using its own power. No payment is made during transport for the transported equipment.

   If the Contractor wants to return the equipment to a location other than its original location, the payment to move the equipment must not exceed the cost of returning the equipment to its original location. If the Contractor uses the equipment for work other than work paid by force account, the transportation cost is included in the other work.

   Before moving or loading the equipment, obtain authorization for the equipment rental's original location.

The Engineer determines rental costs:

1. Using rates in the Caltrans Labor Surcharge and Equipment Rental Rates:

1.1. By classifying equipment using manufacturer's ratings and manufacturer-approved changes.

1.2. Current during the work paid by force account.

1.3. Regardless of equipment ownership; but the City uses the rental document rates or minimum rental cost terms if:

1.3.1. Rented from equipment business the Contractor does not own.

1.3.2. The Labor Surcharge and Equipment Rental Rates hourly rate is $10.00 per hour or less.

2. Using rates established by the Engineer for equipment not listed in Labor Surcharge and Equipment Rental Rates. The Contractor may submit cost information that helps the Engineer establish the rental rate; but the City uses the rental document rates or minimum rental cost terms if:

2.1. Rented from equipment business the Contractor does not own.

2.2. The Engineer establishes a rate of $10.00 per hour or less.

3. Using rates for transport equipment not exceeding the hourly rates charged by established haulers.

Equipment rental rates include the cost of:

1. Fuel.
2. Oil.

3. Lubrication.
4. Supplies.
5. Small tools that are not consumed by use.
6. Necessary attachments.
7. Repairs and maintenance.
8. Depreciation.
9. Storage.
10. Insurance.
11. Incidentals.

The City pays for small tools consumed by use. The Engineer determines payment for small tools consumed by use based on Contractor-submitted invoices.

The Engineer may authorize rates in excess of those in the Labor Surcharge and Equipment Rental Rates if:

1. The Contractor submits a request to use rented equipment
2. Equipment is not available from the Contractors normal sources or from one of the Contractors subcontractors
3. Rented equipment is from an independent rental company
4. Proposed equipment rental rate is reasonable
5. The Engineer authorizes the equipment source and the rental rate before the Contractor uses the equipment

EQUIPMENT ON THE JOB SITE

For equipment on the job site at the time required to perform work paid by force account, the time paid is the time:

1. To move the equipment to the location of work paid by force account plus an equal amount of time to move the equipment to another location on the job site when the work paid by force account is completed
2. To load and unload equipment
3. Equipment is operated to perform work paid by force account and:
   - 3.1. Hourly rates are paid in 1/2-hour increments
   - 3.2. Daily rates are paid in 1/2-day increments

EQUIPMENT NOT ON THE JOB SITE REQUIRED FOR ORIGINAL CONTRACT WORK

For equipment not on the job site at the time required to perform work paid by force account and required for original-Contract work, the time paid is the time the equipment is operated to perform work paid by force account and the time to move the equipment to a

location on the job site when the work paid by force account is completed.

The minimum total time paid is:

1. 1 day if daily rates are paid.
2. 8 hours if hourly rates are paid.

If daily rates are recorded, equipment:

1. Idled is paid as 1/2 day.
2. Operated 4 hours or less is paid as 1/2 day.
3. Operated 4 hours or more is paid as 1 day.

If the minimum total time exceeds 8 hours and if hourly rates are listed, the City rounds up hours operated to the nearest 1/2-hour increment and pays based on the hours shown the following table. The table does not apply when equipment is not operated due to breakdowns, in which case rental hours are the hours the equipment was operated.

Equipment Rental Hours

Hours operated	Hours paid
0.0	4.00
0.5	4.25
1.0	4.50
1.5	4.75
2.0	5.00
2.5	5.25
3.0	5.50
3.5	5.75
4.0	6.00
4.5	6.25
5.0	6.50
5.5	6.75
6.0	7.00
6.5	7.25
7.0	7.50

7.5	7.75
≥8.0	hours used

EQUIPMENT NOT ON THE JOB SITE NOT REQUIRED FOR ORIGINAL CONTRACT WORK

For equipment not on the job site at the time required to perform work paid by force account and not required for original-Contract work, the time paid is the time:

1. To move the equipment to the location of work paid by force account plus an equal amount of time to return the equipment to its source when the work paid by force account is completed
2. To load and unload equipment
3. Equipment is operated to perform work paid by force account

NON-OWNER OPERATED DUMP TRUCK RENTAL

Submit the rental rate for non-owner-operated dump truck rental. The Engineer determines the payment rate. Payment for non-owner-operated dump truck rental is for the cost of renting a dump truck, including its driver. For the purpose of markup payment only, the non-owner-operated dump truck is rental equipment and the owner is a subcontractor.

The above markups shall constitute full compensation for all home office overhead, field office overhead, bond costs, profit, labor liability insurance, and other fixed or administrative costs that are not costs specifically designated as cost or equipment rental as stated above. The total payment made as provided above shall be deemed to be the actual cost of the work and shall constitute full compensation therefor.

SC-13.03 Unit Price Work

SC-13.03 Delete Paragraph 13.03.E in its entirety and insert the following in its place:

E. The unit price of an item of Unit Price Work shall be subject to reevaluation and adjustment under the following conditions:

1. if the extended price of a particular item of Unit Price Work amounts to 25 percent or more of the Contract Price (based on estimated quantities at the time of Contract formation) and the variation in the quantity of that particular item of Unit Price Work actually furnished or performed by Contractor differs by more than 25 percent from the estimated quantity of such item indicated in the Agreement; and
2. if there is no corresponding adjustment with respect to any other item of Work; and

3. if Contractor believes that Contractor has incurred additional expense as a result thereof, Contractor may submit a Change Proposal, or if Owner believes that the quantity variation entitles Owner to an adjustment in the unit price, Owner may make a Claim, seeking an adjustment in the Contract Price.

ARTICLE 15 - PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

SC-15.01 Progress Payments

SC-15.01 Amend the first sentence in Paragraph 15.01.B.1 to read as follows:

1. At least 30 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents.

SC-15.01 Add following new paragraphs immediately after the last sentence in 15.01.B.1:

a. Payments for stored materials and equipment shall be based only upon the actual cost of the materials and equipment to Contractor and shall not include any overhead or profit to Contractor.

b. Partial payments will not be made for undelivered materials or equipment, except for payments associated with prepurchase vendor contracts initiated by Owner and assigned to Contractor.

SC-15.01 Amend the first sentence in Paragraph 15.01.C.1 to read as follows:

1. Engineer will, within 7 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.

SC-15.01 Amend the first sentence in Paragraph 15.01.D.1 to read as follows:

1. Thirty days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.

SC-15.01 Add the following new paragraph immediately after Paragraph 15.01.D.1:

a. Contractor shall disburse money paid to him, including any interest Contractor receives, to Subcontractors and Suppliers within 15 days after Contractor receives the money, in direct proportion to the Subcontractors' and Suppliers' basis in the total Contract between Contractor and Owner. Any money which is payable to a Subcontractor pursuant to this Section accrues interest at the legal rate. Contractor may withhold a portion of any partial payment as may be set forth in a subcontract. Thereafter Contractor shall pay

any additional funds if, in the opinion of Contractor, satisfactory progress is being made in the work under the subcontract, and the payment must be equal to that paid by Owner to Contractor for the Work performed by the Subcontractor:

1) The Contractor may retain the amount withheld under the subcontract until the subcontract is satisfactorily completed.

2) The amount withheld under the subcontract is due within 15 days after the acceptance of the subcontract work by Contractor.

3) Whenever Contractor receives a payment of interest earned on the amount withheld from the Contract, Contractor shall within 15 days pay to each Subcontractor that portion of the interest received from the state which is attributable to the amount of money withheld from the Subcontractor.

SC-15.03 Substantial Completion

SC-15.03 Add the following subparagraphs immediately after Paragraph 15.03.A:

1. The Work shall be Substantially Complete when the Work may treat water with the new facilities in accordance with the Contract Documents. All process and transmission equipment shall be installed and operational, or temporary arrangements satisfactory to Owner shall have been made. Operational testing must be completed prior to the date of Substantial Completion.

2. To be considered substantially complete, all Work must be operational and ready for Owner's continuous use as intended:

3. Portions of the Work not essential to plant operation, which can be completed without interruption of plant operation, may be completed after the Work is accepted as Substantially Complete, and may include the following items:

    a. Final O&M manuals.

    b. Spare parts.

    c. As-built documents.

    b. Final clean-up.

SC-15.03 Add the following new subparagraph to Paragraph 15.03.B:

1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, shall be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

SC-15.05 Final Inspection

SC-15.05 Add the following new paragraph immediately after Paragraph 15.05.A:

B. If some or all of the Work has been determined not to be at a point of Final Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, shall be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

SC-17.01 Methods and Procedures

SC-17.01 Add the following subparagraphs immediately after Paragraph 17.01.B.3:

4. resolve claims of $375,000 or less pursuant to California Public Contract Code Section 20104 et seq., unless Owner elects to resolve the dispute pursuant to California Public Contract Code Section 10240 et seq.

END OF DOCUMENT

DOCUMENT 00823

ESCROW BID DOCUMENTS

ARTICLE 1 - SCOPE

1.01 The 3 lowest Bidders shall submit, within the specified time after receipt of Bids, 1 copy of all documentary information generated in preparation of Bid prices for this Project. This material is hereinafter referred to as "Escrow Bid Documents." The Escrow Bid Documents of the Successful Bidder will be held in escrow for the duration of the contract.

1.02 The Successful Bidder agrees, as a condition of award of the contract, that the Escrow Bid Documents constitute the complete, only, and all documentary information used in preparation of his Bid. No other Bid preparation information shall be considered in resolving disputes.

1.03 Nothing in the Escrow Bid Documents shall change or modify the terms or conditions of the Contract Documents.

ARTICLE 2 - OWNERSHIP

2.01 The Escrow Bid Documents are, and shall always remain, the property of Contractor, subject only to joint review by Owner and Contractor, as provided in this Document.

2.02 Owner stipulates and expressly acknowledges that the Escrow Bid Documents, as defined in this Document, constitute trade secrets. This acknowledgment is based on Owner's express understanding that the information contained in the Escrow Bid Documents is not known outside the Bidder's business, is known only to a limited extent and only by a limited number of employees of the Bidder, is safeguarded while in Bidder's possession, is extremely valuable to Bidder, and could be extremely valuable to Bidder's competitors by virtue of it reflecting Bidder's contemplated techniques of construction. Owner acknowledges that the Bidder expended substantial sums of money in developing the information included in the Escrow Bid Documents and further acknowledges that it would be difficult for a competitor to replicate the information contained therein. Owner further acknowledges that the Escrow Bid Documents and the information contained therein are made available to Owner only because such action is an express prerequisite to award of the contract. Owner further acknowledges that the Escrow Bid Documents include a compilation of information used in the Bidder's business, intended to give the Bidder an opportunity to obtain an advantage over competitors who do not know of or use the contents of the documentation. Owner agrees to safeguard the Escrow Bid Documents, and all information contained therein, against disclosure to the fullest extent permitted by law.

ARTICLE 3 - PROGRAM

3.01 Escrow Bid Documents will be used to assist in the negotiation of price adjustments and Change Orders and in the settlement of disputes, claims, and other controversies. They will not be used for pre-award evaluation of Contractor's anticipated methods of construction or to assess Contractor's qualifications for performing the Work.

ARTICLE 4 - FORMAT AND CONTENTS

4.01 Bidders may submit Escrow Bid Documents in their usual cost-estimating format. It is not the intention of this section to cause the Bidder extra work during the preparation of the Bid, but to ensure that the Escrow Bid Documents will be adequate to enable complete understanding and proper interpretation for their intended use. The Escrow Bid Documents shall be in the language of the Specifications.

4.02 It is required that the Escrow Bid Documents clearly itemize the estimated costs of performing the work of each Bid item contained in the Bid schedule. Bid items should be separated into subitems as required to present a complete and detailed cost estimate and allow a detailed cost review. The Escrow Bid Documents shall include all quantity takeoffs; crew; equipment; calculations of rates of production and progress; copies of quotations from equipment manufacturers, Subcontractors, and Suppliers; and memoranda, narratives, consultants' reports, add/deduct sheets, and all other information used by the Bidder to arrive at the prices contained in the Bid Form. Estimated costs should be broken down into the Bidder's usual estimate categories, such as direct labor, repair labor, equipment operation, equipment ownership, expendable materials, permanent materials, and subcontract costs as appropriate. Plant and equipment and indirect costs should be detailed in the Bidder's usual format. Contractor's allocation of plant and equipment, indirect costs, contingencies, markup, and other items to each Bid item shall be included.

4.03 All costs shall be identified. For Bid items amounting to less than $10,000, estimated unit costs are acceptable without a detailed cost estimate, provided that labor, equipment, materials, and subcontracts, as applicable, are included, and provided that indirect costs, contingencies, and markup, as applicable, are allocated.

4.04 Bidding Documents provided by the Owner should not be included in the Escrow Bid Documents unless needed to comply with the requirements of this section.

ARTICLE 5 - SUBMITTAL

5.01 The Escrow Bid Documents shall be submitted in a sealed container within 72 hours after the time of receipt of Bids. The container shall be clearly marked on the outside with the Bidder's name, date of submittal, project name, and the words "Escrow Bid Documents."

5.02 The Escrow Bid Documents shall be accompanied with the Bid Documentation Certification, signed by an individual authorized by the Bidder to execute the Bid Form, stating that the material in the Escrow Documentation constitutes the complete, only, and all documentary information used in preparation of the Bid and that he has personally examined the contents of the Escrow Bid Documents container and has found that the documents in the container are complete.

5.03 Prior to award, Escrow Bid Documents of the apparent Successful Bidder will be unsealed, examined, organized, and inventoried by representatives of Owner, together with members of Contractor's staff who are knowledgeable in how the Bid was prepared.

5.04 This examination is to ensure that the Escrow Bid Documents are authentic, legible, and complete. It will not include review of, and will not constitute approval of, proposed construction methods, estimating assumptions, or interpretations of Contract Documents. This examination is subject to the condition that, as trade secrets, the Escrow Bid Documents are proprietary and confidential as described in this Document. Examination will not alter any condition(s) or term(s) of the contract.

5.05 If all the documentation required in this Document has not been included in the original submittal, additional documentation shall be submitted, at Owner's discretion, prior to award of the contract. The detailed breakdown of estimated costs shall be reconciled and revised, if appropriate, by agreement between Contractor and Owner before making the award.

5.06 If the contract is not awarded to the apparent Successful Bidder, the Escrow Bid Documents of the Bidder next to be considered for award shall be processed as described above.

5.07 Timely submission of complete Escrow Bid Documents is an essential element of the Bidder's responsibility and a prerequisite to contract award. Failure to provide the necessary Escrow Bid Documents will be sufficient cause for Owner to reject the Bid.

5.08 If the Bidder's proposal is based on subcontracting any part of the Work, each Subcontractor whose total subcontract price exceeds 5 percent of the total Contract Price proposed by the Bidder shall provide separate Escrow Bid Documents to be included with those of the Bidder. These documents will be opened and examined in the same manner and at the same time as the examination described above for the apparent Successful Bidder.

5.09 If Contractor subcontracts any portion of the Work after award, Owner retains the right to require Contractor to submit Escrow Bid Documents from the Subcontractor before the subcontract is approved.

5.10 Escrow Bid Documents submitted by unsuccessful Bidders will be returned unopened, unless opened as provided above, as soon as they are no longer needed by Owner and no later than immediately following award of the contract.

ARTICLE 6 - STORAGE

6.01 The Escrow Bid Documents of the Successful Bidder will be placed in escrow prior to award of the contract, for the life of the contract, in a mutually agreeable institution. The cost of storage will be paid by Owner.

ARTICLE 7 - EXAMINATION AFTER AWARD OF CONTRACT

7.01 The Escrow Bid Documents shall be examined by both Owner and Contractor, at any time deemed necessary after award of the contract by either Owner or Contractor, to assist in the negotiation of price adjustments and Change Orders, or the settlement of disputes.

7.02 Examination of the Escrow Bid Documents after award of the contract is subject to the following conditions:

1. As trade secrets, the Escrow Bid Documents are proprietary and confidential as described in this Document.
2. Owner and Contractor shall each designate, in writing to the other party and a minimum of 10 days prior to examination, representatives who are authorized to examine the Escrow Bid Documents. No other person shall have access to the Escrow Bid Documents.
3. Access to the Escrow Bid Documents will take place only in the presence of duly designated representatives of both Owner and Contractor.

ARTICLE 8 - FINAL DISPOSITION

8.01 The Escrow Bid Documents will be returned to Contractor at such time as the contract has been completed and final settlement has been achieved.

BID DOCUMENTATION

---- CERTIFICATION ----

I, THE UNDERSIGNED, HEREBY CERTIFY THAT THE BID DOCUMENTATION CONTAINED HEREIN CONSTITUTES THE COMPLETE, ONLY, AND ALL DOCUMENTARY INFORMATION USED IN PREPARATION OF THE BID AND THAT I HAVE PERSONALLY EXAMINED THESE CONTENTS AND HAVE FOUND THAT THIS BID DOCUMENTATION IS COMPLETE.

BY: _____

TITLE: _____

FIRM: _____

DATE: _____

END OF DOCUMENT

DOCUMENT 00899

CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner:	City of Turlock	**Owner's Contract No.:**	15-39C
Contractor:		**Contractor's Project No.:**	
Engineer:	Carollo Engineers, Inc.	**Engineer's Project No.:**	10164A.10
Project:	Turlock Regional Water Quality Control Facility Secondary Clarifier No. 5 and Denitrification Project		

Field Order Execution

This Certificate of Substantial Completion applies to:

☐ All Work: ☐ The following specified portions of the Work:

Date of Substantial Completion

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work shall be as provided in the Contract, except as amended as follows:

Amendments to Owner's responsibilities:
☐ None
☐ As follows

Amendments to Contractor's responsibilities:
☐ None
☐ As follows:

Field Order Execution			
The following documents are attached to and made a part of this Certificate:			
This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents, nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract.			
EXECUTED BY ENGINEER:		RECEIVED:	RECEIVED:
By: _____ (Authorized signature)		By: _____ Owner (Authorized Signature)	By: _____ Contractor (Authorized Signature)
Title: _____		Title: _____	Title: _____
Date: _____		Date: _____	Date: _____

END OF DOCUMENT

SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Identification and summary description of the Project, the Work, location, Owner furnished products, activities by others, coordination, and early occupancy by Owner.

1.02 THE WORK

A. The Work consists of construction of the following components:
   1. Secondary Clarifier No. 5.
   2. RAS Pump Station No. 2.
   3. Mixed Liquor Flume Nos. 5 and 6.
   4. Modifications to Aeration Basins No. 1 through No. 7.
   5. Modifications to Junction Box No. 1A.
   6. Modifications to crane at Biotower Pump Station.
   7. Modifications to Electrical Building No. 7.
   8. Additions and modifications to yard piping system.
   9. Additions and modifications to electrical systems.
   10. Additions and modifications to instrumentation systems.
   11. Additions and modifications to grading, paving and drainage system.
   12. Repair and reconstruction to existing improvements affected by the Work and all work necessary to render the facility complete and operational.

B. Except as specifically noted otherwise, provide and pay for:
   1. Insurance and bonds.
   2. Labor, materials, and equipment.
   3. Tools, equipment, and machinery required for construction.
   4. Utilities required for construction.
   5. Temporary facilities including sheeting and shoring.
   6. Dust control measures.
   7. Other facilities and services necessary for proper execution and completion of the Work.

C. Secure and pay for all permits including OSHA excavation permits, Department of Transportation permits, government fees, and licenses.

D. Comply with codes, ordinances, regulations, orders, and other legal requirements of public authorities having bearing on the performance of the Work.

1.03 LOCATION OF PROJECT

A. The Work is located at 901 S. Walnut Road, Turlock, CA 95380, Stanislaus County, California.

1.04 OWNER ASSIGNED SUBCONTRACTORS

A. Assignment of subcontractors by Owner is not anticipated.

1.05 OWNER FURNISHED EQUIPMENT

A. Owner will furnish:
   1. None.

1.06 ACTIVITIES BY OTHERS

A. Owner, utilities, and others may perform activities within Project area while the Work is in progress. These activities by others which may affect performance of the Work include:
   1. Normal daily operation and maintenance of the wastewater treatment plant by Owner, including hauling of sludge out of sludge drying beds.
   2. Owner will be processing the landfill material excavated by Contractor for recycling and disposal. Contractor shall coordinate excavation and stockpile operations with Owner's scavenger contractor.
   3. Schedule the Work with Owner, utilities, and others to minimize mutual interference.

B. Cooperate with others to minimize interference and delays:
   1. When cooperation fails, submit recommendations and perform Work in coordination with work of others as directed.

C. When the Work depends for proper execution or results upon work performed by others, inspect and promptly report apparent discrepancies or defects in work performed by others:
   1. Assume responsibility for work performed by others, except for defects reported as specified in this paragraph and defects which may become apparent in work performed by others after execution of the Work.

1.07 COORDINATION OF WORK

A. Maintain overall coordination of the Work.

B. Obtain construction schedules from each subcontractor, and require each subcontractor to maintain schedules and coordinate modifications.

1.08 EARLY OCCUPANCY OF PORTIONS OF WORK

A. Substantially Complete following portions of the Work for Owner's occupancy including specified testing, training of Owner's personnel, and other preparations necessary for Owner's occupancy or use, by the date specified:
   1. By Milestone No. 1:
      a. Modification of five (5) of seven (7) existing aeration basins.
      b. Electrical Building No. 7 modifications.
      c. MCC No. 8 Enclosure.
      d. Yard piping work connecting Aeration Basin No. 6 and No. 7 to the Plant Drain/Storm Water Pump Station north of Aeration Basins No. 4 and No. 5.

e. Instrumentation, controls, and programming work associated with Aeration Basins No. 1 through No. 7 modifications.
f. All other work required to modify and place into service five (5) of seven (7) existing aeration basins for denitrification including associated civil, yard piping and electrical work.

B. Certificates of Substantial Completion will be executed for each designated portion of Work prior to Owner occupancy:
1. Such certificate of Substantial Completion will describe the portion of the Work to be occupied by Owner, items that may be incomplete or defective, date of occupancy by Owner, and other information required by Owner and Contractor.

C. After Owner occupancy, allow access for Owner's personnel, access for others authorized by Owner, and Owner operation of equipment and systems.

D. Following occupancy, Owner will:
1. Provide power to operate equipment and systems.
2. Repair damage caused by Owner's occupancy.

E. Correction period for portions of the Work occupied or partially utilized by Owner shall commence with date of Substantial Completion for that portion of the Work and acceptance for use by Owner:
1. However, progress payment withholdings for portions of the Work occupied by Owner will not be released until final acceptance of the total Work.

F. Prior to such occupancy or use, enter into agreement with Owner indicating work that remains to be performed in occupied areas.

G. When Owner's use of occupied facilities reveal defective work, correct defects.

H. No partial acceptance of the Work will be made and no acceptance other than the final acceptance of the completed Work will be made except for those portions of Work designated for early occupancy by Owner.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01116

CONTRACT DOCUMENT LANGUAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Explanation of arrangement, language, reference standards and format.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01600 - Product Requirements.

1.02 REFERENCES

A. Construction Specifications Institute (CSI):
   1. MasterFormat™.
   2. SectionFormat™.
   3. PageFormat™.

1.03 PROJECT MANUAL ARRANGEMENT

A. Document and Section numbers used in Project Manual, and Project Manual arrangement are in accordance with CSI MasterFormat™, except where departures have been deemed necessary.

B. Sections are written in CSI SectionFormat™, Three-Part Section Format, except where departures have been deemed necessary.

C. Page format for Sections in the Project Manual is in PageFormat™, except where departures have been deemed necessary.

1.04 CONTRACT DOCUMENT LANGUAGE

A. Specification Section Paragraphs entitled "Section Includes" summarize briefly what is generally included in the section:
   1. Requirements of Contract Documents are not limited by "Section Includes" paragraphs.

B. Specifications have been partially streamlined by intentionally omitting words and phrases, such as "the Contractor shall," "in conformity therewith," "shall be" following "as indicated," "a," "an," "the" and "all":
   1. Assume missing portions by inference.

C. Phrase "by Engineer" modifies words such as "accepted," "directed," "selected," "inspected," and "permitted," when they are unmodified.

D. Phrase "to Engineer" modifies words such as "submit," "report," and "satisfactory," when they are unmodified.

E. Colons (:) are used to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation:
   1. When used as an appositive after designation of product, colons are used in place of words "shall be."

F. Word "provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.

G. Words "Contractor shall" are implied when direction is stated in imperative mood.

H. Term "products" includes materials and equipment as specified in Section 01600.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01140

WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for sequencing and scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.

B. Related sections:
   1. Section 01110 - Summary of Work.
   2. Section 01324A - Progress Schedules and Reports.
   3. Section 01500 - Temporary Facilities and Controls.
   4. Section 01738 - Selective Site Demolition.
   5. Section 01756 - Commissioning.

1.02 SUBMITTALS

A. Baseline Schedule with MOP tasks.

B. Method of Procedure (MOP) Form.

C. Method of Procedure (MOP) Log.

D. Progress Schedule with MOP tasks.

1.03 GENERAL

A. The City of Turlock's Regional Water Quality Control Facility is the City of Turlock's only means of treating domestic and industrial wastewater prior to discharging to San Joaquin River. Impairing the operational capabilities of this treatment plant will result in serious environmental damage and monetary fines.

B. Conduct Work in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels required to treat the entire quantity of raw wastewater received by the treatment plant to the water quality limitations specified in the Owner’s National Pollutant Discharge Elimination System (NPDES) permit (discharge permit).

C. Conduct commissioning and process start-up activities as specified in Section 01756 in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels required to treat the quantity and quality of influent raw wastewater to the water quality limitations specified in the discharge permit.

D. Include costs in bid price for compliance with the specific limitations and constraints and the related general factors pertaining to maintaining the operational capacity of the treatment facility.

1.04 INTERRUPTION OF TREATMENT PROCESSES

A. Execute the Work while the existing facility is in operation as specified in Section 01738.

B. Indicate required shutdowns of existing facilities or interruptions of existing operations on Progress Schedule. Shutdowns will be permitted to the extent that existing operation of the plant will not be jeopardized and identified constraints are satisfied.

C. Submit notification of required shutdowns of existing facilities at least 14 days prior to the planned date of shutdown.

D. The Owner and Engineer will evaluate the request based on the plant's ability to reliably meet capacity demands.

E. Do not begin alterations until Engineer's written permission has been received.

F. Minimize shutdown times by thorough advanced planning. Have required equipment, materials, and labor on hand at time of shutdown.

G. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.05 METHOD OF PROCEDURE (MOP)

A. MOP Instructions: See Appendix A.

B. Prepare a MOP for the following conditions:
   1. Shutdowns, diversions, and tie-ins to the existing facility.
   2. Process start-up activities.
   3. Power interruption and tie-ins.
   4. Switch over between temporary and permanent facilities, equipment, piping, and electrical and instrumentation systems.
   5. Process constraints requiring interruption of operating processes or utilities.

C. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.

D. Submit Baseline Schedule, as specified in Section 01324A, with proposed MOPs.

E. Submit MOP Log at construction progress meetings.

F. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilitates proper operation of the facility and compliance with effluent discharge criteria.

G. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.06 COMPLIANCE WITH NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

A. The existing facility is operating under the terms of a NPDES permit issued by the State of California. This permit specifies the water quality limits that the plant must meet prior to discharge of effluent. A copy of the existing permit is on file for review at the City of Turlock Water Quality Control Facility.

B. Perform work in a manner that will not prevent the existing facility from achieving the finished water quality requirements established by regulations.

C. Bear the cost of penalties imposed on the Owner for discharge violations caused by actions of the Contractor.

1.07 REQUIREMENTS FOR OPERATION OF PLANT AND MAINTAINING CONTINUOUS OPERATION OF EXISTING FACILITIES

A. Facilities or conditions required to keep the existing plant operational include, but are not limited to, the following:
   1. Electrical power including transformers, distribution wiring, and motor control centers.
   2. Piping for conveyance of raw wastewater to the facility.
   3. All existing wastewater pumping and treatment process facilities. These existing facilities include:
      a. Raw Wastewater Treatment Pumping Stations No. 1 and 2.
      b. Preliminary Treatment (fine screening).
      c. Primary Influent Flume Nos. 1, 2, and 3.
      d. Primary Flotator Nos. 1, 2 and 3.
      e. Grit Removal and Handling Facilities.
      f. Primary Sludge Pumping Stations No. 1 and No. 2.
      g. Primary Effluent Overflow Piping and Holding Ponds.
      h. Biotower Pump Station.
      i. Biotowers No. 1 and No. 2.
      j. Mixed Liquor Splitter Boxes.
      k. Aeration Basins No. 1 through No. 7.
      l. Blower Building No. 1 and No. 2.
      m. RAS Flumes.
      n. Secondary Clarifiers No. 1 through No. 4.
      o. RAS Pump Station (adjacent to Secondary Clarifier No. 4).
      p. Chlorine Building and associated scrubber and sprinkler system.
      q. Chemical Feed System.
      r. Densadeg High Rate Flocculation/Sedimentation Processes.
      s. Disk Filters.
      t. Chlorine Contact Tank.
      u. Plant No. 2 Water Pump Station.
      v. Dechlorination Facility.
      w. WAS Pumping Facilities.
      x. Gravity Belt Thickener.

y. Digesters Control Buildings (including digested sludge heating, boilers 1,2 and 3, heat exchangers, recirculation and mixing pumps, and waste gas flare).
z. Acid Phase Digester No. 1 and associated pumping and heating equipment.
aa. Anaerobic Digesters No. 1 through No. 6.
bb. Administration and Laboratory Buildings.
cc. Plant No. 1 and No. 2 water distribution system, and plant drain lines.

4. Piping for conveyance of untreated and treated water between the influent pumping stations, throughout the entire treatment process, and of treated effluent to the San Joaquin River.
5. All means of measuring and controlling the wastewater treatment processes at the existing WWTP.
6. All existing treatment equipment, piping, controls, pumps, and accessories.
7. All existing chemical feed systems (dry and liquid), metering, conveyance, and control facilities.
8. Piping for conveyance of wastewater, chemicals, and utilities between treatment units.
9. Chlorinators and associated equipment; chlorine residual analyzers; chemical solution piping at various locations in the plant. Plant No. 2 water is required at all times to permit chlorination.
10. Plant air.
11. Laboratory facilities.
12. Office, toilets, and washrooms.
13. Sludge Disposal: Existing digested sludge piping between Anaerobic Digester No. 4 and sludge drying beds to the south of the facility.
14. Fencing and gates.
15. Lighting.
16. Heating, ventilation, and air conditioning.
17. Instrumentation, meters, controls, and telemetry equipment.
18. Safety equipment and features.
19. Parking for City employees and vehicles required for operation and maintenance of the wastewater treatment plant (WWTP).
20. Telephone system.
21. Storm drainage.
22. Natural gas service.

B. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational.

C. Do not remove or demolish existing facilities required to keep the existing plant operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment:
1. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.

1.08 OPERATIONS AND MAINTENANCE ACCESS

A. Provide safe, continuous access to process control equipment for plant operations personnel.

1.09 UTILITIES

A. Provide advance notice to and utilize services of Underground Services Alert (U.S.A.) for location and marking of underground utilities operated by utility agencies other than the Owner. Refer to Section 01350 for additional requirements.

B. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.

1.10 PLANT ACCESS

A. Maintain restricted access to the treatment plant at all times through the use of gates, fences, or other approved means.

B. Plant access gates shall normally stay closed.

C. On-site parking area for Contractor is only within staging area designated in Contract Documents.

1.11 WORK ON OWNER'S EXISTING FACILITIES

A. Dewatering of existing process facilities and disposal of residue:
   1. Costs for dewatering, disposal of solids and residuals, and preparation of surfaces of existing tanks and pipelines for the Work are Contractor’s responsibility.
   2. When the Owner has turned a process unit over to the Contractor for modification or temporary use, the Contractor is responsible for costs and procedures required to dewater and dispose of liquids and solids contained in the process unit.
   3. Drainage and disposal of process unit liquids, solids, etc. into another treatment process unit on the plant site may be allowed if approved in advance by the Engineer and Owner and if work is done in accordance with Owner’s requirements.
   4. Include tipping fees for the removal and disposal of the grit/debris accumulated in the bottom of tanks, pipeline, and other existing facilities.
   5. Dewatering of grit/debris to meet landfill requirements is the responsibility of the Contractor.
   6. Contractor shall provide adequate time in schedules for draining and cleanup of basins, channels, pipelines, and similar facilities.

1.12 TEMPORARY FACILITIES

A. Locate temporary facilities in a manner that minimizes interference to Owner's operation and maintenance personnel.

B. Temporary piping:
   1. Unless otherwise specified, install temporary pipe of the same size as its connection to the existing facility at the downstream end of the pipeline.
   2. Provide piping material compatible with the material being conveyed.

C. Provide submittals on proposed temporary electrical and instrumentation components necessary to maintain existing facilities.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 COORDINATION OF WORK

A. Maintain overall coordination of execution of work.

B. Obtain schedules from subcontractors and suppliers and assume responsibility for correctness.

C. Incorporate schedules from subcontractors and suppliers into Progress Schedule to plan for and comply with sequencing constraints.

3.02 WORK BY OTHERS

A. Where proper execution of the Work depends upon work by others, inspect and promptly report discrepancies and defects.

3.03 GENERAL REQUIREMENTS FOR EXECUTION OF WORK

A. Dimensions for all existing structures, piping, paving, and other nonstructural items are approximate. The Contractor shall field verify all dimensions and conditions and report any discrepancies to the Engineer a minimum of 14 days in advance of any construction in the area.

B. Inspection of installed piping:
   1. After completing installation of piping and before placing piping in service, inspect all piping 30-inches in diameter or larger using Engineer circuit television for review and record keeping. Submit video logs to Engineer on CD-ROM in a commonly viewable format pre-approved by the Owner.
   2. Clean all debris from piping prior to placing new or modified pipelines in service.
   3. Protect downstream equipment from potential damage caused by construction debris during startup.

3.04 WORK SEQUENCE AND CONSTRAINTS

A. General:
   1. Utilize description of critical events in work sequence in this Section as a guideline for scheduling and undertaking the Work.
   2. Work sequence and constraints presented do not include all items affecting completion of the Work, but are intended to describe critical events necessary to minimize disruption of the existing facilities and to ensure compliance with water quality permit requirements.
   3. The following general suggested work sequence is provided to the Contractor by the Engineer as a possible sequence and is included solely as a general guideline and for informational purposes only:
      a. The Work Sequence listed in this section is not intended to dictate means, methods of construction, or direct construction activities.

b. The general work sequence is a conceptual general construction sequence that was reviewed with the Owner to provide minimum outage, shut downs, and state the minimum operating units to be maintained in service.
c. This outline is not intended to be all-inclusive and does not list all required work elements or details that may be required to complete the work, complete treatment processes, or place unit processes in service.
d. Contractor shall be responsible for implementing any additional details required, including temporary piping, bypass pumping, or temporary construction at no additional cost to Owner.

4. Contractor may propose alternate sequence or modifications to this work sequence. Owner will review the proposed modifications and determine if such proposed modifications of the work sequence interferes with the activities associated with proper operation of the wastewater treatment. Any modifications shall be submitted by the Contractor in writing and shall be approved by Owner in writing prior to their implementation.

B. Field Verification of Existing Utilities:

1. Prior to proceeding with any excavation or ordering fabrication shop drawings for the yard piping, Contractor shall proceed with field verification of the location of existing utilities and yard piping.
2. Information shown on yard piping drawings is based on the best available information at the time these drawings were prepared. However, the yard piping drawings should not be construed as portraying an accurate and complete representation of actual delineation of underground facilities. Not all existing piping and utilities are shown. Locations, depth of bury, sizes, and types of existing underground piping shown are approximate.
3. Prior to commencement of any work, Contractor shall perform potholing exploration to field verify both vertical and horizontal alignment and locations of existing piping and underground utilities shown crossing or tying into new piping and underground utilities.
4. See Section 01210 for Unanticipated Existing Underground Utilities and Yard Piping Location Allowance addressing existing utilities and yard piping that are not recorded on the contract documents.
5. Contractor shall notify Owner in advance of intent and schedule time and location for each potholing exploration to avoid interference with plant operation.
6. Once the exact locations of existing yard piping and utilities have been determined by Contractor, the Contractor shall determine if any modifications are required to the yard piping drawings.
7. Contractor shall notify Owner and Engineer of potential conflicts between existing yard piping as field located and new piping shown on the drawings as soon as they are uncovered so they can be remedied in a timely manner.
8. Engineer will review each conflict on a case-by-case basis and propose modifications to the yard piping to meeting field conditions, as required. If required, Engineer will provide revised drawings based on these field conditions within 30 days following completion of the “potholing” work and after receiving field data from the Contractor.
9. Once the Contractor receives the revised yard piping drawings, Contractor will then have 15 days to review the revised yard piping drawings and determine if a change in contract price is required to complete the work based on the revised drawings. No time extension to the Contract time shall be granted

unless Engineer cannot provide revised drawings within the time allotted and stated above.

C. Paving:
   1. New asphalt paving shall not be completed until all heavy equipment work and all underground work has been completed, and Contractor's heavy equipment has been moved off-site.

D. Secondary Clarifier No. 5:
   1. Process Connection and Shutdown Constraints:
      a. The following facilities shall be complete and operational prior to performing process startup:
         1) Mixed Liquor Flume Nos. 4-6 Structure.
         2) Connection of Junction Box No. 1 to the Secondary Clarifier No. 5 effluent piping.
         3) RAS Pump Station No. 2 and associated RAS piping work.
   2. Suggested Work Sequence:
      a. Over-excavate and remove landfill material.
      b. Construct new facility.
      c. Water test structure.
      d. Backfill structure.
      e. Tie-in process and utility piping to new facility.
      f. Commission facility.

E. Junction Box No. 1A - Tie-in of New 36 Inch Secondary Effluent Pipe:
   1. Process Connection and Shutdown Constraints:
      a. Verify dimensions, alignment, materials of construction of existing bell ring at Junction Box No. 1A prior to submitting fabrication drawings.
      b. Construction of the following facilities shall be complete prior to tie-in:
         1) Secondary Clarifier No. 5.
      c. Complete work between April 16 and October 15 (dry weather season).
      d. Conduct pipeline connection work during low flow periods. Coordinate work with Owner.
      e. Secondary Clarifier Nos. 1, 2 and 3 must be operational during tie-in.
      f. Secondary Clarifier No. 4 shall not be taken out of service for more than 1 week (7 days) for the completion of this work.
   2. Suggested Work Sequence:
      a. Pothole Junction Box No. 1A to verify dimensions, alignment, and materials of construction of existing wall thimble prior to submitting fabrication drawings.
      b. Install new 36-inch SE pipeline between Secondary Clarifier and Junction Box No. 1A.
      c. Coordinate with Owner to take Secondary Clarifier No. 4 out of service.
      d. Isolate Secondary Clarifier No. 4 by closing gates at Mixed Liquor Flume No. 4.
      e. Place temporary plug in 42-inch SE pipeline between Junction Box No. 1A and Junction Box No. 2A.
      f. Dewater piping and junction box.
      g. Remove existing bulkhead, connect new 36-inch SE piping to existing bell ring and complete all other associated work.
      h. Leak test new pipeline and connection.
      i. Remove temporary plug.

j. Notify Owner upon completion of work so that Secondary Clarifier No. 4 can be placed back in service.

3. Isolation:
   a. Upstream:
      1) Secondary Clarifier No. 4 can be isolated from accepting flow by closing the isolation gates on the discharge side of Mixed Liquor Flume No. 4.
   b. Downstream:
      1) Contractor shall supply and install temporary plugs as required.

F. Mixed Liquor Flume Nos. 4-6 Modifications:
1. Process Connection and Shutdown Constraints:
   a. Construction of the following facilities shall be complete prior to connecting the new portion of Mixed Liquor Flume No. 5 to the existing portion and installing the new motorized gates:
      1) All other work at the flume structure including structural, electrical and controls work.
      2) Secondary Clarifier No. 5.
      3) Connection of Junction Box No. 1 to the Secondary Clarifier No. 5 effluent piping.
   b. Complete structure connection work and gate installation between April 16 and October 15.
   c. Conduct work during low flow periods. Coordinate work with Owner.
   d. Secondary Clarifier No. 4 shall not be taken out of service for more than 1 week (7 days).
   e. Aeration Basins Nos. 1 through 5 must be in operation so that Aeration Basins 6 and 7 can be taken out of service for this work.
2. Suggested Work Sequence:
   a. Coordinate isolation of Mixed Liquor Flume No. 4, Secondary Clarifier No. 4 and Aeration Basin Nos. 6 and 7 with Owner.
   b. Owner will take Aeration Basins Nos. 6 and 7 out of service.
   c. Owner will take Secondary Clarifier No. 4 out of service.
   d. Close isolation gates on the pipeline from Aeration Basin Nos. 6 and 7 and the pipeline from Aeration Basin Nos. 1-3 effluent channel.
   e. Dewater upstream end of flume and connecting piping as required to perform the work.
   f. Create opening in existing wall to connect new and existing structures, install new motorized gates, and complete other work as indicated on the Drawings.
   g. Open isolation gates and restore flow from the aeration basins to Secondary Clarifier No. 4.
3. Isolation:
   a. Upstream:
      1) Mixed Liquor Flume Nos. 4-6 Structure can be isolated from Aeration Basin Nos. 1-5 by closing the gate at the mixed liquor effluent channel drop box and/or by closing the east inlet gate to Mixed Liquor Flume Nos. 4-6 Structure.
      2) Mixed Liquor Flume Nos. 4-6 Structure can be isolated from Aeration Basin Nos. 6 and 7 effluent channel by closing the west inlet gate to Mixed Liquor Flume Nos. 4-6 Structure.

b. Downstream:
    1) If necessary, Mixed Liquor Flume Nos. 4-6 Structure can be isolated from Secondary Clarifier No. 4 by closing the mixed liquor flume outlet gate.

G. RAS Pump Station No. 2:
1. Process Connection and Shutdown Constraints:
    a. The following facilities shall be complete and operational prior to performing process startup:
        1) Secondary Clarifier No. 5.
        2) RAS piping connection to Biotower Pump Station.
        3) All RAS discharge piping work from both RAS pump stations to the Biotower Effluent Boxes.
2. Suggested Work Sequence:
    a. Over-excavate and remove landfill material.
    b. Construct new facility.
    c. Backfill structure.
    d. Tie-in process and utility piping to new facility.
    e. Commission facility.

H. RAS Piping Tie-in at RAS Vault near Filter Pump Station:
1. Process Connection and Shutdown Constraints:
    a. Verify dimensions, alignment, and materials of construction of existing at valve vault prior to submitting piping shop drawings.
    b. RAS discharge pipeline between RAS Pump Station No. 1 and Aeration Basins Nos. 1-3 Splitter Box (or Biotower Effluent Boxes) must remain in service during tie-in work.
    c. Complete all tie-in work within 48 hours.
    d. Provide temporary piping and pumps to bypass RAS flow from Secondary Clarifier Nos. 1 - 3 RAS Weir Structure to the Biotower Pump Station. Size temporary bypass system for flow rates between 5 and 10 mgd. See Section 02553 for additional requirements.
    e. Make provisions to accommodate a small amount of leakage though existing isolation valves and gates during work at the RAS Vault.
2. Suggested Work Sequence:
    a. Verify dimensions, alignment, materials of construction of existing bell ring at Junction Box No. 1A prior to submitting fabrication drawings.
    b. Install new 24-inch RAS piping between RAS Pump Station No. 2 and RAS Vault.
    c. Install temporary bypass piping and pumps to pump RAS from the effluent channel of the RAS Weir Structure to the Biotower Pump Station to accommodate the operation of Secondary Clarifier Nos. 1-3. Isolate RAS Weir Structure effluent channel from effluent piping by installing a temporary plug, temporary bulkhead, or other measure.
    d. Commence bypass pumping.
    e. Confirm with Owner that RAS Pump Station No. 1 is operational and in service, pumping RAS from the Secondary Clarifier No. 4 to the aeration basins.
    f. Close isolation gate on 24-inch RAS outlet pipe at RAS Pump Station No. 1.
    g. Close 30-inch butterfly valve on RAS pipeline entering the Biotower Pump Station.

h. Dewater the existing 30-inch RAS pipeline from the discharge side of the RAS Weir Structure. Make provisions to accommodate a small amount of leakage though existing isolation valves and gates.
i. Remove existing blind flange at RAS Vault and connect new piping to existing system.
j. Pressure test new piping and connection.
k. Open gates and valves and coordinate work with Owner to restore RAS withdrawal operations to former configuration.

3. Isolation:
   a. Upstream:
      1) RAS Pump Station No. 1: Existing slide gate can be closed.
      2) RAS Weir Structure: Existing slide gates can be raised.
   b. Downstream:
      1) Biotower Pump Station: Existing buried butterfly valve south of structure can be closed.

I. RAS Discharge Piping Replacement:
1. Process Connection and Shutdown Constraints:
   a. Verify dimensions, alignment, and materials of construction of existing RAS piping prior to submitting piping shop drawings.
   b. RAS discharge pipeline between RAS Pump Station No. 1 and Aeration Basins Nos. 1-3 Splitter Box (or Biotower Effluent Boxes) shall not be out of service for more than 2 months.
2. Suggested Work Sequence:
   a. Field verify dimensions, alignment, materials of construction of existing RAS discharge piping prior to submitting pipeline shop drawings.
   b. Coordinate with Owner to stop using RAS Pump Station No. 1 and change operational modes to return all RAS withdrawal flows to the Biotower Pump Station.
   c. Dewater existing pipeline and begin work to demolish existing RAS discharge piping and replace with larger RAS piping.
   d. See sequencing and constraints related to Biotower Effluent Box Modifications for requirements related to connection of RAS discharge piping to the Biotower Effluent Boxes.

J. Biotower Effluent Box Modifications:
1. Process Connection and Shutdown Constraints:
   a. Complete all work between April 16 and October 15.
   b. A single Biotower shall not be taken out of service for more than 14 consecutive days.
   c. If a Biotower is take out of service, a minimum of 5 aeration basins must be in service to accommodate the increased loading.
   d. When one Biotower is out of service, the second Biotower shall not be taken out of service for more than 6 consecutive hours. Primary effluent flow may be diverted to the holding ponds during a shutdown for no more than 6 consecutive hours. If more than one 6-hour period is required, flow diversions shall be timed a minimum of 2 calendar days apart.
   e. After flow has been restored to a biotower that has been out of service for more than one day, provide a two week period of parallel biotower operation to allow for re-growth of biomass in the tower that was out of service. Do not take the operational biotower out of service until plan operations staff has confirmed proper operation.

f. Provide temporary utility water piping, hoses, sump pumps and other provisions to continuously wet the wooden media in the out-of-service Biotower. Coordinate this activity with Owner's plant staff and provide assistance to operations staff as required.

2. Suggested Work Sequence:
   a. Complete all RAS discharge piping work between RAS pump stations and Biotower effluent boxes.
   b. Coordinate isolation of Biotower No. 1 with Owner.
   c. Begin primary effluent diversion.
   d. Close influent isolation valve to Biotower No. 1.
   e. Open bypass valves to aeration basins, if required by Owner.
   f. Install plug in 42-inch filter effluent (FE) pipeline between Biotower No. 1 Effluent Drop Box and the 42-inch by 42-inch by 42-inch by 36-inch cross located east of the drop box . Adequately restrain plug to accommodate anticipated pressures in the FE pipeline.
   g. Install plug on Biotower No. 1 recycle line at the recycle flow drop box located south of the effluent drop box.
   h. End primary effluent diversion and restore flow through Biotower No. 2.
   i. Tie in new RAS pipeline and perform other work at the Biotower No. 1 Effluent Box indicated on the drawings. Following completion of work, remove existing plate over 42-inch FE pipeline connecting box to Aeration Basin Nos. 4-7 Splitter Box.
   j. Begin second primary effluent diversion.
   k. Remove plugs and adjust valve positions to restore operation of Biotower No. 1
   l. End second primary effluent diversion and restore flow through Biotowers No. 1 and No. 2.
   m. Repeat sequence outlined above for work at Biotower No. 2 Effluent Box following a minimum 2 week period where both Biotower No. 1 and No. 2 are in service.
3. Isolation:
   a. Upstream:
      1) Biotowers may be taken off line by closing an existing isolation valve in the inlet line.
      2) If required by the Owner, some flow can bypass the biotowers and proceed directly to the aeration basins by opening an existing isolation valve.
   b. Downstream:
      1) The Contractor may isolate the effluent box by using a plug in the line between the drop box and the cross in biotowers effluent line.
      2) The Contractor may isolate the biotower from the biotower recycle flow by using a plug or bulkhead located in the biotower recycle drop box.

K. Aeration Basin Nos. 4-7 Splitter Box - Installation of New Gate:
1. Process Connection and Shutdown Constraints:
   a. Complete work between April 16 and October 15 (dry weather season).
   b. Conduct structure and pipeline connection work during low flow periods. Coordinate work with Owner.
   c. Aeration Basin Nos. 1, 2 and 3 must be operational during shutdown.
   d. Aeration Basin Nos. 4 through 7 shall not be taken out of service for more than 6 hours for the completion of this work.

e. Provide bypass pumping around inlet side of Aeration Basin Nos. 4-7 Splitter Box during connection and tie-in work. Extend temporary bypass pumping from existing Aeration Basins Influent Distribution Box (south side of Aeration Basin No. 2) to outlet side of Aeration Basin Nos. 4-7 Splitter Box for flow distribution to Aeration Basin Nos. 4 - 7.

2. Suggested Work Sequence:
   a. Install temporary bypass piping and pumps between Aeration Basins Influent Distribution Box to outlet side of Aeration Basin Nos. 4-7 Splitter Box.
   b. Close isolation gate at Aeration Basins Influent Distribution Box, begin bypass pumping, and dewater splitter box, pipeline, and downstream aeration basins as necessary.
   c. Install new gate and test installation.
   d. Open isolation gate and restore flow to Aeration Basins Nos. 4-7 through Splitter Box.
   e. Remove temporary discharge piping and pumps.
3. Isolation:
   a. Upstream:
      1) Aeration Basin Nos. 4-7 Splitter Box can be isolated from the Aeration Basins Influent Distribution Box by closing the gate at the southeast corner of the distribution box.
      2) Aeration Basin Nos. 4-7 Splitter Box is currently isolated from the Biotower No. 1 Effluent Box with a bolted stop plate.
   b. Downstream:
      1) Aeration Basin Nos. 4 and 5: The outlet side of the existing splitter box is piped directly to aeration basins. The inlet side of the existing splitter box can be isolated from Aeration Basin Nos. 4 and 5 by raising the existing weir gates. If leakage through these existing gates prevents work from being accomplished, temporarily dewater Aeration Basin Nos. 4 and 5 and provide temporary plugs in the 30-inch outlet pipelines. Allow time for this activity in the schedule.
      2) Aeration Basin Nos. 6 and 7: Raise new downward opening slide gates to isolate flow from the new Aeration Basin Nos. 6 and 7.

L. Aeration Basin Modifications:
1. Process Connection and Shutdown Constraints:
   a. Work at the following facilities shall be complete and facilities shall be operational prior to placing the new facility in service:
      1) Electrical Building No. 7 electrical and controls modifications.
      2) MCC No. 8 Enclosure and related electrical and controls modifications.
   b. Complete aeration basin modifications in three phases:
      1) Phase 1: No more than 3 basins and no more than 4 million gallons of aerated volume may be taken out of service during the initial phase of modification.
      2) Phase 2 and 3: No more than 2 basins and no more than 3.2 million gallons of aerated volume may be taken out of service during the subsequent phases of modifications.
   c. Provide temporary pumps and piping or other means to fill aeration basins with tertiary treated effluent (2W) for aeration diffuser testing.

d. Geotechnical inspection at Aeration Basin Nos. 1, 2 and 3:
    1) Provide access to Engineer's geotechnical consultant to perform soil property verification testing within Aeration Basin Nos. 1, 2 and 3 following completion of all demolition work, including demolition of concrete base slab and removal of material.
    2) Provide minimum 14 days' notice to Engineer prior to each basin being available for inspection so that Engineer can arrange for the inspection work.
    3) Provide minimum 2 working days for each aeration basin in the project schedule to allow time for geotechnical inspection work to be completed. Show this requirement as a line item for each basin on the project progress schedule.
    4) Await written approval from the Engineer prior to beginning any structural foundation work within Aeration Basin Nos. 1, 2 and 3 following the geotechnical inspection.

2. Suggested Work Sequence:
    a. Isolate and dewater Aeration Basin Nos. 2, 4 and 5.
    b. Complete demolition work.
    c. Provide access to Engineer's geotechnical engineer to perform soil property verification testing within Aeration Basin No. 2.
    d. Completestructural, mechanical, electrical and controls work on these basins.
    e. Complete commissioning process specified in Section 01756 for Aeration Basin Nos. 2, 4, and 5 including testing, training, process start-up and process operational period.
    f. Upon Owner acceptance of Aeration Basin Nos. 2, 4 and 5, isolate and dewater Aeration Basin Nos. 6 and 7.
    g. Complete demolition, structural, mechanical, electrical and controls work on these basins.
    h. Complete commissioning process specified in Section 01756 for Aeration Basin Nos. 6 and 7 including testing, training, process start-up and process operational period.
    i. Request Owner acceptance of Aeration Basin Nos. 6 and 7.
    j. Complete all other work associated with Milestone No. 1 and notify Engineer when work is complete.
    k. Isolate and dewater Aeration Basin Nos. 1 and 3.
    l. Complete demolition work.
    m. Provide access to Engineer's geotechnical engineer to perform soil property verification testing within Aeration Basin Nos. 1 and 3.
    n. Complete structural, mechanical, electrical and controls work on these basins.
    o. Complete commissioning process specified in Section 01756 for Aeration Basin Nos. 6 and 7 including testing, training, process start-up and process operational period.

3. Isolation:
    a. Upstream: Influent flow (FE) into the aeration basins may be controlled by raising the downward opening weir gates at Aeration Basins Nos. 1-3 Distribution Structure and Aeration Basin Nos. 4-7 Splitter Box.
    b. Downstream:
        1) Effluent flow (ML) from the aeration basins discharges over weirs into a discharge channel that is connected via a piping network to the Mixed Liquor Flumes and all other aeration basin effluent channels.

2) The effluent channel for Aeration Basin Nos. 6 and 7 can be isolated using the isolation gate at Mixed Liquor Flume No. 4.

M. Biotower Crane:
1. Process Connection and Shutdown Constraints:
a. Biotower Crane facility may be out of service for not more than a single 2-month period.
b. Assist Owner with removal of existing submersible pumps, as required, during the period that the Biotower Crane is not available.
2. Suggested Work Sequence:
a. Demolish existing Biotower Crane and provide salvaged equipment to Owner.
b. Construct new facility.
c. Commission facility.

N. Miscellaneous Yard Piping Connections:
1. Tie-In New 2W Pipeline to Existing 6-Inch 2W Pipeline:
a. Process Connection and Shutdown Constraints:
1) Complete tie-in prior to start-up of Secondary Clarifier No. 5 and RAS Pump Station.
2) Do not remove from service the existing 6-inch 2W located in road west of Secondary Clarifier No. 5 for more than a single 24 hour period.
3) Contractor shall provide necessary pumping, piping and containment to dewater existing 2W pipeline. Assume that flow will be returned to the existing Mixed Liquor Flume No. 4.
b. Suggested Work Sequence:
1) Coordinate isolation of existing 2W line with Owner.
2) Isolate existing 6-inch 2W line using existing valve located south of tertiary filters.
3) Tap existing 6-inch 2W line, and install new isolation valve.
4) Restore service to existing 2W line and test new piping and connection.
2. Tie-In New 3-Inch Chlorine Solution (CLS) Pipeline to Existing 3-Inch CLS Pipeline:
a. Process Connection and Shutdown Constraints:
1) Complete tie-in prior to start-up of Secondary Clarifier No. 5 and RAS Pump Station No. 2.
2) The CLS piping feeding the tertiary filters shall not be taken out of service for more than a 6-hour period.
3) Contractor shall provide necessary pumping, piping and containment to dewater existing CLS pipeline. Assume that flow will be returned to the existing Secondary Effluent Pump Station.
b. Suggested Work Sequence:
1) Coordinate isolation of existing CLS line with Owner.
2) Shutdown CLS line and drain chemical solution line as directed by the Owner.
3) Tie-in new 3-inch CLS pipeline to existing CLS pipeline.
4) Restore flow in to CLS pipeline.

3. Construct New 8-inch ML Between Aeration Basin Nos. 6 & 7 and Aeration Basin Nos. 4 & 5 Drainage Pump Stations:
    a. Process Connection and Shutdown Constraints:
        1) Install and commission pipeline prior to starting work on Aeration Basin Nos. 6 & 7 to facilitate transfer of mixed liquor between aeration basins.
        2) Do not impact operation of Aeration Basin Nos. 4 & 5 drainage pump station during tie-in work. This pump station also serves as a storm drain pump station and must be operational during rainfall events.
    b. Suggested Work Sequence:
        1) Pothole all utilities in path of new pipeline.
        2) Install buried piping.
        3) Coordinate tie-ins at drainage pump stations and effluent channel with Owner's operations staff.
        4) Test piping and commission pipeline.

END OF SECTION

APPENDIX A
"Method of Procedure" (MOP)
Instructions and Forms

Definition and Purpose

"Method of Procedure" (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

MOP Process Summary

WHO	STEP	TIMING
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	7 days prior to Preconstruction Scheduling Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	7 days prior to work
Contractor	6. Complete Readiness Checklist.	5 days prior to work
Contractor	7. Complete Safety Checklist.	Just prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

MOP Process Detail

STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting.

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

STEP 3. Submits MOP.

Contractor completes the MOP Form and submit 3 copies for approval to the Owner's Project Manager (OPM).

STEP 4. Reviews MOP.

OPM distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in contract documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer, and Contractor.

STEP 6. Complete Readiness Checklist.

Contractor verifies everything is ready for the work.

STEP 7. Complete Safety Checklist.

Contractor ensures safety.

STEP 8. Complete work.

Contractor complete work.

STEP 9. Update MOP Log and Progress Schedules.

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

METHOD OF PROCEDURE (MOP) FORM

Owner: _____ Date: _____

Contractor: _____ Carollo Project No.: _____

Project Name: _____ Submittal No.: _____

Submittal Title: _____ Spec/Dwg. Reference: _____

MOP #	Task Title *(Provide <10 word title)*:	Submittal Date: *(No later than 28 days prior to work)*

SCHEDULE OF WORK ACTIVITY START: *(Date/Time)*	END: (Date/Time)
REQUESTOR:	
PRIMARY POINT OF CONTACT:	PHONE/PAGER:
SECONDARY POINT OF CONTACT:	PHONE/PAGER:
NOTIFY ☐ Control Room, Phone	☐ Security, Phone
BUILDING:	LOCATION OF WORK FLOOR/LEVEL:

DESCRIPTION OF WORK: *(Provide sufficient details on process isolation, work sequencing, and safety (i.e., control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)*

Task Summary: _____

Processes Affected: _____

Trades Affected: _____

WORK PLAN:

Work Sequencing: _____

Process Isolation: _____

Spill Prevention Plan: _____

Contingency Plans: _____

CRITICAL EQUIPMENT/TOOLS: *(pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)*

☐	Acoustic Ceiling/or Walls Access	☐	Excavation Permit	☐	Lock Out/Tag Out
☐	Chemical Use Approval	☐	Fire Sprinkler Impairment	☐	Life Safety Systems
☐	Confined Space Permit	☐	Flammable Materials	☐	Roof Protocol
☐	Critical Lift Plan	☐	Flush / Discharge	☐	Work After Dark
☐	Energized Electrical Work	☐	High Pressure Test	☐	
☐	Elect. Panel Schedules	☐	Hot Work/Open Flame	☐	

EXISTING SERVICE(S) AT RISK:

☐	Breathing Air	☐	Elect Normal	☐	Process Access	☐	Telephones
☐	Chemical Distribution	☐	Fire Protection	☐	Safety Showers	☐	UPS
☐	City Water	☐	HVAC	☐	SCADA	☐	VAX/DATA
☐	Communication	☐	Inert Gas	☐	Security	☐	
☐	Domestic Drain	☐	Instrument - Air	☐	Solvent Drain	☐	
☐	Elect-Bus Duct	☐	Life Safety System	☐	Specialty Gases	☐	
☐	Elect Emergency	☐	Natural Gas	☐	Storm Drain	☐	

REVIEWER'S INSTRUCTIONS / COMMENTS: _____

☐ PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:

	Full Name (printed)	Signature	Phone	Date
Submitted By				
System Owner				
Reviewer (if needed)				
Reviewer (if needed)				

READINESS CHECKLIST
(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____
2. Review work plan: _____
3. Review contingency plan: _____

SAFETY CHECKLIST
(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
   a. Emergency exits: _____
   b. Emergency shower and eyewash: _____
   c. Telephones and phone numbers: _____
   d. Shut-off valve: _____
   e. Electrical disconnects: _____
2. Inspect work area:
   a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. SDS (Safety Data Sheets):
   a. Understand the chemicals and substances in the area you are working in by reading the SDS.
4. Lockout/Tagout Procedure:
   a. Lockout/tagout energy sources before beginning work.
   b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
   c. Make sure the lines are depressurized.
5. Overhead work:
   a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
   b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
   c. Spotter assigned and in position.
   d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
   a. Shepherd's hook.
   b. ARC flash protection.
   c. Fire extinguisher.
   d. Other: _____.
7. Accidents:
   a. Should accidents occur, do not shut off and do not attempt to correct the situation, unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
   a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
   a. Do not obstruct evacuation routes.
   b. Take time to survey the area for evacuation routes.

Method of Procedure (MOP) Log
Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (yes/no)
001					
002					
003					

SECTION 01201

PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for submitting applications for payment and means used as a basis for Progress Payments, including:
   1. Cost Summaries.
   2. Payment for Mobilization.
   3. Commissioning and Process Start-Up.
   4. Demobilization.

1.02 REFERENCES

A. Occupational Safety and Health Administration (OSHA).

1.03 BASIS FOR PROGRESS PAYMENTS

A. Base Application for Payment on the breakdown of costs for each scheduled activity in the Progress Schedule and the Percentage of Completion for each activity. Generate Application for Payment by downloading cost data from the Progress Schedule to a spreadsheet type format. Identify each activity on the Progress Schedule that has a cost associated with it, the cost of each activity, the estimated Percent Complete for each activity, and the Value of Work Completed for both the payment period and job to date.

1.04 PAYMENT REQUESTS

A. Prepare progress payment requests on a monthly basis. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.

B. Indicate total dollar amount of work planned for every month of the project. Equate sum of monthly amounts to Lump Sum Contract Price.

C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format. Identify each activity on the Progress Schedule that has a cost associated with it, the cost for each activity, the estimated percent complete for each activity, and the value of work completed for both the payment period and job to date.

D. Provide Summary of Cost Information.

E. Submit progress payment requests at progress meetings.

1.05 COST SUMMARIES

A. Prepare Summary of Cost Information for each Major Item of Work listed in the Schedule of Values. Identify the Value of Work Completed for both the payment period and job to date.

B. Cash flow summary: Prepare cash flow summary, indicating total dollar amount of work planned for each month of the project. Equate sum of monthly amounts to Lump Sum contract price.

1.06 PAYMENT FOR MOBILIZATION

A. Limit amounts included under mobilization to the following items:
   1. Moving on the site any equipment required for first month operations.
   2. Installing temporary construction power, wiring, and lighting facilities.
   3. Establishing fire protection plan and safety program.
   4. Developing construction water supply.
   5. Providing field office trailers for the Contractor and the Engineer, complete with all specified furnishings and utility services including telephones.
   6. Providing on-site sanitary facilities and potable water facilities as specified.
   7. Arranging for and erection of Contractor's work and storage yard, employee parking facilities, and entrance road.
   8. Submit all required insurance certificates and bonds.
   9. Obtaining all required permits, licenses, and fees.
   10. Submit preliminary schedule of values of the Work.
   11. Submit preliminary schedule and develop baseline schedule.
   12. Submit standardized traffic maintenance and control plans.
   13. Submit cash flow in tabular and graphical formats.
   14. Submit Contractor’s quality control plan.
   15. Submit Schedule of Submittals.
   16. Submit pre-construction photographs and videos.
   17. Provide and erect the project sign.
   18. Post all OSHA, (state agency), Department of Labor, and all other required notices.
   19. Location and flagging of construction and clearing.
   20. Have Contractor’s project manager and/or general superintendent on job site full-time.

B. Furnish data and documentation to substantiate the amounts claimed under mobilization.

C. Limit price for mobilization to no more than 4 percent of Contract Price.

D. No payment for mobilization, or any part thereof, will be recommended until all mobilization items listed above have been completed.

1.07 PAYMENT FOR COMMISSIONING AND PROCESS START-UP

A. Total Price for commissioning and process start-up shall not be less than 3 percent of Contract Price.

1.08 PAYMENT FOR DEMOBILIZATION

A. Total Price for demobilization shall not be less than 2 percent of Contract Price.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01210

ALLOWANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Listing of allowance items:
      a. Related responsibilities of Contractor and procedures.

B. Related sections:
   1. Document 00410 - Bid Form.

1.02 ALLOWANCE AMOUNTS

A. Include following amounts in Contract Price:
   1. Bid Item 4: Unanticipated Existing Underground Utilities and Yard Piping Location Allowance: Contractor shall include an allowance of $25,000 in the Total Lump Sum Bid to cover the cost of the "potholing" (exploratory excavation) to field locate horizontal and vertical locations of existing utilities and yard piping that were not shown on the contract drawings at bid time prior to excavating the site for construction and prior to preparing pipe fabrication shop drawings. The actual amount of the potholing cost will be adjusted by change order (add or deduct) based on the actual cost based on actual time and material basis.

1.03 COSTS INCLUDED AND EXCLUDED IN ALLOWANCES

A. Costs included in allowances for furnishing products only:
   1. Net cost of product.
   2. Delivery and unloading at site.
   3. Applicable taxes and fees.

B. Costs included in Contract Price, but not included in allowances for furnishing products only:
   1. Handling at site, including uncrating and storage.
   2. Protection from elements, theft, and damage.
   3. Labor, installation, testing, and finishing.
   4. Other expenses required to complete installation.
   5. Overhead and profit.

C. Costs included in allowances for furnishing and installing products:
   1. Net cost of product.
   2. Delivery and unloading at site.
   3. Applicable taxes.
   4. Handling at site, including uncrating and storage.
   5. Protection from elements and from damage.
   6. Labor, installation, testing, and finishing.
   7. Other expenses required to complete installation.

1.04 DUTIES OF CONTRACTOR IN PROVIDING PRODUCTS BY ALLOWANCE

A. Advise Engineer at least 60 days in advance of purchase date necessary to avoid impacts to Progress Schedule.

B. Obtain proposals from suppliers, including:
   1. Quantity.
   2. Complete description of product and services provided under allowance.
   3. Unit cost.
   4. Total amount of purchase.
   5. Taxes and delivery charges.

C. On notification of selection, enter into purchase agreement with designated supplier.

D. Arrange for delivery and unloading.

E. Install products in accordance with Contract Documents.

1.05 ADJUSTMENT OF COSTS

A. When actual cost is more or less than amount of allowance, Contract Price will be adjusted by Change Order.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01260

CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for executing a change in the Work.

B. Related section:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Document 00632 - Request for Information or Interpretation.

1.02 PRELIMINARY REQUIREMENTS

A. Change Order Cost Basis Summary Form:
   1. Submit a sample to Engineer for review within 15 calendar days following Notice to Proceed:
      a. Items will be reviewed and their value, percentage, or calculation method mutually agreed to by the Contractor and Owner prior to executing a Change Order on the Project.
   2. Used by the Contractor for pricing each Change Order required for additions, deletions, or revisions in the Work.
   3. Include the following information:
      a. Agreed upon markups, percentages, and procedures for calculating all surcharges, etc. associated with the Cost of the Change Order Work.
      b. References for unit price information and special unit price information.
      c. Attachments with the following information:
         1) Certified labor rates breakdown.
         2) Equipment rates.
         3) Bond and insurance rates (PI&I).

1.03 REQUEST FOR INFORMATION OR INTERPRETATION (RFI)

A. Contractor may issue RFIs to request interpretation of the documents or to request for information that may be missing.

B. General Instructions:
   1. Use RFI Form as specified in Document 00632:
      a. Use of other RFI Forms is acceptable if the form includes the information in the form provided in the referenced form, at a minimum.

2. Number RFIs consecutively:
    a. Add a consecutive letter to the RFI number on modified submittals of the same RFI (i.e., RFI 4B).
1. Provide RFI for 1 item:
    a. There may be exceptions when multiple items are so functionally related that expediency indicates review of the group of items as a whole.
    b. RFIs with multiple items will be rejected without review.
1. Contractor sign and date RFIs indicating review and approval:
    a. Contractor’s signature indicates that they have satisfied RFI review responsibilities and constitutes Contractor's written approval of RFI.
    b. RFIs without Contractor's signature will be returned to the Contractor unreviewed. Subsequent submittal of this information will be counted as the first resubmittal.

C. Engineer will render a written clarification, interpretation, or decision on the issue submitted or initiate an amendment or supplement to the Contract within 21 days:
    1. In the event the Contractor identifies an RFI as critical to the progress of the project, Engineer will make every effort to reduce the RFI response time.

1.04 PRELIMINARY PROCEDURES

A. Owner or Engineer may initiate changes by submitting a Request for Proposal (RFP) to Contractor including the following information:
    1. Detailed description of the Change, Products, and location of the change in the Project.
    2. Supplementary or revised drawings or specifications.
    3. Projected time span for making the change, and a specific statement if overtime work is authorized.
    4. A specific period of time during which the requested price will be considered valid.
    5. Such request is for information only, and is not an instruction to execute the changes, or to stop work in progress.

B. Contractor may initiate changes by submitting a Change Proposal to Engineer containing the following:
    1. Description of proposed changes.
    2. Reason for making changes.
    3. Specific period of time during which requested price will be considered valid.
    4. Effect on Total Contract Cost and/or Contract Time.
    5. Documentation supporting any change in Total Contract Cost and/or Contract Time, as appropriate.

1.05 WORK CHANGE DIRECTIVE AUTHORIZATION

A. In lieu of a Request for Proposal (RFP), Engineer may issue a Work Change Directive Authorization for Contractor to proceed with a change for subsequent inclusion in a Change Order.

B. Authorization will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change, and will designation method of determining any change in the Contract Sum and/or the Contract Time, as appropriate.

C. Owner and Engineer will sign and date the Work Change Directive Authorization as authorization for the Contractor to proceed with the changes.

D. Contractor may sign and date the Work Change Directive Authorization to indicate agreement with the terms.

1.06 DOCUMENTATION OF CHANGE PROPOSALS

A. Change proposal:
   1. Support with sufficient substantiating data to allow Engineer to evaluate the quotation:
      a. Lump sum.
      b. Unit prices: Use previously established unit prices.
      c. Time-and-material/force account basis:
         1) Name of the Owner's authorized agent who ordered the work, and date of the order.
         2) Dates and times work was performed, and by whom.
         3) Time record, summary of hours worked, and hourly rates paid.
         4) Receipts and invoices for:
            a) Equipment used, listing dates and times of use.
            b) Products used, listing of quantities.
            c) Subcontracts.
   2. Provide additional data to support time and cost computations:
      a. Labor required.
      b. Equipment required.
      c. Products required:
         1) Recommended source of purchase and unit cost.
         2) Quantities required.
      d. Taxes, insurance, and bonds.
      e. Credit for work deleted from Contract, similarly documented.
      f. Overhead and profit.
      g. Justification for change to Contract Time.

1.07 PREPARATION OF CHANGE ORDERS AND FIELD ORDERS

A. Engineer will prepare each Change Order and Field Order.

B. Change Orders:
   1. Will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.
   2. Will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.
   3. Recommendation of Change Proposal is indicated by Engineer's signature.
   4. Upon signature and execution by Owner, the Change Proposal becomes a Change Order altering the Contract Time and Total Contract Cost, as indicated:
      a. Owner's Representative will transmit one signed copy each to Contractor and Engineer.
   5. Contractor may only request payment for changes in the Work against an approved Change Order.

6. If either Engineer or Owner's Representative disapproves the Change Proposal, the reason for disapproval will be stated:
    a. A request for a revised proposal or cancellation of the proposal will be shown.

C. Field Orders:
1. Order minor changes in the Work without changes in Contract Price or Contract Times.

1.08 LUMP-SUM/FIXED PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
1. Engineer's Proposal Request and Contractor's responsive Change Proposal as mutually agreed between Owner and Contractor.
2. Contractor's Change Proposal for a change, as recommended by Engineer.

B. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

C. Contractor will sign and date the Change Order to indicate agreement with the terms.

1.09 UNIT PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:
1. Engineer's definition of the scope of the required changes.
2. Contractor's Change Proposal for a change, recommended by Engineer.
3. Survey of completed work.

B. The amounts of the unit prices to be:
1. Those stated in the Contract.
2. Those mutually agreed upon between Owner and Contractor.

C. When quantities of each of the items affected by the Change Order can be determined prior to start of the work:
1. Owner and Engineer will sign and date the Change Order as authorization for Contractor to proceed with the changes.
2. Contractor will sign and date the Change Order to indicate agreement with the terms.

D. When quantities of the items cannot be determined prior to start of the work:
1. Engineer or Owner will issue a Work Change Directive authorization directing Contractor to proceed with the change on the basis of unit prices, and will cite the applicable unit prices.
2. At completion of the change, Engineer will determine the cost of such work based on the unit prices and quantities used.
3. Contractor shall submit documentation to establish the number of units of each item and any claims for a change in Contract Time.

E. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

F. Contractor will sign and date the Change Order to indicate their agreement with the terms.

1.10 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/WORK CHANGE DIRECTIVE AUTHORIZATION

A. Engineer will issue a Work Change Directive for the Owner's signature authorizing Contractor to proceed with the changes.

B. At completion of the change, Contractor shall submit itemized accounting and supporting data as specified in this Section.

C. Engineer will determine the allowable cost of such work, as provided in the Contract Documents.

D. Owner and Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time and serve as authorization for the Contractor to proceed with the changes.

E. Contractor will sign and date the Change Order to indicate their agreement.

1.11 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically revise Schedule of Values and Applications for Payment forms to record each Change Order as a separate item of Work, and to record the adjusted Contract Sum.

B. Periodically revise the Construction Schedule to reflect each change in Contract Time. Revise subschedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01270

UNIT PRICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for measurement and payment of Work performed on a unit price basis.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Document 00410 - Bid Forms.

1.02 MEASUREMENT OF QUANTITIES

A. Work paid at a unit price times number of units measured will be measured by Engineer in accordance with United States Standard Measures:
   1. One ton shall consist of 2,000 pounds avoirdupois.

B. Provide and pay for accurate scales:
   1. Use platform scales of sufficient size and capacity to permit the entire vehicle or combination of vehicles to rest on the scale platform while being weighed.
   2. Combination vehicles may be weighed as separate units provided they are disconnected while being weighed.
   3. Have scales inspected and certified as often as necessary to ascertain accuracy.
   4. Furnish weigh slips and daily summary weigh sheets to Engineer.

C. When material is shipped by rail, certified car weights will be acceptable, provided that not more than the actual weight of material will be paid, without consideration of minimum car weight used for assessing freight tariff:
   1. Car weight will not be acceptable for materials passing through mixing plants.

D. Daily, or at shorter intervals when necessary to ensure accuracy, weigh empty trucks used to haul material paid by weight:
   1. Provide such trucks with plain, unique, permanent, legible identification marks.

E. Reinforcing steel, steel shapes, castings, and similar items paid by weight will be measured by handbook weights for the type and quantity indicated for the Work.

1.03 PAY ITEMS

A. General: The following pay items are included in Document 00410.

B. Schedule of unit price bid items.

C. Measurement:
   1. Bituminous concrete pavement and base will be measured by square foot.
   2. Liquid asphalt for prime coat will be measured in gallons.
   3. Adjustment of manholes and other structures to grade will not be measured for payment, but costs in connection therewith will be considered incidental to the item of work to which they pertain.

D. Payment: Payment for asphalt concrete pavement and base, and liquid asphalt will be made at the Contract unit prices for the quantities determined as specified.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01292

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for preparation, format, and submittal of Schedule of Values.

B. Related section:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01324A - Progress Schedules and Reports.
      b. Section 16050 - Common Work Results for Electrical.

1.02 PREPARATION

A. Print out Schedule of Values from accepted Preliminary or Baseline Schedule submitted and accepted under Section 01324A.

B. Schedule of Values shall be a listing of all cost loaded, on- site construction activities from the progress schedule, listed in numerical order, showing that the sum total of all cost loaded activities equals the value of Contract.

C. When the schedule is changed or revised to include added or deleted work, the Schedule of Values shall also be revised such that the sum total of all cost loaded activities continuously equals the current Contract value.

D. Prepare satisfactory Schedule of Values identifying costs of Major Items of Work and other costs.

E. Assign prices to Major Items of Work, which aggregate the Contract Price. Base prices on costs associated with scheduled activities for each Major Item of Work.

F. Breakdown material and labor for each trade.

G. For each Structure, Provide the Following Breakdown:
   1. Dewatering.
   2. Excavation.
   3. Backfill.
   4. Concrete formwork material and labor (for large structure breakdown foundations, walls, elevated slab separately).
   5. Concrete reinforcing material and labor.
   6. Concrete placement material and labor.

7. Masonry material and labor (if applicable).
8. Mechanical piping material and labor.
9. Equipment itemized with separate installation cost for each.

H. For each of the following Divisions, provide breakdown between material and labor, for each sections and by Structure if applicable:
1. Division 2.
2. Division 5.
3. Division 6.
4. Division 7.
5. Division 8.
6. Division 9.
7. Division 10.

I. For Division 11, Provide the Following Breakdown, and by Structure if Applicable:
1. Material separated by section.
2. Labor for installation separated by section.
3. Testing and start-ups of mechanical equipment.

J. For Division 15, Provide the Following Breakdown, and by Structure if Applicable:
1. Material for piping separated by size and process designation.
2. Labor for piping installation.
3. Pipe testing.
4. Manholes.
5. HVAC material and labor.
6. HVAC testing.

K. For Division 16, Provide the Following Breakdown, and by Structure if Applicable:
1. Material separated by section.
2. Labor for installation separated by section.
3. Testing and start-ups of electrical systems.

L. For Division 17, Provide the Following Breakdown, and by Structure if Applicable:
1. Material separated by section.
2. Labor for installation separated by section.
3. Testing and start-ups of instruments and controls.

M. Divide the Work into Following Major Items of Work:
1. Mobilization.
2. Demolition.
3. Site work (including roads and paved areas).
4. Landscaping.
5. Shoring.
6. Yard piping.
7. Secondary Clarifier No. 5.
8. RAS Pump Station No. 2.
9. Yard Structures (for each structure).
10. Aeration Basins No. 1 through No. 7 Modifications (for each basin).
11. Electrical Building No. 7 Modifications.
12. MCC No. 8 Enclosure.
13. Electrical systems.

14. Instrumentation systems.
15. Testing.
16. Training.
17. Start-up.
18. Punch list.
19. Demobilization.
20. Contract allowances.

1.03 SUBMITTALS

A. Submit Schedule of Values for the Preliminary Schedule in accordance with the requirements in Article "Preliminary Schedule", Section 01324A.

B. Submit Schedule of Values for the Baseline Schedule in accordance with the requirements in Article "Baseline Schedule", Section 01324A.

C. Submittal of the Schedule of Values is a condition precedent to the issuance of any payment under this Contract.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01294

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for preparation and submittal of Applications for Payment.

B. Related section:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Document 00620 - Contractor's Application for Payment.

1.02 FORMAT

A. Develop satisfactory spreadsheet-type form generated by downloading cost data from the Progress Schedule:
   1. Submit payment requests using Document 00620 and attach spreadsheet with cost data related to Progress Schedule.

B. Fill in information required on form.

C. When Change Orders are executed, add Change Orders at end of listing of scheduled activities:
   1. Identify change order by number and description.
   2. Provide cost of change order in appropriate column.

D. After completing, submit Application for Payment.

E. Engineer will review application for accuracy. When accurate, Engineer will transmit application to Owner for processing of payment.

F. Execute application with signature of responsible officer of Contractor.

1.03 SUBSTANTIATING DATA

A. Provide Substantiating Data with cover letter identifying:
   1. Project.
   2. Application number and date.
   3. Detailed list of enclosures.

4. For stored products with item number and identification on application, description of specific material, and proof of insurance coverage for offsite stored products.
5. Submit “certified” payroll, if applicable.

1.04 SUBMITTALS

A. Submit 5 copies of Application for Payment and Substantiating Data with cover letter.

1.05 PAYMENT REQUESTS

A. Prepare progress payment requests on a monthly basis. Base requests on the breakdowns of costs for each scheduled activity and the percentage of completion for each activity.

B. Indicate total dollar amount of work planned for every month of the project. Equate sum of monthly amounts to Lump Sum Contract Price.

C. Generate Progress Payment request forms by downloading cost data from the schedule information to a spreadsheet type format. Identify each activity on the Progress Schedule that has a cost associated with it, the cost for each activity, the estimated percent complete for each activity, and the value of work completed for both the payment period and job to date.

D. Prepare summary of cost information for each Major Item of Work listed in the Schedule of Values. Identify the value of work completed for both the payment period and job to date.

E. Payment period:
1. Monthly Application for Payment period shall begin on the 1st day of each month, and end on the last day of each month.
2. Submit Application for Payment to Engineer no later than the 5th day of each month for work completed the previous month.
3. Engineer will finalize and submit recommendation for Application for Payment to Owner by the 15th day of each month to allow time for processing and approval.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01312

PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
   1. Qualifications of Meeting Participants.
   2. Preconstruction Conference.
   3. Progress Meetings.
   4. Pre-Installation Meetings.
   5. Pre-Shutdown Meetings.
   6. Pre-Process Start-up Meetings.
   7. Electrical and Instrumentation Coordination Meetings.
   8. Close-out meeting.
   9. Post Construction Meeting.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01140 - Work Restrictions.
      b. Section 16050 - Common Work Results for Electrical.
      c. Section 16305 - Electrical System Studies.
      d. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.02 QUALIFICATIONS OF MEETING PARTICIPANTS

A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of entity each represents.

1.03 PRECONSTRUCTION CONFERENCE

A. Upon issuance of Notice to Proceed, or earlier when mutually agreeable, Engineer will arrange preconstruction conference in place convenient for most invitees.

B. Preconstruction Conference invitees: Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to agenda.

C. Engineer will preside at conference.

D. Purpose of conference: To establish working understanding between parties and to discuss Construction Schedule, shop drawing and other submittals, cost breakdown of major lump sum items, processing of submittals and applications for payment, and other subjects pertinent to execution of the Work.

E. Agenda will include:
   1. Adequacy of distribution of Contract Documents.
   2. Distribution and discussion of list of major subcontractors and suppliers.
   3. Proposed progress schedules and critical construction sequencing.
   4. Major equipment deliveries and priorities.
   5. Project coordination.
   6. Designation of responsible personnel.
   7. Procedures and processing of:
      a. Field decisions.
      b. Proposal requests.
      c. Submittals.
      d. Change Orders.
      e. Request for Information/Interpretations.
      f. Applications for Payment.
      g. Record Documents.
   8. Use of premises:
      a. Office, construction, and storage areas.
      b. Owner's requirements.
   9. Construction facilities, controls, and construction aids.
   10. Shoring requirements and submittal of Contractor's geotechnical report.
   11. Temporary utilities.
   12. Safety and first aid procedures.
   13. Security procedures.
   14. Housekeeping procedures.

F. Engineer will record minutes of meeting and distribute copies of minutes within 7 days of meeting to participants and interested parties.

1.04 PROGRESS MEETINGS

A. Engineer will schedule and administer meetings throughout progress of the Work at maximum weekly intervals.

B. Engineer will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

C. Attendance required: Owner, Engineer, Contractor, Contractor’s Project Manager, superintendent, quality control manager, project scheduler, major subcontractors and suppliers as appropriate to agenda topics for each meeting.

D. Additional invitees: Owner utility companies when the Work affects their interests, and others necessary to agenda.

E. Agenda:
   1. Review minutes of previous meeting/minutes.
   2. Safety and security.
   3. Construction schedule summary.
   4. Review of 6 weeks schedule.
   5. Review of off-site fabrication and delivery schedules.
   6. Review of submittals schedule and status of submittals.
   7. Request for information (RFI's) status.
   8. MOP's/shutdown coordination.
   9. Complete and bring Application for Payment and Progress Schedule to progress meeting.
   10. Review percentage completion of items on Application for Payment.
   11. Change order management status.
   12. Maintenance of quality standards (QA/QC).
   13. Field observations, problems, and conflicts.
   14. Commissioning and process start-up.
   15. Partnering recognition status (optional).
   16. General Items.
   17. Action items.
   18. Next meeting.

F. Engineer will record minutes and distribute copies within 7 calendar days after meeting to participants, with copies to Contractor, Owner, and those affected by decisions made.

1.05 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections or requested by Engineer, convene pre-installation meeting at Project site before commencing work of specific section. Major units of construction which require pre-installation meetings include but not limited to:
   1. Painting.
   2. Secondary Clarifier No. 5 Mechanism.
   3. Submersible Pumps.
   4. Aeration Basin Mixers and Mixed Liquor Return Pumps.
   5. Aeration Diffusers.
   6. PLC and SCADA Programming.

B. Review percentage completion of items on Application for Payment. Require attendance of parties directly affecting, or affected by, Work of specific section.

C. Notify Engineer 7 calendar days in advance of meeting date.

D. Contractor shall prepare agenda and preside at meeting:
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.

E. Contractor will record minutes and distribute electronic copies within 7 calendar days after meeting to participants, with copies to Engineer, Owner, and those affected by decisions made.

1.06 PRESHUTDOWN MEETINGS

A. Follow Owner's standard Construction Method of Procedure (MOP). See Appendix A of Section 01140 for MOP format.

B. All short-term and longer-term shutdowns and other tie-ins that require an Owner approved MOP also require a pre-shutdown meeting at Project site prior to commencing shutdown for tie-in or modification of specific plant systems.

C. Require attendance of parties directly affecting, or affected by shutdown, including Engineer, specific work crews, Owner's construction, operations, and maintenance staff.

D. Notify Engineer 7 calendar days in advance of meeting date.

E. Contractor shall prepare agenda and preside at meeting:
   1. Review accepted MOP including conditions of shutdown, preparation, and installation procedures.
   2. Review timelines and sequences.
   3. Review responsibilities.
   4. Review dry run plan and schedule, as necessary.
   5. Review coordination with related work.

F. Contractor will record minutes and distribute copies within 5 calendar days after meeting and prior to scheduled shutdown to participants, with copies to Engineer, Owner, and those affected by decisions made.

1.07 PRE-PROCESS START-UP MEETINGS

A. All processes and equipment that requires testing and process start-up also requires a pre-startup meeting at Project site before commencing process start-up of specific plant systems.

B. Require attendance of parties directly affecting, or affected by process start-up and testing, including Engineer, specific work crews, Owner's construction operations, and maintenance staff.

C. Notify Engineer 7 calendar days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review accepted MOP including conditions of process start-up and testing, preparation, and installation procedures.
   2. Review timelines and sequences.
   3. Review responsibilities.
   4. Review dry run plan and schedule, as necessary.
   5. Review coordination with related work.

E. Contractor will record minutes and distribute electronic copies within 5 calendar days after meeting and prior to scheduled process start-up to participants, with copies to Engineer, Owner, and those affected by decisions made.

F. Follow Owner's standard Construction Method of Procedure (MOP). See Appendix A of Section 01140 for MOP format.

1.08 ELECTRICAL AND INSTRUMENTATION COORDINATION MEETINGS

A. Electrical Meetings:
   1. Pre-submittal review meeting as specified in Section 16050.
   2. Electrical System Study Meetings (3 separate meetings) as specified in Section 16305.
   3. Other meetings as required and as otherwise specified.

B. Instrumentation and Control Meetings:
   1. Pre-Submittal Conference as specified in Section 17050.
   2. System Configuration Meetings (2 separate meetings) as specified in Section 17050.
   3. Graphics Meetings (2 separate meetings) as specified in Section 17762.
   4. Report Meetings (1 separate meetings) as specified in Section 17762.
   5. Other meetings as required and as otherwise specified.

1.09 CLOSE-OUT MEETING

A. Engineer will schedule close-out meeting.

B. Engineer will make arrangements for meeting, prepare agenda with copies for participants, and preside at meeting.

C. Attendance required: Owner, Engineer, Contractor, Contractor's Project Manager, Superintendent.

D. Agenda:
   1. Review punchlist completion.
   2. Transfer of record documents.
   3. Finalize payment.

E. Engineer will record minutes and within 7 calendar days after meeting distribute copies to participants.

1.10 POST CONSTRUCTION MEETING

A. Meet with and inspect the Work 11 months after date of Substantial Completion with Owner and Engineer.

B. Arrange meeting at least 7 days before meeting.

C. Meet in Owner's office or other mutually agreed upon place.

D. Inspect the Work and draft list of items to be completed or corrected.

E. Review service and maintenance contracts, and take appropriate corrective action when necessary.

F. Complete or correct defective work and extend correction period accordingly.

G. Require attendance of Contractor, Project Manager, or Superintendent, appropriate manufacturers and installers of major units of constructions, and affected subcontractors.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01322

WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for web-based construction document management.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.

1.02 REQUIREMENTS

A. The Owner and Contractor shall utilize EADOC (EADOC is a registered trademark of EADOC LLC) for submission of all data and documents (unless specified otherwise in this Section) throughout the duration of the Contract:
   1. EADOC is a web-based electronic media site hosted by EADOC LLC.
   2. EADOC is paid for by the Owner.
   3. EADOC will be made available to all Contractor's personnel, subcontractor personnel, suppliers, consultants, and Engineer.
   4. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
   5. EADOC shall be the primary means of project information submission and management.

B. User access limitations:
   1. The Engineer will control the Contractor's access to EADOC by allowing access and assigning user profiles to accepted Contractor personnel. User profiles will define levels of access into the system; determine assigned function based authorizations and user privileges. Subcontractors and suppliers will be given access to EADOC by and through the Contractor. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on EADOC shall be the responsibility of the Contractor.

C. Joint ownership of data:
   1. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the EADOC system) by the Engineer and the Contractor will be jointly owned.

D. Automated system notification and audit log tracking:
   1. Review comments made (or lack thereof) by the Owner on Contractor submitted documentation shall not relieve the Contractor from compliance with requirements of the Contract Documents. The Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

E. Computer Requirements:
   1. The Contractor shall use computer hardware and software that meets the requirements of the EADOC system as recommended by EADOC LLC to access and utilize EADOC. As recommendations are modified by EADOC, the Contractor will upgrade their system(s) to meet or exceed the recommendations. Upgrading of the Contractor's computer systems will not be justification for a cost or time modification to the Contract.
   2. The Contractor shall ensure that connectivity to the EADOC system is accomplished through DSL, cable, T-1 or wireless communications systems. The minimum bandwidth requirements for using the system is 128kb/s. It is recommended a faster connection be used when uploading pictures and files into the system.
   3. EADOC supports the current and prior two major versions of Chrome, Mozilla's Firefox, Microsoft's Internet Explorer and Apple's Safari on a rolling basis:
      a. Each time a new version of one of these browsers is released, EADOC will begin supporting the update and stop supporting the fourth-oldest version.

F. Contractor responsibility:
   1. The Contractor shall be responsible for the validity of their information placed in EADOC and for the abilities of their personnel.
   2. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, cad drawing applications, and Adobe Portable Document Format (PDF) document distribution program.
   3. The Contractor shall utilize the existing forms in EADOC to the maximum extent possible. If a form does not exist in EADOC the Contractor must include a form of their own or provided by the Engineer as an attachment to a submittal.
   4. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. The Contractor is responsible for the training of their personnel in the use of EADOC (outside what is provided by the Owner) and the other programs indicated above as needed.

G. Connectivity problems:
   1. Provide a list of Contractor's key EADOC personnel for the Engineer's acceptance. Contractor is responsible for adding and removing users from the system. The Engineer reserves the right to perform a security check on all

potential users. The Contractor will be allowed to add additional personnel and subcontractors to EADOC.

1.03 SUBMITTALS

A. Preconstruction Submittals List of Contractor's key EADOC personnel. Include descriptions of key personnel's roles and responsibilities for this project. Contractor should also identify their organizations administrator on the list.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. EADOC project management application (no equal) Provided by EADOC LLC www.EADOCsoftware.com.

PART 3 EXECUTION

3.01 EADOC UTILIZATION

A. EADOC shall be utilized in connection with all document and information management required by these Contract Documents.

3.02 SUBMITTALS

A. Shop drawings:
   1. Shop drawing and design data documents shall be submitted PDF attachments to the EADOC submittal work flow process and form. Examples of shop drawings include, but are not limited to:
      a. Standard manufacturer installation drawings.
      b. Drawings prepared to illustrate portions of the work designed or developed by the Contractor.
      c. Steel fabrication, piece, and erection drawings.
   2. Hard copy submittals may be allowed, if approved by the Engineer on a case-by-case basis:
      a. Hard copy submittals shall be handled following procedures for Samples defined below.

3.03 PRODUCT DATA

A. Product catalog data and manufacturer’s instructions shall be submitted as PDF attachments to the EADOC submittal work flow process and form. Examples of product data include, but are not limited to:
   1. Manufacturer's printed literature.
   2. Preprinted product specification data and installation instructions.

3.04 SAMPLES

A. Sample submittals shall be physically submitted as specified in Section 01330. Contractor shall enter submittal data information into EADOC with a copy of the

submittal form(s) attached to the sample. Examples of samples include, but are not limited to:

1. Product finishes and color selection samples.
2. Product finishes and color verification samples.
3. Finish/color boards.
4. Physical samples of materials.

3.05 ADMINISTRATIVE SUBMITTALS

A. All correspondence and pre-construction submittals shall be submitted using EADOC. Examples of administrative submittals include, but are not limited to:
   1. Permits.
   2. Requests for substitutions (RFS).
   3. List of contact personnel.
   4. Requests for Information (RFI).

B. Network Analysis Schedules and associated reports and updates. Each schedule submittal specified in these Contract Documents shall be submitted as a native backed-up file (.PRX or .STX) of the scheduling program being used. The schedule shall also be posted as a PDF file in the format specified in these Contract Documents.

C. Plans for safety, demolition, environmental protection, and similar activities.

D. Quality Control Plan(s), Testing Plan and Log, Quality Control Reports, Production Reports, Quality Control Specialist Reports, Preparatory Phase Checklist, Initial Phase Checklist, Field Test reports, Summary reports, Rework Items List, etc.

E. Meeting minutes for quality control meetings, progress meetings, pre-installation meetings, etc.

F. Any general correspondence submitted.

3.06 COMPLIANCE SUBMITTALS

A. Test reports, certificates, and manufacture field report submittals shall be submitted on EADOC as PDF attachments. Examples of compliance submittals include, but are not limited to:
   1. Inspection requests:
      a. When a portion of Work is ready for inspection and prior to covering up the Work (for example, a concrete pour that has waterstop, rebar and embeds placed prior to pouring the concrete), inspection requests shall be submitted via EADOC and approved via EADOC.
      b. Reports associated with this element of the Work will be submitted via EADOC and associated with the inspection request.
   2. Field test reports.
   3. Quality Control certifications.
   4. Manufacturers documentation and certifications for quality of products and materials provided.

3.07 RECORD AND CLOSEOUT SUBMITTALS

A. Operation and maintenance data and closeout submittals shall be submitted on EADOC as PDF documents during the approval and review stage as specified, with actual set of documents submitted for final. Examples of record submittals include, but are not limited to:
   1. Operation and Maintenance Manuals: final documents shall be submitted as specified.
   2. Extra materials, spare stock, etc.: submittal forms shall indicate when actual materials are submitted.

3.08 CLOSEOUT ACTIVITIES

A. Training:
   1. The Owner has arranged and paid for training to be provided to the Contractor.
   2. Training consists of web-based seminars in conjunction with a conference call.

B. Contractor shall arrange and pay for the facilities and hardware/software required to facilitate his own training.

3.09 FINANCIAL SUBMITTALS

A. Schedule of Value, Pay Estimates, and Change Request Proposals shall be submitted on EADOC. Supporting material for Pay Estimates and Change Requests shall be submitted on EADOC as PDF attachments. Examples of compliance submittals include, but are not limited to:
   1. Contractor's Schedule of Values.
   2. Contractor's Monthly Progress Payment Requests.
   3. Contract Change proposals requested by the Owner.

END OF SECTION

SECTION 01324A

PROGRESS SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preparation, submittal, and maintenance of computerized progress schedule and reports, Contract Time adjustments, and payment requests, including the following:
   1. Preliminary Schedule.
   2. Baseline Schedule.
   3. Monthly Schedule Updates.
   4. Weekly Summary Schedule.
   5. Schedule of Submittals.
   6. Manpower Schedule.
   7. Equipment Schedule.
   8. Commissioning and Process Start-up Schedule.
   9. As-built Schedule.
   10. Time Impact Analyses.
   11. Final Schedule Submittal.

B. Related sections:
   1. Document 00700 - General Conditions.
   2. Section 01292 - Schedule of Values.
   3. Section 01294 - Applications for Payment.
   4. Section 01312 - Project Meetings.
   5. Section 01756 - Commissioning.

1.02 SCHEDULER

A. Designate, in writing and within 5 calendar days after Notice of Award, person responsible for preparation, maintenance, updating, and revision of all schedules.

B. Qualifications of scheduler:
   1. Authority to act on behalf of Contractor.
   2. 8 years verifiable experience in preparation of complex construction schedules for projects of similar value, size, and complexity.
   3. Knowledge of critical path method (CPM) scheduling utilizing Primavera P6 Professional software.

C. References: Submit written reference of 3 project Owners who have personal experience with this scheduler on previous projects. Identify name, address, telephone number, project name, and cost.

D. Scheduler: Dedicated full time to this project, located on-site. All scheduling software and hardware located on-site. Scheduler will attend all project meetings called for as specified in Section 01312.

E. Owner reserves the right to disapprove scheduler when submitted by Contractor if not qualified. Owner reserves the right to remove scheduler from the project if found to be incompetent.

1.03 SCHEDULING FORMAT AND SOFTWARE

A. Schedule format: Utilize CPM format.

B. Prepare computerized schedule utilizing Primavera P6 Professional, most current version:
   1. Provide 1 licensed copy of the scheduling software to the engineer, registered in the Engineer's name, for the duration of the project.
   2. The provided copy of the software shall be a standalone version for installation on a standalone computer.

1.04 PRECONSTRUCTION SCHEDULING MEETING

A. Engineer will conduct Preconstruction Scheduling Meeting with Contractor's Project Manager, General Superintendent, and scheduler within 7 calendar days after Notice To Proceed. This meeting is separate from the Preconstruction Conference Meeting and is intended to cover schedule issues exclusively.

B. At the meeting, review scheduling requirements. These include schedule preparation, reporting requirements, labor and equipment loading, updates, revisions, and schedule delay analysis. Present schedule methodology, planned sequence of operations, resource loading methodology, and proposed activity coding structure.

C. Coding structure:
   1. Submit proposed coding structure, identifying the code fields and the associated code values it intends to use in the project schedule.
   2. A minimum, include code fields for Project Segment or Phase, Area of Work, Type of Work, Submittal/Procurement/Construction and Responsibility/Subcontractor. Refer to NETWORK DETAILS AND GRAPHICAL OUTPUT for listing of activity categories to be included in the schedule.

D. Naming convention: Name schedule files with the year, month and day of the data date, revision identifier, and a description of the schedule:
   1. Example 1: 2014_07_30 rev 1 draft baseline schedule.xer.
   2. Example 2: 2014_09_30 rev 2 sep final update.xer.

E. Filing: Post submitted files to Owner's construction document control system.

1.05 SCHEDULE PREPARATION

A. Preparation and submittal of Progress Schedule represents Contractor's intention to execute the Work within specified time and constraints. Failure to conform to requirement may result in termination for cause as defined in Document 00700, under Suspension of Work and Termination.

B. Contractor's bid covers all costs associated with the execution of the Work in accordance with the Progress Schedule.

C. During preparation of the preliminary Progress Schedule, Engineer will facilitate Contractor's efforts by being available to answer questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.

D. Prepare schedule utilizing Precedence Diagramming Method (PDM).

E. Prepare schedule utilizing activity durations in terms of working days. Do not exceed 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work. Coordinate holidays to be observed with the Owner and incorporate them into the schedule as non-working days.

F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract. Contract requirements are not waived by failure of Contractor to include required schedule constraints, sequences, or milestones in schedule. Contract requirements are not waived by Owner’s acceptance of the schedule. In event of conflict between accepted schedule and Contract requirements, terms of Contract govern at all times, unless requirements are waived in writing by the Owner.

G. Reference schedule to working days with beginning of Contract Time as Day "1.”

H. Baseline Schedule and Project Completion: Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor’s schedule completion date. Adjust accordingly any Contract milestone dates.

I. Contract float is for the mutual benefit of both Owner and Contractor. Changes to the project that can be accomplished within this available period of float may be made by Owner without extending the Contract Time, by utilizing float. Time extensions will not be granted nor delay damages owed until Work extends beyond currently accepted Contract completion date. Likewise, Contractor may utilize float to offset delays other than delays caused by Owner. Mutual use of float can continue until all available float shown by schedule has been utilized by either Owner or Contractor, or both. At that time, extensions of the Contract Time will be granted by Owner for valid Owner-caused or third party-caused delays which affect the planned completion date and which have been properly documented and demonstrated by Contractor.

J. Resource loading and leveling: Input labor and equipment data on each schedule activity. Manpower data consist of the man-hours estimated to perform each task, categorized by trade. Equipment data consist of equipment hours estimated to perform each task, categorized by piece of equipment. Optimize and level manpower and equipment requirements. Resource leveling reflect a reasonable plan for accomplishing Work. Individual activities may be sequenced within limits of available float. Keep to a minimum critical or near critical paths resulting from use of labor or equipment restraints. Near critical path identified as path with 15 or less working days of float.

K. Schedule logic: Assembled to show order in which Contractor proposes to carry out Work, indicate restrictions of access, availability of Work areas, and availability and use of manpower, materials, and equipment. Form basis for assembly of schedule logic on the following criteria:
   1. Which activities must be completed before subsequent activities can be started?
   2. Which activities can be performed concurrently?
   3. Which activities must be started immediately following completed activities?
   4. What major facility, equipment, or manpower restrictions are required for sequencing these activities?

L. Non-sequestering of float: Pursuant to float sharing requirements of Contract, schedule submittals can be rejected for, use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, extended activity durations or imposed dates.

M. Major subcontractor, parallel prime contractor sign off: Provide written confirmation of concurrence from all major subcontractors and independent prime contractors on site with all schedule submittals. Term “major subcontractor” as used in this Section means any subcontractor, at any tier, with a subcontract worth 5 percent or more of the total cost of the Work.

N. Imposed dates, hidden logic prohibited: Do not use imposed dates or hidden logic in preparation of schedule.

O. Interim milestone dates, operational constraints: In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on schedule. Do not use Zero Total Float constraint or Mandatory Finish Date on such Contract requirements.

P. Schedule windows for Owner-furnished, Contractor-installed equipment or materials: Immediately after Award of Contract, obtain from Engineer anticipated delivery dates of Owner furnished equipment or materials. Show these dates in the schedule in same manner indicated by Engineer.

Q. Cost loading: All schedules:
   1. Only on-site construction activities.
   2. The sum total of all cost loaded activities equal to the current value of the Contract, including change orders, at all times.
   3. Owner acceptance of the Baseline Schedule creates the Schedule of Values required as specified in Section 01292.
   4. Provide updated Schedule of Values as the monthly Payment Application as specified in Section 01294.
   5. Payments will not be made until updated Schedule of Values is accepted.

1.06 NETWORK DETAILS AND GRAPHICAL OUTPUT

A. Produce a clear, legible, and accurate calendar based, time scaled, graphical network diagram. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.

B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.

C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.

D. Indicate the critical path for the project.

E. Delineate the specified contract duration and identify the planned completion of the Work as a milestone. Show the time period between the planned and Contract completion dates, if any, as an activity identified as project float unless a Change Order is issued to officially change the Contract completion date.

F. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion date as milestones.

G. Include, in addition to construction activities:
   1. Submission dates and review periods for major equipment submittals and shoring submittals:
      a. Shoring reviews: Allow 4-week review period for each shoring submittal.
   2. Any activity by the Owner or the Engineer that may affect progress or required completion dates.
   3. Equipment and long-lead material deliveries over 8 weeks.
   4. Approvals required by regulatory agencies or other third parties.

H. Produce network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.

I. Identify the execution of the following:
   1. Mobilization.
   2. All required submittals and submittal review times showing 30 calendar day duration for such activities and equal amount of time for re-submittal reviews.
   3. Permits.
   4. Equipment and materials procurement/fabrication/delivery.
   5. Excavation.
   6. Shoring design and submission of detailed shoring submittals. Identify submission as a milestone.
   7. Shoring review, shoring materials procurement, shoring installation, and shoring removal.
   8. Backfill and compaction.
   9. Dewatering.
   10. Grading, subbase, base, paving, and curb and gutters.
   11. Fencing and landscaping.
   12. Concrete, including installation of forms and reinforcement, placement of concrete, curing, stripping, finishing, and patching.
   13. Tests for leakage of concrete structures intended to hold water.
   14. Masonry.
   15. Metal fastenings, framing, structures, and fabrications.
   16. Wood structures, finish carpentry, architectural woodwork, and plastic fabrications.
   17. Waterproofing and dampproofing, insulation, roofing and flashing, and sealants.

18. Doors and windows, including hardware and glazing.
19. Finishes including coating and painting, flooring, ceiling, and wall covering.
20. Building specialties including furnishings, laboratory equipment, and toilet and bath accessories.
21. Process equipment, including identification of ordering lead-time, factory testing, and installation.
22. Pumps and drives, including identification of ordering lead time, factory testing, and installation.
23. Conveying equipment including hoists and cranes, conveyor systems, and materials handling equipment, including identification of ordering lead-time and installation.
24. Other mechanical equipment including fans and heating, ventilating, and air conditioning equipment.
25. Trenching, pipe laying, and trench backfill and compaction.
26. Piping, fittings, and appurtenances, including identification of ordering and fabrication lead time, layout, installation and testing.
27. Valves, gates, and operators, including identification of order lead-time, installation, and testing.
28. Plumbing specialties.
29. Electric transmission, service, and distribution equipment, including identification of ordering lead-time, and factory testing.
30. Other electrical work including lighting, heating and cooling, and special systems, including identification of ordering lead-time.
31. Instrumentation and controls, including identification of ordering lead-time.
32. Preliminary testing of equipment, instrumentation, and controls.
33. Final testing, including preparation time.
34. Commissioning Phase:
    a. Source Testing.
    b. Owner Training.
    c. Installation Testing.
    d. Functional Testing.
    e. Clean Water Facility Testing.
35. Process Start-up Phase:
    a. Process Start-up.
    b. Process Operational Period.
    c. Instrumentation and Controls Performance Testing.
36. Seven-day operational test.
37. Substantial completion.
38. Punch list work.
39. Demobilization.

1.07 SUBMITTAL OF PROGRESS SCHEDULES

A. Submit preliminary and baseline schedule.

B. Submit, on a monthly basis, updated schedules as specified.

C. Submit final schedule update as specified.

D. Submit revised schedules and time impact analyses as specified.

E. Submit schedules in the media and number of copies as follows:
   1. 3 sets of the CPM network and/or barchart (as specified by the Owner) on D-size sheets. Color-coding to be specified by the Owner.
   2. 3 sets of Tabular reports listing all activities sorted numerically identifying duration, early start, late start, early finish, late finish, total float, and all predecessor/successor information.
   3. 2 sets of CPM Schedule data electronic files stored on CD/DVD.

1.08 PRELIMINARY SCHEDULE

A. Submit Preliminary Schedule within 10 calendar days after Notice to Proceed. Include a detailed plan of operations for first 90 calendar days of Work after receipt of Notice to Proceed.

B. Meet with Engineer within 7 calendar days after receipt of Preliminary Schedule to review and make necessary adjustments. Submit revised preliminary schedule within 5 calendar days after meeting.

C. Submit schedule of manpower and costs for all activities with revised Preliminary Schedule. Provide realistic and level manpower and costs so as not to have unusual manpower requirements.

D. Schedule of costs:
   1. Schedule of Values as specified in Section 01292 for first 90 calendar days of Work.
   2. Submittal and acceptance of Preliminary Schedule is condition precedent to making of progress payments as specified in Section 01294 and payments for mobilization costs otherwise provided for in the Contract.
   3. Proceed with pay item Work after Preliminary Schedule and schedule of costs have been accepted by Owner.

E. Incorporate unchanged, the accepted Preliminary Schedule as first 90 calendar days of activity in Contractor’s Baseline Schedule.

F. Update Preliminary Schedule monthly during first 90 calendar days after Notice to Proceed. Use Preliminary Schedule as the payment application as specified in Section 01294.

1.09 BASELINE SCHEDULE

A. No more than 45 calendar days after Notice to Proceed, submit the Baseline Schedule for all Work of the project. Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.

B. Acceptance of the Baseline Schedule by the Owner is a condition precedent to making payments as specified in Section 01294 after the first 90 calendar days after Notice to Proceed.

1.10 WEATHER DAY ALLOWANCE

A. Include as a separate identifiable activity on the critical path, an activity labeled "Weather Days Allowance." Insert this activity at the end of the schedule.

B. Insert an activity in critical path to reflect weather day occurrences when weather days are experienced and accepted by Engineer. Identify this activity as a weather delay.

C. Reduce duration of Weather Days Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in Weather Day Allowance at completion of project is considered float.

D. Weather conditions that prevent or inhibit the Contractor's performance of the Work and affect the Critical Path indicated on the Schedule shall be referred to as a Weather Day. A Weather Day is defined as the Contractor being unable to perform at least 4 hours of work on the Critical Path. The Contractor shall provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and shall describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted. A schedule update will not suffice as a written notice. The Engineer will determine if the weather day constitutes a use of a portion of the Weather Day Allowance. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions. Weather days are considered excusable delay as defined in this Section.

1.11 ALLOWANCE FOR OWNER-CAUSED DELAY

A. Include as a separate identifiable activity on the critical path, an activity labeled "Allowance for Owner-Caused Delay." Insert this activity at the end of the schedule, following the Project Completion Milestone.

B. Duration of this activity is specified in Bid Form. The duration of this Owner-Caused Delay Allowance is in addition to the contractual time frame.

C. Insert an activity in critical path to reflect Owner-caused delay occurrences when Owner-caused delay days are experienced and accepted by Engineer. Identify this activity as an Owner-caused delay.

D. Reduce duration of Owner-Caused Delay Allowance activity as Owner-caused delays are experienced and inserted into the schedule. Remaining days in Owner-Caused Delay Allowance at completion of project is considered float.

1.12 REVIEW AND ACCEPTANCE OF SCHEDULES

A. Engineer will review Baseline Schedule, Schedule Updates, Schedule Revisions and Time Impact Analyses to ascertain compliance with specified project constraints, compliance with milestone dates, reasonableness of durations and sequence, accurate inter-relationships, and completeness.

B. Engineer and Owner will issue written comments following completion of review of Baseline Schedule within 21 calendar days after receipt.

C. Written comments on review of Schedule Updates and Schedule Revisions and Time Impact Analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.

D. Revise and resubmit schedule in accordance with Engineer's comments within 7 calendar days after receipt of such comments, or request joint meeting to resolve objections.

E. If Engineer requests a meeting, the Contractor and all major subcontractors must participate in the meeting with Engineer:
   1. Revise and resubmit schedule within 7 calendar days after meeting.

F. Use accepted schedule for planning, organizing, and directing the work and for reporting progress.

G. Engineer's submittal review response:
   1. When schedule reflects Owner's and Contractor's agreement of project approach and sequence, schedule will be accepted by Owner.
   2. Engineer's submittal review response for schedule submittal will be "Receipt Acknowledged – Filed for Record" including applicable comments.
   3. Acceptance of the schedules by the Owner is for general conformance with the Contract Documents and for Owner's planning information, and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the contract completion dates. Omissions and errors in the accepted schedules shall not excuse performance less than that required by the Contract Documents. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

1.13 SCHEDULE UPDATES

A. Any update:
   1. Prepare update using most recent accepted version of schedule including:
      a. Actual start dates of activities that have been started.
      b. Actual finish dates of activities that have been completed.
      c. Percentage of completion of activities that have been started but not finished.
      d. Actual dates on which milestones were achieved.
      e. Update activities by inputting percent complete figures with actual dates.
      f. Use retained logic in preparing Schedule Updates.
      g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
      h. Revisions to the schedule may be included that have been previously approved as specified in this Section under Revisions to Schedule.

B. Monthly updates:
   1. Submit written narrative report in conjunction with each Schedule Update including descriptions of the following:
      a. Activities added to or deleted from the schedule are to adhere to cost and other resource loading requirements:
         1) Identify added activities in manner distinctly different from original activity designations.
      b. Changes in sequence or estimated duration of activities.
      c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.

d. Assumptions made and activities affected by incorporating change order work into the schedule.

2. Submit updated schedule and materials specified under Submittal of Progress Schedules, 5 calendar days before the monthly schedule update meeting.
3. Since Monthly Schedule Update is the application for progress payment required as specified in Section 01294, submittal and acceptance of the monthly Schedule Update is a condition precedent to the making of any progress payments.

C. Weekly progress meeting:
   1. Update the schedule prior to weekly progress meeting:
      a. Identify overall progress of each Major Item of Work in the Summary Schedule.
      b. If there are significant changes to the schedule, submit a written report at the weekly progress meeting.
   2. Should monthly Schedule Update show project completion earlier than current Contract completion date, show early completion time as schedule activity, identified as “Project Float”.
   3. Should monthly Schedule Update show project completion later than current Contract completion date, prepare and submit a Schedule Revision in accordance with the Revisions to Schedule.

1.14 REVISIONS TO SCHEDULE

A. Submit Revised Schedule within 5 days:
   1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
   2. When delays in submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
   3. When the schedule does not represent the actual progress of activities.
   4. When any change to the sequence of activities, the completion date for major portions of the work, or when changes occur which affect the critical path.
   5. When Contract modification necessitates schedule revision, submit schedule analysis of change order work with cost proposal.

B. Create a separate submittal for Schedule Revisions:
   1. Comply with schedule updates as specified in this Section.
   2. Do not submit with Schedule Updates.

C. Schedule Revisions will not be reflected in the schedule until after the revision is accepted by the Owner:
   1. This includes Schedule Revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

1.15 PAYMENT REQUESTS AND CASH FLOW

A. After Baseline Schedule has been submitted and accepted by the Owner, submit on a monthly basis a tabular and graphic report showing anticipated earnings each month of the Contract period. This tabulation will be based on the summation of the cost-loaded activities each month. Submit an updated payment schedule each month showing actual earned amounts and anticipated remaining earnings.

B. Utilize cost loaded monthly Progress Schedule Updates as the applications for payment specified in Section 01294. List payment application in Excel format of all schedule activities showing cost and percentage completion during the current month for which payment is sought. Progress payments will not be made until monthly Progress Schedule Update is provided.

1.16 WEEKLY SCHEDULE

A. Submit to Engineer, at every weekly progress meeting, a 6-Week Schedule showing the activities completed during the previous week and the Contractor's schedule of activities for following 5 weeks.

B. Use the logic and conform to the status of the current progress schedule when producing a Weekly Schedule in CPM schedule or a bar chart format:
   1. In the event that the Weekly Schedule no longer conforms to the current schedule, Contractor may be required to revise the schedule as specified in this Section.

C. The activity designations used in the Weekly Schedule must be consistent with those used in the Baseline Schedule and the monthly Schedule Updates.

D. Contractor and Engineer must agree on the format of the Weekly Schedule.

1.17 SCHEDULE OF VALUES

A. Requirements for Schedule of Values are specified in Section 01292.

B. Submit, in conjunction with the Progress Schedule, a Schedule of Values identifying costs of all on-site construction activities as generated by the cost loaded schedule. Equate the aggregate of these costs to the Lump Sum Contract Price.

1.18 ADJUSTMENT OF CONTRACT TIMES

A. Contract Time will be adjusted only for causes specified in Contract Documents:
   1. Non-excusable delay: Non-excusable delays include actions or inactions of the Contractor, or events for which the Contractor has assumed contractual responsibility (including actions or inactions of subcontractors, suppliers, or material manufacturers at any tier) that would independently delay the completion of the Work beyond the current Contract completion date). No time extensions will be granted for non-excusable delays.
   2. Excusable delay: Events which are unforeseeable, outside the control of, and without the fault or negligence of either the Owner or the Contractor (or any party for whom either is responsible), which would independently delay the completion of the Work beyond the current Contract completion date. The Contractor is entitled to a time extension only. No other damages will be approved.
   3. Compensable delay: Actions or inactions of the Owner, or events for which the Owner has assumed contractual responsibility, which would independently delay the completion of the Work beyond the current Contract completion date. The Contractor is entitled to a time extension and delay damages.

4. Concurrent delay: Concurrent delay is any combination of the above 3 types of delay occurring on the same calendar date:
    a. Exception to concurrent delay: Cases where the combination consists of 2 or more instances of the same type of delay occurring on the same calendar date. When one cause of delay is Owner-caused or caused by an event which is beyond the control and without the fault or negligence of either the Owner or the Contractor and the other Contractor-caused, the Contractor is entitled only to a time extension and no delay damages.

B. If the Contractor believes that the Owner has impacted its work, such that the project completion date will be delayed, the Contractor must submit proof demonstrating the delay to the critical path. This proof, in the form of a Time Impact Analysis, may entitle the Contractor to an adjustment of Contract Time.

C. Time Impact Analysis:
    1. Use the accepted schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the schedule by:
        a. Inserting new activities associated with the delay event into the schedule.
        b. Revising activity logic.
        c. Revising activity durations.
    2. If the project schedule's critical path and completion date are impacted as a result of adding this delay event to the schedule, a time extension equal to the magnitude of the impact may be warranted.
    3. The Time Impact Analysis submittal must include the following information:
        a. A fragment of the portion of the schedule affected by the delay event.
        b. A narrative explanation of the delay issue and how it impacted the schedule.
        c. A CD containing the schedule file used to perform the Time Impact Analysis.

D. When a delay to the project as a whole can be avoided by revising preferential sequencing or logic, and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.

E. Indicate clearly that the Contractor has used, in full, all project float available for the work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date. Utilize the latest version of the Schedule Update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

F. Adjustment of the Contract Times will be granted only when the Contract Float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.

G. Actual delays in activities which do not affect the critical path work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.

H. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to job-site or home office overhead beyond the Contractor's originally planned occupancy of the site.

I. Notify Engineer of a request for Contract Time adjustment. Submit request as specified with Contract Documents. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.

J. The Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing:
   1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule Update.
   2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

1.19 SUMMARY SCHEDULE

A. Provide Summary Schedule, which consolidates groups of activities associated with Major Items of Work shown on Baseline Schedule. Summary Schedule is intended to give an overall indication of the project schedule without a large amount of detail.

B. Submit updated Summary Schedule at weekly progress meetings and after each Schedule Update or Schedule Revision.

1.20 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals shall include submittals required in the Contract Documents but not limited to Commissioning and Process Start-up Plans, Training Plans, test procedures, operation and maintenance manuals, shop drawings, samples, record documents, and specifically required certificates, warranties, and service agreements.

B. Preliminary Schedule of Submittals:
   1. Due date: After Preliminary Schedule has been submitted and accepted by Owner.
   2. Format:
      a. Include submittals anticipated in the first 90 calendar days after Notice to Proceed using early start dates.
      b. Indicate week and month anticipated for each submittal.

c. Indicate “Priority” submittals where review time can impact Contractor’s schedule:
1) “Priority” indication will not alter review times specified in Section 01330.
2) Engineer will endeavor to provide early review of “Priority” submittals where possible.

3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after Notice to Proceed.

C. Final Schedule of Submittals:
1. Due date: After Baseline Schedule has been submitted and accepted by Owner.
2. Format:
a. Include submittals using early start dates.
b. Include all submittals, including those required in the Preliminary Schedule of Submittals.
c. Indicate week and month anticipated for each submittal.
d. Indicate “Priority” submittals where review time can impact Contractor’s schedule:
1) “Priority” indication will not alter review times specified in Section 01330.
2) Engineer will endeavor to provide early review of “Priority” submittals where possible.

3. Submittal of Final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.

D. Provide updated Schedule of Submittals with updated schedules if schedule revisions change listing and timing of submittals.

1.21 MANPOWER SCHEDULES

A. Due date: After Baseline Schedule has been submitted and accepted by Owner.

B. Format:
1. Schedule histogram depicting total craft manpower and craft manpower for Contractor’s own labor forces and those of each subcontractor.
2. Submit electronically on a computer disk in Excel format, with 1 paper copy.

C. Progress payments after the first 90 calendar days after Notice to Proceed will not be made until manpower schedule is provided.

1.22 EQUIPMENT SCHEDULE

A. Due date: After Baseline Schedule has been submitted and accepted by Owner.

B. Format:
1. Tabular report listing each major piece of construction equipment to be used in performing the Work.
2. Include major equipment for Contractor and each subcontractor.
3. Submit electronically on a computer disk in Excel format with 1 paper copy.

C. Progress payments after the first 90 calendar days after Notice to Proceed will not be made until equipment schedule is provided.

1.23 COMMISSIONING AND PROCESS START-UP SCHEDULE SUBMITTAL

A. Proposed Commissioning and Process Start-up Schedule:
   1. Due date: As specified in Section 01756.
   2. Schedule requirements: As specified in Section 01756.
   3. Engineer response due within 20 calendar days of receipt.
   4. Contractor responsible for updating schedule and resubmitting within 10 calendar days of receipt of Engineer and Owner comments.

B. The Commissioning and Process Start-up Schedule may not be combined with the Detailed Schedule until Engineer acceptance of the Proposed Commissioning and Process Start-up Schedule.

C. Commissioning and Process Start-up Schedule monthly update requirements:
   1. Highlight percentages of completion, actual start and finish dates, and remaining durations, as applicable.
   2. Include activities not previously included in the previously accepted detail work plan Commissioning and Process Start-up Schedule.
   3. Change Order required for any change to contractual dates.
   4. Reviews of these submittals by Engineer will not be construed to constitute acceptance within the time frames, durations, or sequence of work for each added activity.

1.24 FINAL SCHEDULE SUBMITTAL

A. The final Schedule Update becomes the As-Built Schedule:
   1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.
   2. Contractor's Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.

B. Retainage will not be released until final Schedule Update is provided.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01329

SAFETY PLAN

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Development and maintenance of a Construction Safety Plan.

1.02 REFERENCES

A. California Labor Code, Section 6401.7.

B. National Fire Protection Association (NFPA):
   1. 70E - Standard for Electrical Safety in the Workplace.

C. Occupational Safety and Health Standards (OSHA).

1.03 CONSTRUCTION SAFETY PLAN

A. Detail the Methods and Procedures to comply with California Labor Code Section 6401.7, NFPA 70E, Federal, and Local Health and Safety Laws, Rules and Requirements for the duration of the Contract Times. Methods and procedures must also comply with the Owner's Safety Plan. Include the following:
   1. Identification of the Certified or Licensed Safety Consultant who will prepare, initiate, maintain and supervise safety programs, and procedures.
   2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.
   3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, safety equipment used in multi-level structures, personal protective equipment (PPE) as required by NFPA 70E.
   4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.
   5. Procedures for reporting safety or health hazards.
   6. Procedures to follow to correct a recognized safety and health hazard.
   7. Procedures for investigation of accidents, injuries, illnesses, and unusual events that have occurred at the construction site.
   8. Periodic and scheduled inspections of general work areas and specific workstations.
   9. Training for employees and workers at the jobsite.
   10. Methods of communication of safe working conditions, work practices and required personal protection equipment.
   11. Provision of a site specific emergency action and evaluation plan.
   12. Verify safety plan includes reference to and compliance with latest Owner safety policies.

B. Assume sole responsibility for every aspect of Health and Safety on the jobsite, including the health and safety of subcontractors, suppliers, and other persons on the jobsite:
   1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.
   2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers in accordance with OSHA guidelines.

C. Transmit to Owner and Engineer copies of reports and other documents related to accidents or injuries encountered during construction.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements and procedures for submittals.

B. Related sections:
   1. Section 01292 - Schedule of Values.
   2. Section 01294 - Applications for Payment.
   3. Section 01322 - Web Based Construction Document Management.
   4. Section 01324A - Progress Schedules and Reports.
   5. Section 01770 - Closeout Procedures.
   6. Section 16222 - Low Voltage Motors Up to 500 Horsepower.

1.02 REFERENCES

A. NSF International:
   1. NSF 61 - Drinking Water System Components – Health Effects.

1.03 DEFINITIONS

A. Certificates: Describe certificates that document affirmations by the Contractor or other entity that the work is in accordance with the Contract Documents.

B. Extra stock materials: Describe extra stock materials to be provided for the Owner's use in facility operation and maintenance.

C. Maintenance material submittals: Use this article to categorize maintenance materials submittals requiring no Engineer action other than confirmation of receipt under an explanatory heading.

D. Manufacturer's instructions: Instructions, stipulations, directions, and recommendations issued in printed form by the manufacturer of a product addressing handling, installation, erection, and application of the product; manufacturer's instructions are not prepared especially for the Work.

E. Product data: Product data usually consists of manufacturers' printed data sheets or catalog pages illustrating the products to be incorporated into the project.

F. Samples: Samples are full-size actual products intended to illustrate the products to be incorporated into the project. Sample submittals are often necessary for such characteristics as colors, textures, and other appearance issues.

G. Spare parts: Describe spare parts necessary for the Owner's use in facility operation and maintenance; identify the type and quantity here, but include the actual characteristics of the spare parts in Product as part of the specification of the product.

H. Shop drawings: Shop drawings are prepared specifically for the project to illustrate details, dimensions, and other data necessary for satisfactory fabrication or construction that are not shown in the contract documents. Shop drawings could include graphic line-type drawings, single-line diagrams, or schedules and lists of products and their application.

I. Submittals: Submittals are samples, product data, shop drawings, and others that demonstrate how Contractor intends to conform with the Contract Documents.

J. Tools: Tools are generally defined as items such as special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a system that would not normally be in the Owner's tool kit.

1.04 GENERAL INSTRUCTIONS

A. Provide submittals that are specified or reasonably required for construction, operation, and maintenance of the Work.

B. Provide submittal information from only 1 manufacturer for a specified product. Submittals with multiple manufacturers for 1 product will be rejected without review.

C. Where multiple submittals are required, provide a separate submittal for each specification section:
   1. In order to expedite construction, the Contractor may make more than 1 submittal per specification section, but a single submittal may not cover more than 1 specification section.
   2. The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section.

D. For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.

E. Edit all submittals so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.

F. Prepare submittals in the English language. Do not include information in other languages.

G. Present measurements in customary American units (feet, inches, pounds, etc.).

H. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.

I. Indicate project designated equipment tag numbers from P&IDs for submittal of devices, equipment, and assemblies.

J. Hardcopy submittals:
   1. Must be clear and legible, and of sufficient size for presentation of information:
      a. Minimum page size will be 8 1/2 inches by 11 inches.
      b. Maximum page size will be 11 inches by 17 inches.

K. Submittals in electronic media format:
   1. General: Provide all information In PC-compatible format using Windows® operating system as utilized by the Engineer and Owner.
   2. Text: Provide text documents and manufacturer's literature using current version of Adobe® Acrobat® (i.e., PDF extension) as utilized by the Owner and Engineer.
   3. Graphics: Provide all graphic submittals (drawings, diagrams) utilizing current version of Adobe® Acrobat® (i.e., PDF extension) as utilized by the Engineer and Owner.
   4. Contractor using other software shall be required to provide to the Engineer conclusive evidence of 100-percent data transfer compatibility.

L. Approved Material List:
   1. General: Provide the Approved Material List that documents all products that have been determined to be without exceptions through the submittal process. Maintain and update the list throughout the construction period. Provide Owner and Engineer with current copy of list weekly. Provide the list electronically in Microsoft® Excel file.
   2. Content: Provide Approved Material List in log form with columns titled, "Spec. Section", "Paragraph", "Submittal No.", "Approval Date", "Product Description", and "Manufacturer Name". Include only products submitted and found to be approved.

1.05 SUBMITTAL ORGANIZATION

A. Fully indexed with a tabbed divider for every component.

B. Sequentially number pages within the tabbed sections:
   1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.

C. Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.

D. For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is used.

E. Consolidate electronic format submittals with multiples pages into a single file.

1.06 SUBMITTAL COVER SHEETS

A. Submittal Transmittal Form is provided in Appendix A of this Section:
   1. Substitute forms require Engineer approval based on forms providing the same information, statements, and certifications.
   2. Submittal Number Field: Required submittal numbering format: Section number-sequential number-resubmittal number:
      a. Example: 03200-002-1:
         1) "03200" indicates the affected specification is Section 03200.
         2) "002" indicates the second submittal under this Section.
         3) "1" indicates the first resubmittal of the Submittal.

b. Contractor may add a separate numbering scheme for Contractor's internal use. However, all correspondence with Engineer must include the required submittal numbering.

3. "From" Field: Provide name and address of company responsible for preparation of submittal. This could be General Contractor, subcontractor, supplier, manufacturer, etc.
4. "General Contractor Reviewer" Field: Verify that the General Contractor has reviewed the submittal by signature.

B. Contractor sign and date submittals indicating review and approval:
   1. Signature indicates Contractor certifies that they have satisfied submittal review responsibilities and constitutes Contractor's written approval of submittal.
   2. Submittals without Contractor's signature will be returned to the Contractor unreviewed. Subsequent submittal of this information will be counted as the first resubmittal.

C. Attachments:
   1. Specification section: Include with each submittal a copy of the relevant specification section:
      a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
   2. Drawings: Include with each submittal a copy of the relevant Drawing, including relevant addendum updates:
      a. Indicate either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
      c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.

D. Contractor: Prepare submittal information in sufficient detail to show compliance with specified requirements:
   1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
   2. Coordinate submittal with other submittals and with the requirements of the Contract Documents.
   3. Check, verify, and revise submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.

1.07 SUBMITTAL CONTENT

A. Shop Drawings:
   1. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in prior to the preparation of shop drawings.
   2. Details:
      a. Fabrication drawings: drawn to scale and dimensioned.

b. Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
c. Locations of conduit entrances and access plates.
d. Component layout and identification.
e. Weight.
f. Finish.
g. Temperature limitations, as applicable.
h. Nameplate information.

B. Product Information:
1. Product Data:
a. Details:
1) Supplier name and address.
2) Subcontractor name and address.
b. Include:
1) Catalog cuts.
2) Bulletins.
3) Brochures.
4) Manufacturer's Certificate of Compliance: signed by product manufacturer along with supporting reference data, affidavits, and tests, as appropriate.
5) Manufacturer's printed recommendations for installation of equipment.
6) Quality photocopies of applicable pages from manufacturer's documents.
2. Completely fill out a Motor Data Sheet, as specified in Section 16222, for every motor furnished:
a. Submit 1 copy of the Motor Data Sheet to the Engineer for review as part of the associated equipment submittal.
3. Samples:
a. Details:
1) Submit labeled samples.
2) Samples will not be returned.
3) Provide samples from manufacturer's standard colors, materials, products, or equipment lines:
a) Clearly label samples to indicate any that represent non-standard colors, materials, products, or equipment lines and that if selected, will require an increase in Contract Time or Contract Price.
4. Minor or incidental products and equipment schedules:
a. Details:
1) Shop Drawings of minor or incidental fabricated products will not be required, unless requested.
2) Submit tabulated lists of minor or incidental products showing the names of the manufacturers and catalog numbers, with Product Data and Samples as required to determine acceptability.

C. Design calculations:
1. Details:
a. Defined in technical sections.

b. Calculations must bear the original seal and signature of a Professional Engineer licensed in the state where the project is located and who provided responsible charge for the design.

D. Qualifications Statements:
   1. Details:
      a. Defined in technical sections.
      b. Licensing documentation.
      c. Certification documentation.
      d. Education documentation.

E. Quality assurance/control submittals:
   1. Mill test reports:
      a. Details:
         1) Submit certified copies of factory and mill test reports.
         2) Do not incorporate Products in the Work which have not passed testing and inspection satisfactorily.
         3) Pay for mill and factory tests.
   2. Test reports:
      a. Details:
         1) Include the following information:
            a) A description of the test.
            b) List of equipment used.
            c) Name of the person conducting the test.
            d) Date and time the test was conducted.
            e) Ambient temperature and weather conditions.
            f) All raw data collected.
            g) Calculated results.
            h) Clear statement if the test passed or failed the requirements stated in Contract Documents.
            i) Signature of the person responsible for the test.
   3. Factory Acceptance Test:
      a. Details: Include complete test procedure and all forms to be used during test.
   4. Certificates:
      a. Details: Defined in technical sections.
      b. For products that will be in contact with potable water, submit evidence from a nationally recognized laboratory that the products comply with the requirements of the NSF 61 standard.
   5. Manufacturers' field reports:
      a. Details: Manufacturer's Certificate of installation and functionality compliance.
   6. Field samples:
      a. Details: Defined in technical sections.
   7. Test plans:
      a. Details: Defined in technical sections.

F. Project management submittals:
   1. Applications for payment:
      a. Details:
         1) As specified in Section 01294.

2. Schedules:
    a. Details:
        1) Progress schedules: As specified in Section 01324A.
        2) Schedule of values: As specified in Section 01292.
        3) Schedule of submittals: As specified in Section 01324A.
3. Progress reports and quantity charts:
    a. Details: As specified in Section 01324A.

1.08 SUBMITTAL PROCEDURE

A. Contractor: Send submittal to Engineer:
1. Provide number of hard copies of document submittal as below:
    a. Total: 6 minimum except where noted.
    b. Owner: 2 copies.
    c. Engineer: 3 copies.
    d. Contractor: Remaining copies will be returned.
2. Provide number of sample submittals as below:
    a. Total: 3 minimum.
    b. Owner: 1.
    c. Engineer: 2.
    d. Contractor: None.
3. Delivery:
    a. Deliver hard copy submittals and samples to Engineer at 2700 Ygnacio Valley Road, Suite 300, Walnut Creek, California, 94598, unless another mutually agreeable place is designated.
    b. Deliver electronic submittals to Engineer using web-based construction document management system described in Section 01322.
4. Timeliness: Schedule and make submissions in accordance with the requirements of the individual specification sections and in such a sequence as to cause no delay in Work.
5. Contractor assumes risk of expense and delays when proceeding with work related to required submittals without review and approval.

B. Engineer: Review submittal and provide response:
1. Review description:
    a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
    b. Engineer's review of submittals shall not release Contractor from Contractor's responsibility for performance of requirements of Contract Documents. Neither shall Engineer's review release Contractor from fulfilling purpose of installation nor from Contractor's liability to replace defective work.
    c. Engineer's review of shop drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
    d. Engineer's review does not extend to:
        1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by Contractor.

2) Contractor's means, methods, techniques, sequences, or procedures except when specified, indicated on the Drawings, or required by Contract Documents.
3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.

e. Engineer can Approve or Not Approve any exception at their sole discretion.

2. Review timeframe:
   a. Except as may be provided in technical specifications, a submittal will be returned within 30 days.
   b. When a submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the submittal, give notice of the date by which that submittal will be returned.
   c. Engineer's acceptance of progress schedule containing submittal review times less than those specified or agreed to in writing by Engineer will not constitute Engineer's acceptance of review times.
   d. Critical submittals:
      1) Contractor will notify Engineer in writing that timely review of a submittal is critical to the progress of Work.
      2) Engineer will provide decision on request:
         a) Written agreement by Engineer to reduce submittal review time will be made only for unusual situations.
         b) Written rejection of request.
3. Schedule delays:
   a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer's review of submittals, unless all of the following criteria are met:
      1) Engineer has failed to review and return first submission within the agreed upon time frame.
      2) Contractor demonstrates that delay in progress of Work is directly attributable to Engineer's failure to return submittal within time indicated and accepted by Engineer.
4. Review responses: 1 copy of submittal will be returned to Contractor with one of the following reviewer's response:
   a. Approved:
      1) No Exceptions:
         a) There are no notations or comments on the submittal and the Contractor may release the equipment for production.
      2) Make Corrections Noted - See Comments:
         a) The Contractor may proceed with the work, however, all notations and comments must be incorporated into the final product.
         b) Resubmittal not required.
      3) Make Corrections Noted - Confirm:
         a) The Contractor may proceed with the work, however, all notations and comments must be incorporated into the final product.
         b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.

b. Not approved:
    1) Correct and Resubmit:
        a) Contractor may not proceed with the work described in the submittal.
        b) Contractor assumes responsibility for proceeding without approval.
        c) Resubmittal of complete submittal package is required within 30 calendar days of the date of the Engineer's submittal review response.
    2) Rejected - See Remarks:
        a) Contractor may not proceed with the work described in the submittal.
        b) The submittal does not meet the intent of the Contract Documents. Resubmittal of complete submittal package is required with materials, equipment, methods, etc. that meet the requirements of the Contract Documents.
c. Receipt Acknowledged: Filed for Record:
    1) This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.

C. Contractor: Prepare resubmittal, if applicable:
1. Clearly identify each correction or change made.
2. Include a response in writing to each of the Engineer's comments or questions for submittal packages that are resubmitted in the order that the comments or questions were presented throughout the submittal:
    a. Acceptable responses to Engineer's comments are listed below:
        1) "Incorporated" Engineer's comment or change is accepted and appropriate changes are made.
        2) "Response" Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
    b. Reviews and resubmittals:
        1) Suppliers shall provide resubmittals which include responses to all submittal review comments separately and at a level of detail commensurate with each comment.
        2) Supplier responses shall indicate how the supplier resolved the issue pertaining to each review comment. Responses such as "acknowledged" or "noted" are not acceptable.
        3) Resubmittals which do not comply with this requirement may be rejected and returned without review.
        4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant submittals.
        5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.
    c. Any resubmittal that does not contain responses to the Engineer's previous comments shall be returned for Revision and Resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.

3. Resubmittal timeframe:
    a. Contractor shall provide resubmittal within 15 days.
    b. When a resubmittal cannot be returned within the specified period, Contractor shall notify Engineer in writing.
4. Review costs:
    a. Costs incurred by Owner as a result of additional reviews of a particular submittal after the second time it has been reviewed shall be borne by Contractor.
    b. Reimbursement to Owner will be made by deducting such costs from Contractor's subsequent progress payments.

1.09 CONTRACTOR'S PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

A. Submit a completed Contractor's P.E. Certification Form, provided in this Section, to comply with technical sections requirement for a professional engineer's certification from an engineer licensed in the state the project is located.

1.10 CLOSEOUT SUBMITTALS

A. Provide closeout submittals as specified in Section 01770.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A

CONTRACTOR SUBMITTAL TRANSMITTAL FORM

DOCUMENT 01330
CONTRACTOR SUBMITTAL TRANSMITTAL FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY
Contractor:	Click here to enter text.	**Project No.:**	XXXXX.XX
Project Name:	Click here to enter text.	**Submittal Number:**	000
Submittal Title:	Click here to enter text.		
To:	Click here to enter text.		
From:	Click here to enter text.	Click here to enter text.	
	Click here to enter text.	Click here to enter text.	

Specification No. and Subject of Submittal / Equipment Supplier			
Spec ##:	Spec ##.	**Subject:**	Click here to enter text.
Authored By:	Click here to enter text.	**Date Submitted:**	XX/XX/XXXX

Submittal Response

Check Either (A) or (B):

☐ (A) We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings with no exceptions.

☐ (B) We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings except for the following deviations (list deviations):

Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.

General Contractor's Reviewer's Signature:

Printed Name:

In the event, Contractor believes the Submittal response does or will cause a change to the requirements of the Contract, Contractor shall immediately give written notice stating that Contractor considers the response to be a Change Order.

Firm: Click here to enter text. **Signature:** **Date Returned:** XX/XX/XXXX

PM/CM Office Use	
Date Received GC to PM/CM:	
Date Received PM/CM to Reviewer:	
Date Received Reviewer to PM/CM:	
Date Sent PM/CM to GC:	

APPENDIX B

CONTRACTOR'S P.E. CERTIFICATION FORM

DOCUMENT 01330
CONTRACTOR'S P.E. CERTIFICATION FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY.
Contractor:	Click here to enter text.	**Registration State:**	Click here to enter text.
Project Name:	Click here to enter text.	**Project No.:**	00000.00
Responsibilities:	Click here to enter text.		
Spec Section:	Click here to enter text.		

Statement of Certification

The undersigned hereby certifies that he/she is a professional engineer registered in the State of and that he/she has been employed by

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state, and federal codes, rules, and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculation and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to:

Click here to enter text.

(Name of Owner, or Owner's representative within 7 days of receiving a written request by the Owner.)

Prof. Engineer Signature: _____ **Date:** _____

Printed Name: _____ **Company Name:** _____

Contractor's Signature: _____ **Date:** _____

Printed Name: _____

SECTION 01350

SPECIAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Special procedures for locating and verifying concealed existing facilities.

1.02 CONCEALED EXISTING FACILITIES

A. Verify locations of utilities and facilities which may exist by consulting with the Owner, utility companies, and Underground Services Alert (USA) or other service available in area of Project:
   1. Abide by easement and right-of-way restrictions.

B. Perform exploratory vacuum excavation potholing, as necessary to more accurately identify location, depth, configuration, and utility service in congested utility areas prior to preparation of shop drawings and subsequent excavation:
   1. Potholing shall be backfilled immediately after purpose has been satisfied and the surface restored and maintained in a manner satisfactory to Engineer.
   2. Adjustments in construction methods shall be made to accommodate utility location information gained from potholing as necessary to protect existing utilities and maintain plant in operations.
   3. Note that installation of all underground yard piping and utilities in this project are considered to be installed in congested utility areas.
   4. Some variation from the conditions indicated on the Drawings is to be expected.

C. Notify the Owner, owners of facilities when the Work will be in progress. Make arrangements for potential emergency repairs in accordance with requirements of owners of utility facilities, including individual or residential facilities.

D. Assume responsibility for repair of facilities damaged by performance of the Work.

E. Expose sanitary and storm sewers, water, gas, electric, telephone utility lines, and other underground facilities indicated to permit survey location prior to commencement of Work in affected area:
   1. Expose in ample time to permit relocation of interfering utilities with minimum delaying effect on Contract Time.

F. Work required for raising, lowering, or relocating utilities not indicated will be performed by affected utility owners or as part of the Work at option of affected owners of utilities:
   1. When part of the Work, perform work in accordance with standards of affected utility owner, and adjustment to Contract Price and Contract Times will be made as stipulated in conditions of Contract.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01354

HAZARDOUS MATERIAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures required when encountering hazardous materials at the Work site.

1.02 REFERENCES

A. California Code of Regulations (CCR):
   1. Title 8: Industrial Relations.
   2. Title 22: Social Security:

B. California Occupational Safety and Health Administration (Cal-OSHA).

C. Occupational Safety and Health Administration (OSHA).

D. United States Code of Federal Regulation (CFR):
   1. Title 29 - Labor:
      a. 1926.62 - Lead.
   2. Title 40 - Protection of Environment:
      a. 261 - Identification and Listing Of Hazardous Waste.

1.03 SUBMITTALS

A. Submit laboratory reports, hazardous material removal plans, and certifications.

B. Submit the following work plan:
   1. Removal and Legal Disposal of Asbestos Cement Pipe Plan:
      a. Work plan shall include, but not be limited, to the following:
         1) Schedule of work.
         2) Security measures for work and disposal area.
         3) Staff training: Contractor shall provide at least one competent person who is capable of identifying asbestos hazards at the job site for the entire duration of the AC pipe removal and disposal operation.
         4) Trenching and removal of pipe procedure.

1.04 DEFINITIONS

A. Adequately Wet: Penetration of the pipe wall with liquid to prevent release of particulates.

B. Asbestos Cement Pipe: Also commonly referred to as AC Transit Pipe, AC pipe or ACP. Pipe that is generally composed of cement and asbestos fibers.

C. Competent Person: A trained worker who is capable of identifying existing and predictable asbestos hazards, perform exposure assessment and monitoring, is

qualified to train other workers, and has the authority to take immediate corrective action to eliminate a hazardous exposure.

D. Non-friable Asbestos – Containing Material (NACM): Material containing more than 1 percent asbestos, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

E. Regulated Asbestos – Containing Material (RACM): Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder in the course of work.

1.05 OPERATING DIGESTERS

A. Observe safety precautions in vicinity of operating digesters which contain digester gases, including methane, hydrogen sulfide, and carbon dioxide.

1.06 HAZARDOUS MATERIALS PROCEDURES

A. Hazardous materials are those defined by 40 CFR and California Health and Safety Code, Section 25117.

B. When hazardous materials have been found:
   1. Prepare and initiate implementation of plan of action.
   2. Notify immediately Owner, Engineer, and other affected persons.
   3. Notify such agencies as are required to be notified by Laws and Regulations with the times stipulated by such Laws and Regulations.
   4. Designate a Certified Industrial Hygienist to issue pertinent instructions and recommendations for protection of workers and other affected persons' health and safety.
   5. Identify and contact subcontractors and licensed personnel qualified to undertake storage, removal, transportation, disposal, and other remedial work required by, and in accordance with, laws and regulations.

C. Forward to Engineer, copies of reports, permits, receipts, and other documentation related to remedial work.

D. Assume responsibility for worker health and safety, including health and safety of subcontractors and their workers:
   1. Instruct workers on recognition and reporting of materials that may be hazardous.

E. File requests for adjustments to Contract Times and Contract Price due to the finding of Hazardous Materials in the Work site in accordance with Contract Documents:
   1. Minimize delays by continuing performance of the Work in areas not affected by hazardous materials operations.

1.07 LEAD PAINT REMOVAL AND DISPOSAL

A. Existing paint on the exterior surfaces of the existing structures that contain lead in concentrations which will require implementation of hazardous material shall comply with procedures as legislated by the following:
   1. CFR, Title 29 and Title 40.
   2. CCR, Title 8 and Title 22.

B. No structures with lead paint have been identified for this project. Implement the following procedures if lead paint is identified at locations impacting the Work during construction.

C. Remove samples of paint from the structures identified herein and have samples tested by a certified testing laboratory to determine lead content in samples:
   1. Ensure that sufficient numbers of paint samples are removed and tested to provide adequate information regarding lead content in paint.
   2. Ensure that samples contain the total thickness of the paint to the substrate where removed.
   3. Ensure that each sample contains a sufficient quantity of paint to facilitate proper and adequate analyses by testing laboratory.
   4. Ensure that samples are adequately identified with location from which it was removed.

D. Laboratory testing of paint samples: In accordance with 40 CFR 261:
   1. Submit 10 copies of complete laboratory analyses of paint samples.

E. Submit a plan for the removal, containment, and disposal of lead-based paint and associated debris:
   1. Submit 10 copies of plan.

F. Prior to beginning work associated with the removal, containment, and disposal of lead-based paints, prepare and submit to the Engineer for his review 6 copies of the following:
   1. Listing of lead paint removal equipment to be used.
   2. Outline of procedures to be used to remove lead paint.
   3. Data and specifications describing chemical stripping materials to be used.
   4. Data and specifications describing abrasive blast materials and grit size to be used.
   5. Plan describing lead paint removal, hazardous waste debris containment, and hazardous waste disposal methods.
   6. Safety plan, consisting of a written plan of action covering operational requirements for safe removal of lead paint, safe handling and containment of waste and debris generated by the operation, and safe disposal of hazardous waste and non-hazardous waste materials, complying with the most stringent requirements of the following:
      a. Equipment and material manufacturer's safety sheets.
      b. 29 CFR 1926.62.

G. Carry out lead paint removal, containment, and disposal work in accordance with the following SSPC guidelines:
   1. SSPC-Guide 6:
      a. Open Abrasive Blast Cleaning with Expendable Abrasive.
      b. Open Abrasive Blast Cleaning with Recyclable Abrasive.

c. Closed Abrasive Blast Cleaning with Recyclable Abrasive.
d. Chemical Stripping.

2. SSPC-Guide 7.

H. Assume responsibility for the proper utilization of the paint removal method selected. When abrasive blast cleaning is selected to remove lead-based paint, comply with all applicable federal, state, and local air quality, pollution, and environmental control regulations for blast cleaning. When chemical stripping is selected to remove the lead based paint, adhere to the chemical manufacturer's recommendations for the application of the product, the removal of the paint, and the containment of the debris.

I. Lead paint removal work shall be performed by a Contractor having prior experience in the removal method selected and shall provide at least 5 references of similar projects completed, 3 of which must have been completed within the past 12 months, documenting his experience.

J. Utilize a minimum of Class 3 containment and ventilation system as described in SSPC-Guide 6 during lead paint removal and containment procedures as required for the conditions.

K. Do not leave spent abrasive blast material, chemical stripping material, or lead paint debris uncontained on the project site overnight.

L. Test each container of paint debris, spent blast cleaning abrasive, chemical stripping debris, and other waste material generated by the operation to determine the waste material hazardous waste classification.

M. Assume responsibility for the disposal of lead paint waste and associated waste generated by the removal of the lead paint and the preparation of the surfaces for recoating. Dispose in accordance with applicable federal, state, and local requirements and regulations.

N. Accurately complete the Uniform Hazardous Waste Manifest included at the end of SSPC-Guide 7. Indicate on the Manifest that the Owner is the hazardous waste generator, and obtain the Owner's Environmental Protection Agency identification number for use in completing the Manifest.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01355A

STORMWATER POLLUTION PREVENTION
CONSTRUCTION ACTIVITIES: BEST MANAGEMENT PRACTICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for the preparation and implementation of the Stormwater Pollution Prevention Plan (SWPPP) for the Contractor's construction activities. This document (and other identified in this Section will be used for the purpose of applying for and obtaining a State of California General Construction Activity Stormwater Permit. This permit authorizes the discharge of stormwater associated with construction activities from the construction site.

1.02 REFERENCES

A. National Pollutant Discharge Elimination System (NPDES).

B. State of California, State Water Resources Control Board, Regional Water Quality Control Board (SWRCB).

C. United States Code of Federal Regulation (CFR):
   1. 40 - Protection of Environmental:
      a. 117 - Determination of reportable quantities for hazardous substance.
      b. 302 - Designation, reportable quantities, and notification.

1.03 SUBMITTALS

A. Construction General Permit:
   1. The Contractor shall prepare and submit all Permit Registration Documents (PRD's) to the Engineer for review, approval, and certification by the Legally Responsible Person (LRP) prior to start of work and mobilization:
      a. The LRP will electronically submit the PRDs to the Stormwater Multiple Application and Report Tracking System (SMARTS) to obtain approval of the Construction General Permit (CGP).
   2. The PRD's shall include but are not limited to the Notice of Intent (NOI), Risk Determination Worksheet, Site Maps, Stormwater Pollution Prevention Plan (SWPPP), Annual Fee's and Owner Certification. It shall also include all other reports, calculations, studies, exhibits, and documentation required to obtain the CGP.
   3. The Contractor shall provide a Qualified SWPPP Practitioner (QSP), who will be responsible for maintaining the existing CGP active throughout the duration of the project:
      a. The Contractor shall be responsible for providing all reports required by the CGP (monitoring, inspection, Rain Event Action Plans, sampling, exceedance reports, annual reports, etc.) to the Engineer for review.
      b. Upon approval, the Contractor's QSP shall upload the information to SMARTS.

c. Time sensitive reports involving monitoring data shall be provided as soon as the information is made available.
d. All other reports shall be provided to the Engineer a minimum of 2 weeks prior to their deadline for submittal to the SWRCB through SMARTS.
e. All CGP documents shall be submitted to the Owner for reference and a copy shall be located on site at all times.

B. Pollution Prevention Plan:
1. Prepare and submit a site-specific Stormwater Pollution Prevention Plan (SWPPP) in accordance with Section A of the General Construction Activity Stormwater Permit to the Owner for reference.
2. Prepare and submit a monitoring program and reporting plan in accordance with Section B of the General Construction Activity Stormwater Permit to the Owner for reference.
3. Submit to the Owner for reference a Stormwater Pollution Prevention Plan detailing the placement of physical Best Management Practices (BMPs) required for installation and the methods used to comply with those BMPs directed at operational procedures, Monitoring Program, and Reporting Plan.
4. The plan shall specifically address and detail changes from the alternatives called out in this Section. The Contractor's preferred techniques shall show how it will comply with the stated objectives of the program.
5. The SWPPP shall be prepared and amended by a Qualified SWPPP Developer (QSD), as defined by the CGP.

C. The Contractor shall submit a copy of the BMP Handbook with each BMP to be utilized check marked to show compliance or marked to show deviation.

D. The entire plan shall be kept and maintained by the Contractor on the construction site during the duration of the project.

E. The Contractor shall be responsible for taking the proper actions to prevent contaminants and sediments from entering the storm sewer drainage system should any unforeseen circumstance occur. The Contractor shall take immediate action if directed by the Engineer, or if the Contractor observes contaminants and/or sediments entering the storm drainage system, to prevent further stormwater from entering the system.

1.04 REGULATORY REQUIREMENTS

A. The Contractor shall comply with the State Water Resources Control Board, Regional Water Quality Control Board, county, city, and other local agency requirements regarding stormwater discharges and management.

B. The Contractor shall not begin any construction work until the Owner receives the State of California General Construction Activity Stormwater Permit. The Contractor shall allow the Owner 30 days to obtain this permit after receipt of the information listed in this Section.

C. The Contractor shall comply with the following prohibitions and limitations, which are contained in the Stormwater Permit:
   1. Discharge prohibitions:
      a. Discharges of materials other than stormwater, which are not otherwise regulated by a NPDES permit, to a separate stormwater sewer system or water of the nation are prohibited.
      b. Stormwater discharges shall not cause or threaten to cause pollution, contamination (including sediment), or nuisance.
      c. Stormwater discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR 117 and 40 CFR 302.
   2. Receiving water limitations:
      a. Stormwater discharges to any surface or groundwater shall not adversely impact human health or the environment.
      b. Stormwater discharge shall not cause or contribute to a violation of any applicable water quality standards contained in the California Ocean Plan, Inland Surface Waters and Enclosed Bays and Estuaries Plan, or the applicable Regional Water Board's Basin Plan.

D. Requirements:
   1. In order to comply with the permit mandates the Stanislaus County has developed a County-Wide Stormwater Pollution Prevention Program and summary of [Best Management Practices (BMPs)] that are suggested to be utilized by the Contractor. BMPs are measures or practices used to reduce the amount of pollution entering surface water. BMPs may take the form of a process, activity, or physical structure. Some BMPs are simple and can be put into place immediately, while others are more complicated and require extensive planning or space. They may be inexpensive or costly to implement. No additional compensation shall be made for implementation of BMPs.
   2. The Stanislaus County-Wide Stormwater Pollution Prevention Program and Summary of BMPs are available for review at the Owner's Water Quality Control Plant.

1.05 STORMWATER POLLUTION PREVENTION PLAN IMPLEMENTATION

A. The Contractor's QSP shall implement all activities required by the General Permit and as detailed in the Stormwater Pollution Prevention Plan, Monitoring Program, and Reporting Plan.

1.06 NON-STORMWATER MANAGEMENT

A. The Stormwater Pollution Prevention Plan shall discuss any non-stormwater sources (i.e., landscaping irrigation, pipe flushing, street washing, and dewatering). In addition, the Plan shall include standard observation measures and best management practices, including best available technologies economically achievable and best conventional pollutant control technologies that are to be implemented in order to reduce the pollutant loading to the waters.

1.07 AMENDMENTS

A. The Contractor's QSP shall amend the Stormwater Pollution Prevention Plan, Monitoring Program, and Reporting Plan whenever there is a change in construction or operations which may affect the discharge of pollutants to stormwater.

B. The Stormwater Pollution Prevention Plan shall also be amended if it is in violation of any conditions of the general permit or has not achieved the general objective of reducing pollutants in stormwater discharges.

C. All amendments shall be completed at no additional cost to the Owner.

1.08 ANNUAL SUMMARY

A. Contractor:
   1. Prepare an annual summary report (annual report) in accordance with all Regional Water Quality Control Board requirements.
   2. Utilize the annual report form available in the SMARTS, and submit it to the Engineer a minimum of 2 weeks prior to the deadline for submittal.
   3. Upon approval of the report by the Engineer, the LRP will review and certify the report for final submittal via SMARTS.

1.09 NOTICE OF TERMINATION

A. The Contractor shall provide all necessary information for the completion of a Notice of Termination (NOT) upon completion of all construction activities (refer to Section C of the General Construction Activity Stormwater Permit for general requirements). Upon review of the information submitted, the LRP will certify and submit the NOT via SMARTS.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Nonhazardous material/waste management:
   1. Designated area: The Contractor shall propose designated areas of the project site, for approval by the Engineer, suitable for material delivery, storage, and waste collection that, to the maximum extent practicable, are near construction entrances and away from catch basins, gutters, drainage courses, and creeks.
   2. Granular material:
      a. The Contractor shall store granular material at least 50 feet away from catch basin and curb returns.
      b. The Contractor shall not allow granular material to enter storm drains, creeks, or rivers.
      c. When rain is forecast within 24 hours or during wet weather, the Engineer may require the Contractor to cover granular material with a tarpaulin and to surround the material with sand bags:
         1) All stockpiles are required to be protected immediately if they are not scheduled to be used within 14 days.
   3. Dust control: The Contractor shall use reclaimed water to control dust on a daily basis or as directed by the Construction Manager.

4. Street sweeping and vacuuming:
    a. At the end of each working day or as directed by the Engineer, the Contractor shall clean and sweep roadways and on-site paved areas of all materials attributed to or involved in the work.
    b. The Contractor shall not use water to flush down streets in place of street sweeping.
    c. Additionally, the Contractor shall not use kick brooms or sweeper attachments.

B. Spill prevention and control:
    1. The Contractor shall keep a stockpile of spill cleanup materials, such as rags or absorbents, readily accessible on-site.
    2. The Contractor shall immediately contain and prevent leaks and spills from entering storm drains, and properly clean up and dispose of the waste and cleanup materials:
        a. If the waste is hazardous, the Contractor shall dispose of hazardous waste only at authorized and permitted treatment, storage, and disposal facilities, and use only licensed hazardous waste haulers to remove the waste off-site, unless quantities to be transported are below applicable threshold limits for transportation specified in State and Federal regulations.
    3. The Contractor shall not wash any spilled material into streets, gutters, storm drains, creeks, or rivers and shall not bury spilled hazardous materials.
    4. The Contractor shall immediately report any hazardous materials spill to the Owner and Engineer for reporting to all applicable regulatory agencies.

C. Vehicle/equipment cleaning:
    1. The Contractor shall not perform vehicle or equipment cleaning on-site or in the street using soaps, solvents, degreasers, steam cleaning equipment, or equivalent methods.
    2. The Contractor shall perform vehicle or equipment cleaning, with water only, in a designated, bermed area that will not allow rinse water to run off-site or into streets, gutters, storm drains, creeks or rivers.

D. Vehicle/equipment maintenance and fueling:
    1. The Contractor shall perform maintenance and fueling of vehicles or equipment in designated, bermed area(s) or over a drip pan that will not allow run-on of stormwater or runoff of spills.
    2. The Contractor shall use secondary containment, such as a drip pan, to catch leaks or spills any time that vehicle or equipment fluids are dispensed, changed, or poured.
    3. The Contractor shall keep a stockpile of spill cleanup materials, such as rags or absorbents, readily accessible on-site.
    4. The Contractor shall clean up leaks and spills of vehicle or equipment fluids immediately and dispose of the waste and cleanup materials as hazardous waste, as described in section ”Spill prevention and control“ above.
    5. The Contractor shall not wash any spilled material into streets, gutters, storm drains, creeks, or rivers and shall not bury spilled hazardous materials.
    6. The Contractor shall report any hazardous materials spill to the Owner and Engineer and all applicable regulatory agencies.

7. The Contractor shall inspect vehicles and equipment arriving on-site for leaking fluids and shall promptly repair leaking vehicles and equipment. Drip pans shall be used to catch leaks until repairs are made.
8. The Contractor shall recycle waste oil and antifreeze, to the maximum extent practicable.
9. The Contractor shall comply with Federal, State, and City requirements for aboveground storage tanks.

E. Contractor training and awareness:
   1. Contractor's QSP shall train all employees/subcontractors on the stormwater pollution prevention requirements contained in these specifications.
   2. Contractor's QSP shall inform subcontractors of the stormwater pollution prevention contract requirements and include appropriate subcontract provisions to ensure that these requirements are met.
   3. Contractor shall post warning signs in areas treated with chemicals.
   4. Contractor shall paint new, reset or raised catch basins, constructed as part of the project, with a "No Dumping" stencil.

3.02 SPECIFIC REQUIREMENTS

A. Paving operations:
   1. Project site management:
      a. When rain is forecast within 24 hours or during wet weather, the Engineer may prevent the Contractor from paving.
      b. The Engineer may direct the Contractor to protect drainage courses by using control measures, such as earth dike, straw bale, and sand bag, to divert runoff or trap and filter sediment in addition to those already shown on the construction plan sheets.
      c. The Contractor shall place drip pans or absorbent material under paving equipment when not in use.
      d. The Contractor shall cover catch basins and manholes when paving or applying seal coat, tack coat, slurry seal, or fog seal.
      e. If the paving operation includes an on-site mixing plant, the Contractor shall comply with applicable Federal, State, and local General Industrial Activities Stormwater Permit requirements.
   2. Paving waste management:
      a. The Contractor shall not sweep or wash down excess sand (placed as part of a sand seal or to absorb excess oil) into gutters, storm drains, or creeks:
         1) Instead, the Contractor shall either collect the sand and return it to the stockpile, or dispose of it in a trash container.
      b. The Contractor shall not use water to wash down fresh asphalt concrete pavement.

B. Saw cutting:
   1. During saw cutting, the Contractor shall cover or barricade catch basins using control measures, such as filter fabric, straw bales, sand bags, and fine gravel dams, to keep slurry out of the storm drain system. When protecting a catch basin, the Contractor shall ensure that the entire opening is covered.
   2. The Contractor shall vacuum saw cut slurry and pick up the waste prior to moving to the next location or at the end of each working day, whichever is sooner.

3. If saw cut slurry enters catch basins, the Contractor shall remove the slurry from the storm drain system immediately.

C. Concrete, grout, and mortar waste management:
   1. Material management: The Contractor shall store concrete, grout, and mortar away from drainage areas and ensure that these materials do not enter the storm drain system.
   2. Concrete truck/equipment washout:
      a. The Contractor shall not washout concrete trucks or equipment into streets, gutters, storm drains, creeks, or rivers:
         1) Washout areas should be located at least 50 feet from storm drains, open ditches, or water bodies.
      b. The Contractor shall perform washout of concrete trucks or equipment in a designated area:
         1) Washout site should be lined so there is no discharge into the underlying soil.
   3. Exposed aggregate concrete wash water:
      a. The Contractor shall avoid creating runoff from washing of exposed aggregate concrete. .The Contractor shall collect and return sweepings from exposed aggregate concrete to a stockpile or dispose of the waste in a trash container.

END OF SECTION

SECTION 01410

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Regulatory authorities and codes.

1.02 APPLICABLE CODES

A. California Code of Regulations (CCR), California Building Standards Code, CCR Title 24:
   1. Building code:
      a. California Building Code (CBC), Title 24, Part 2 – 2016.
   2. Electrical code:
      a. California Electrical Code (CEC), Title 24, Part 3 – 2016.
   3. Existing building code.
      a. California Existing Building Code (CEBC), Title 24, Part 10 – 2016.
   4. Fire code:
      a. California Fire Code (CFC), Title 24, Part 9 – 2016.
   5. Green building standards code:
      a. California Green Building Standards Code (Cal Green), Title 24, Part 11 – 2016.
   6. Historical building code:
      a. California Historical Building Code (CHBC), Title 24, Part 8 – 2016.
   7. Mechanical code:
      a. California Mechanical Code (CMC), Title 24, Part 4 – 2016.
   8. Plumbing code:
      a. California Plumbing Code (CPC), Title 24, Part 5 – 2016.
   9. Energy code:
      a. California Energy Code (CEC), Title 24, Part 6 – 2016.

B. California Code of Regulations (CCR), California Building Standards Code, CCR Title 8:
   1. Industrial Relations. Division 1: Department of Industrial Relations. Chapter 4: Division of Industrial Safety:
      a. California Elevator Safety Construction Code - 2007.

C. National Pollutant Discharge Elimination System (NPDES).

D. State of California, State Water Resources Control Board, Regional Water Quality Control Board (SWRCB).

E. City of Turlock NPDES Stormwater Permit and City of Turlock City Ordinance: Stormwater Management and Discharge Controls.

F. San Joaquin Valley Air Pollution Control District Rules and Regulations.

1.03 SYSTEM DESCRIPTION

A. Building code:
   1. California Building Code.
      a. California Existing Building Code
   2. Electrical code:
      a. California Electrical Code
   3. Energy conservation code:
      a. California Energy Code.
   4. Fire code:
      a. California Fire Code:
   5. Mechanical codes:
      a. California Mechanical Code.
   6. Plumbing code:
      a. California Plumbing Code.

1.04 FEES AND PERMITS

A. GENERAL
   1. Contractor shall comply with all the terms, conditions and requirements attached to all permits, bonds and licenses required by any local, state, or federal agencies to perform work, construct, erect, test and startup of any equipment or facility for this Contract. The Contractor shall give all notices necessary and incidental to the due and lawful prosecution of the Work.
   2. Any permits, bonds, licenses and fees therefore required for the performance of the Work under this Contract and not specifically mentioned herein as being obtained and paid for by the Owner shall be included in the Contractor's Bid price. The Contractor shall apply for and obtain all safety permits for excavations, tunneling, trenches, construction (building structure, scaffolding, or falsework) and demolition required by CAL/OSHA.
   3. The Contractor shall post at the site of Work all required permits as stipulated by the respective regulatory agency.

B. Local Agency and Building Code Fees and Permits:
   1. If applicable to any portions of the Work, the Owner has applied for and obtained, in its name, the necessary building, plumbing and electrical permits for this Project. The Contractor shall be responsible for satisfying all code requirements, calling for inspections, and obtaining final approvals on behalf of the Owner. The Contractor shall notify the Construction Manager of the need and the readiness of all required inspections. All inspections are to be coordinated with the Construction Manager. The Contractor shall comply with all construction conditions stipulated in the permits. The Contractor shall be responsible for and the Owner shall not provide reimbursement for any costs required for the re-inspection of defective work or additional costs due to the Contractor’s failure to properly schedule the inspections.
   2. The Owner is not responsible for any local agency or utility permits required for temporary facilities during construction such as field office trailers and temporary electrical service for construction operations. Obtaining all such permits and the costs associated with such permits are the responsibility of the Contractor and shall be included in the Contractor’s Bid Price.

1.05 STORM WATER QUALITY CONTROLS

A. Refer to Section 01355.

1.06 DEWATERING

A. Refer to Section 02240.

B. Construction dewatering in Stanislaus County is regulated by the California Regional Water Quality Control Board-Central Valley Region. In May of 2013, the Central Valley Region adopted Waste Discharge Requirements Order No. R5-2013-0074 and National Pollutant Discharge Elimination System (NPDES) Permit No. CAG995001 to regulate construction dewatering. Should the Contractor need to control groundwater by dewatering and/or depressurization of water bearing soil and rock formations, the Contractor must comply with this NPDES Permit, or any updated NPDES Permit, and all other laws and regulations having jurisdiction over construction dewatering. The Contractor is responsible for obtaining all permits from agencies with control over all dewatering matters including well installation/abandonment, water discharge, use of existing storm drains and natural water sources. Contractor can download a complete copy of Order No. R5-2013-0074 on the internet site: http://www.waterboards.ca.gov/centralvalley/. The Contractor will be held responsible for any fines or penalties from regulatory agencies resulting from its dewatering system.

C. Contractor shall submit to the Construction Manager a complete dewatering plan prepared and signed by a Professional Engineer registered in California.

1.07 AIR POLLUTION CONTROL

A. The Contractor shall comply with all air pollution control rules, regulations, ordinances and statutes which apply to any work performed pursuant to the Contract Documents, including any air pollution control rules, regulations, ordinances and statutes, specified in California Government Code section 11017.

B. The Contractor shall comply with all applicable regulations of the San Joaquin Valley Air Pollution Control District (www.valleyair.org). The Contractor is hereby alerted to the fact that the San Joaquin Valley Air Pollution Control District imposes specific restrictions and requirements on the Contractor related to the construction activities at the site of the Work, including but not limited to the Indirect Source Review (ISR) rule. The Contractor assumes full responsibility for conforming to the San Joaquin Valley Air Pollution Control District's restrictions and requirements as well as application/permit fees. More information on the ISR rule can be found at http://www.valleyair.org/ISR/ISRHome.htm.

C. In the event the regulatory agency levees any fine or charge against the Owner as a result of the Contractor's failure to comply with this regulation, the Contractor shall reimburse the Owner upon demand the full amount of said fine. The Owner shall have the right to deduct funds from monies due the Contractor should the Contractor fail to reimburse the Owner as stated herein.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01424

ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Abbreviations and meanings.

1.02 INTERPRETATIONS

A. Interpret abbreviations by context in which abbreviations are used.

1.03 ABBREVIATIONS

A. Abbreviations used to identify reference standards:

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
ABC	Associated Air Balance Council
AATCC	American Association of Textile Chemists and Colorists
ABPA	Acoustical and Board Products Association
ACGIH	American Conference of Government Industrial Hygienists
ACI	American Concrete Institute
ACIL	American Council of Independent Laboratories
ADC	Air Diffusion Council
ABMA	American Bearing Manufacturers' Association (formerly AFBMA, Anti-Friction Bearing Manufacturers' Association)
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers' Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AI	Asphalt Institute
AIA	American Institute of Architects
AIMA	Acoustical and Insulating Materials Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association International, Inc.
AMG	Arizona Masonry Guild
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
ASAHC	American Society of Architectural Hardware Consultants
ASCE	American Society of Civil Engineers

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	ASTM International
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWSC	American Welding Society Code
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America
BSI	Building Stone Institute
Caltrans	California Department of Transportation
Cal-OSHA	California Occupational Safety and Health Administration
CCR	California Code of Regulations
CFR	United States Code of Federal Regulations
CLFMI	Chain Link Fence Manufacturers Institute
CPSC	U.S. Consumer Product Safety Commission
CRA	California Redwood Association
CRI	Carpet and Rug Institute
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards
CSA	CSA International
CSI	Construction Specifications Institute
CTI	Ceramic Tile Institute
DHI	Door and Hardware Institute
EIFS	Exterior Insulation and Finish System
EJCDC	Engineers Joint Contract Documents Committee
EPA	United States Environment Protection Agency
FDA	Food and Drug Administration
FGMA	Flat Glass Marketing Association
FHWA	Federal Highway Administration
FIA	Factory Insurance Association
FM	FM (Factory Mutual) Global
FS	Federal Specifications
FTI	Facing Tile Institute
GA	Gypsum Association
HI	Hydraulic Institute
HMMA	Hollow Metal Manufacturers Association
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
ICC	International Code Council
ICEA	Insulated Cable Engineer’s Association

IEEE	Institute of Electrical and Electronics Engineers
ISA	International Society of Automation
ISO	International Organization for Standardization
JIC	Joint Industrial Council
MAG	Maricopa Association of Governments
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association
MS	Military Specifications
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International
NAPA	National Asphalt Pavement Association
NAVFAC	Department of the Navy Facilities Engineering Command
NBHA	National Builders Hardware Association
NCMA	National Concrete Masonry Association
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NETA	International Electrical Testing Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMWIA	National Mineral Wool Insulation Association
NPCA	National Paint and Coatings Association
NRCA	National Roofing Contractors Association
NSF	NSF International
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturer's Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PDCA	Paint and Decorating Contractors of America
PDI	Plumbing and Drainage Institute
PEI	Porcelain Enamel Institute
PS	Product Standard
RCSC	Research Council on Structural Connections
RILEM	International Union of Testing and Research Laboratories for Materials and Structures
RTI	Resilient Tile Institute
SAE	SAE International
SCPA	Structural Clay Products Association
SDI	Steel Door Institute
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute

SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Society for Protective Coatings
TABB	Testing, Adjusting, and Balancing Bureau
TCA	Tile Council of America
UL	Underwriters Laboratories, Inc.
UNS	Unified Numbering System
USDA	United States Department of Agriculture
USACE	U.S. Army Corps of Engineers
VA	Vermiculite Association
WCLA	West Coast Lumberman's Association
WCLIB	West Coast Lumber Inspection Bureau
WPA	Western Pine Association
WPOA	Western Plumbing Officials Association
WRC	Welding Research Council
WSCPA	Western States Clay Products Association
WWPA	Western Wood Products Association

B. Abbreviations used in Specifications and Drawings:

a	year or years (metric unit)
A	ampere or amperes
am	ante meridian (before noon)
ac	alternating current
ac-ft	acre-foot or acre-feet
atm	atmosphere
AWG	American Wire Gauge
bbl	barrel or barrels
bd	board
bhp	brake horsepower
BIL	basic impulse insulation level
bil gal	billion gallons
BOD	biochemical oxygen demand
Btu	British thermal unit or units
Btuh	British thermal units per hour
bu	bushel or bushels
BV	bed volume(s)
C	degrees Celsius
cal	calorie or calories
cap	capita
cd	candela or candelas
cfm	cubic feet per minute
Ci	curie or curies
CIPP	Cured-in-Place Pipe
cm	centimeter or centimeters
cmu	concrete masonry unit
CO	carbon monoxide

Co.	Company
CO_2	carbon dioxide
COD	chemical oxygen demand
Corp.	Corporation
counts/min	counts per minute
cu	cubic
cu cm	cubic centimeter or centimeters
cu ft	cubic foot or feet
cu ft/day	cubic feet per day
cu ft/hr	cubic feet per hour
cu ft/min	cubic feet per minute
cu ft/sec	cubic feet per second
cu in	cubic inch or inches
cu m	cubic meter or meters
cu yd	cubic yard or yards
d	day (metric units)
day	day (English units)
db	decibels
D/d	column diameter to particle diameter ratio
DB	dry bulb (temperature)
dc	direct current
diam	diameter
DO	dissolved oxygen
DS	dissolved solids
EBCT	empty bed contact time
emf	electromotive force
fpm	feet per minute
F	degrees Fahrenheit
ft	feet or foot
fc	foot-candle or foot candles
ft/day	feet per day
ft/hr	feet per hour
ft/min	feet per minute
ft/sec	feet per second
g	gram or grams
G	gravitational force
gal	gallon or gallons
gal/day	gallons per day
gal/min	gallons per minutes
gal/sec	gallons per second
gfd	gallons per square foot per day
g/L	grams per liter
gpd	gallons per day
gpd/ac	gallons per day per acre
gpd/cap	gallons per day per capita
gpd/sq ft	gallons per day per square foot
gph	gallons per hour
gpm	gallons per minute

gpm/ft^2	gallons per minute per square foot
gps	gallons per second
g/cm^3	grams per cubic centimeter
h	hour or hours (metric units)
ha	hectare or hectares
hp	high point
hp	horsepower
hp-hr	horsepower-hour or horsepower-hours
hr	hour or hours (English units)
Hz	hertz
ID	inside diameter
ihp	indicated horsepower
Inc.	Incorporated
inch	inch
inches	inches
inches/sec	inches per second
J	joule or joules
JTU	Jackson turbidity unit or units
k	kips
K	kelvin
K	thermal conductivity
kA	kiloampere
kcal	kilocalorie or kilocalories
kcmil	thousand circular mils
kg	kilogram or kilograms
kip	kilopound or kilopounds
km	kilometer or kilometers
kN	kilonewton or kilonewtons
kPa	kilopascal or kilopascals
ksi	kips per square inch
kV	kilovolt or kilovolts
kVA	kilovolt-ampere or kilovolt-amperes
kW	kilowatt or kilowatts
kWh	kilowatt hour
L	liter or liters
lb/1000 cu ft	pounds per thousand cubic foot
lb/acre-ft	pounds per acre-foot
lb/ac	pounds per acre
lb/cu ft	pounds per cubic foot
lb/day/cu ft	pounds per day per cubic foot
lb/day/acre	pounds per day per acre
lb/sq ft	pounds per square foot
L/D Ratio	Ratio of filter height to filter media particle diameter
lin	linear, lineal
lin ft	linear foot or feet
lm	lumen or lumens
lmh	liters per square meter per hour

log	logarithm (common)
ln	logarithm (natural)
lx	lux
m	meter or meters
M	molar (concentration)
mA	milliampere or milliamperes
max	maximum
mCi	millicurie or millicuries
meq	milliequivalent
meq/mL	milliequivalents per milliliter
MFBM	thousand feet board measure
mfr	manufacturer
mg	milligram or milligrams
mgd/ac	million gallons per day per acre
mgd	million gallons per day
mg/L	milligrams per liter
mrem	millirem
µF	microfarad or microfarads
Mil	0.001 inch (used for coating thickness)
mile	mile
mil. gal	million gallons
miles	miles
min	minimum
min	minute or minutes
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
mm	millimeter or millimeters
mol wt	molecular weight
mol	mole
Mpa	megapascal or megapascals
mph	miles per hour
MPN	most probable number
MPT	National Pipe Thread, male fitting
mR	milliroentgen or milliroentgens
Mrad	megarad or megarads
mV	millivolt or millivolts
MW	megawatt or megawatts
µg/L	micrograms per liter
µm	micrometer or micrometers
µS/cm	microSeimens per centimeter
N	newton or newtons
N	normal (concentration)
ND	not detected
No.	number
Nos	numbers
NPT	National Pipe Thread
NRC	noise reduction coefficient
NTU or ntu	nephelometric turbidity unit

oc	on center
OD	outside diameter
ORP	oxidation-reduction potential
OT	ortho-tolidine
OTA	ortha-tolidine-arsenite
oz	ounce or ounces
oz/sq ft	ounces per square foot
Pa	pascal or pascals
pl	plate or property line
pm	post meridiem (afternoon)
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
pr	pair
psf/hr	pounds per square foot per hour
psf	pounds per square foot
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PVC	polyvinyl chloride
qt	quart or quarts
R	radius
R	roentgen or roentgens
rad	radiation absorbed dose
RH	relative humidity
rpm	revolutions per minute
rps	revolutions per second
s	second (metric units)
S	Siemens (mho)
scfh	standard cubic feet per hour
SDI	sludge density index or silt density index
sec	second (English units)
SI	International System of Units
sp	static pressure
sp gr	specific gravity
sp ht	specific heat
sq	square
cm^2 or sq cm	square centimeter or centimeters
sq ft	square feet or foot
sq inch	square inch
sq inches	square inches
km^2 or sq km	square kilometer or kilometers
m^2 or sq m	square meter or meters
mm^2 or sq mm	square millimeter or millimeters
sq yd	square yard or yards
SS	suspended solids
STC	Sound Transmission Class
SVI	sludge volume index

TDS	total dissolved solids
TEFC	totally enclosed, fan-cooled
TKN	total Kjeldahl nitrogen
TLM	median tolerance limit
TOC	total organic carbon
TOD	total oxygen demand
TOW	top of weir
TS	total solids
TSS	total suspended solids
TVS	total volatile solids
U	U Factor/U Value
U	Coefficient of Heat Transfer
U	heat transfer coefficient
UNS	Uniform Numbering System
US	United States
V	volt or volts
VA	volt-ampere or volt-amperes
W	watt or watts
WB	wet bulb
wg	water gauge
wk	week or weeks
WRT	water remediation technologies
wt	weight
yd	yard or yards
yr	year or years (English unit)

C. Abbreviations used on Drawings: As listed on Drawings or in Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Quality control and control of installation.
   2. Tolerances.
   3. References.
   4. Mock-up requirements.
   5. Authority and duties of Owner's representative or inspector.
   6. Sampling and testing.
   7. Testing and inspection services.
   8. Contractor's responsibilities.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01455 - Special Tests and Inspections.

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

H. When specified, products will be tested and inspected either at point of origin or at Work site:
   1. Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
   2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.

I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM): E 329 - Standard for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

B. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

C. Conform to reference standard by date of issue current on date of Contract Documents, except where specific date is established by code.

D. Obtain copies of standards where required by product specification sections.

E. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

1.05 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be comparison standard for remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.06 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

A. Owner's Project Representative employed or retained by Owner is authorized to inspect the Work.

B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

C. Deficiencies or defects in the Work which have been observed will be called to Contractor's attention.

D. Inspector will not:
   1. Alter or waive provisions of Contract Documents.
   2. Inspect Contractor's means, methods, techniques, sequences, or procedures for construction.
   3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor's safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor's employees or others.

E. Inspector will:
   1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
   2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.07 SAMPLING AND TESTING

A. General:
   1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
   2. When specified in sections where products are specified:
      a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
      b. Test materials in accordance with standards of national technical organizations.

B. Sampling:
   1. Furnish specimens of materials when requested.
   2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
   3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
   4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

1.08 TESTING AND INSPECTION SERVICES

A. Contractor will employ and pay for specified services of an independent firm to perform Contractor quality control testing as required in the technical specifications for various work and materials.

B. Owner will employ and pay for specified services of an "Owner's independent testing firm" to perform testing and inspection as required in the technical specifications for various work and materials or stipulated in Section 01455 to confirm Contractor's compliance with Contract Documents:
   1. If Engineer or Owner's independent testing firm is not properly certified to perform specialty inspections required by the building department, Owner will employ and pay for a quality specialty inspection firm to perform required testing and inspection.

C. The Owner's independent testing firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner and requested by the Engineer.

D. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
   1. Has authorization to operate in the state where the project is located.
   2. Meets "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories.
   3. Meets requirements of ASTM E 329.
   4. Laboratory Staff: Maintain full time specialist on staff to review services.
   5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to National Bureau of Standards (NBS) or accepted values of natural physical constants.
   6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NBS during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.

E. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.

F. Reports will be submitted by Owner's independent testing firm to Engineer, Contractor, and Owner in triplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents. Each report shall include:
   1. Date issued.
   2. Project title and number.
   3. Testing laboratory name, address, and telephone number.
   4. Name and signature of laboratory inspector.
   5. Date and time of sampling or inspection.
   6. Record of temperature and weather conditions.
   7. Date of test.
   8. Identification of product and specification section.
   9. Location of sample or test in Project.
   10. Type of inspection or test.

11. Results of tests and compliance with Contract Documents.
12. Interpretation of test results, when requested by Engineer.

G. Contractor shall cooperate with Owner's independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested:
   1. Notify Engineer and Owner's independent testing firm 48 hours prior to expected time for operations requiring testing.
   2. Make arrangements with Owner's independent testing firm and pay for additional samples and tests required for Contractor's use.

H. Limitations of authority of testing Laboratory: Owner's independent testing firm or Laboratory is not authorized to:
   1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency or laboratory may not approve or accept any portion of the Work.
   3. Agency or laboratory may not assume duties of Contractor.
   4. Agency or laboratory has no authority to stop the Work.

I. Testing and employment of an Owner's independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

J. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner's independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

K. The Owner's independent testing firm responsibilities will include:
   1. Test samples of mixes submitted by Contractor.
   2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
   3. Perform specified sampling and testing of products in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
   6. Perform additional tests required by Engineer.
   7. Attend preconstruction meetings and progress meetings.

L. Owner's independent testing firm individual test reports: After each test, Owner's independent testing firm will promptly submit electronically and three hard copies of report to Engineer and to Contractor. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results. Include the following:
   1. Date issued.
   2. Project title and number.
   3. Name of inspector.
   4. Date and time of sampling or inspection.
   5. Identification of product and specifications section.
   6. Location in Project.

7. Type of inspection or test.
8. Date of test.
9. Certified test results stamped and signed by a registered Engineer in the State of California.
10. Summary of conformance with Contract Documents.

M. Owner's independent testing firm will provide monthly report of certification to identify all work performed for special inspections and other contract requirements on this project. The following certified monthly report at a minimum will include but not limited to:
1. Results of testing.
2. Testing logs.
3. Outstanding deficiencies.
4. Various statistical data.
5. Testing curves (up to 4 types) as required by the Engineer.

1.09 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.

B. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

C. Provide to Owner's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

D. Furnish electronically and 5 hard copies of product test reports.

E. Furnish incidental labor and facilities:
1. To provide access to construction to be tested.
2. To obtain and handle samples at Work site or at source of product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing are needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01455

SPECIAL TESTS AND INSPECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: This Section describes the requirements for providing special tests and inspections.

B. Related sections:
   1. Section 01450 - Quality Control.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C140 -Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   2. C270 - Standard Specification for Mortar for Unit Masonry.
   3. C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
   4. C1019 - Standard Test Method for Sampling and Testing Grout.
   5. C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.

B. California Building Code (CBC).

1.03 DESCRIPTION

A. This Section describes special tests and inspections of structural assemblies and components to be performed in compliance with CBC.

B. These special tests and inspections are in addition to the requirements specified in Section 01450, and by the individual Sections.

C. The Owner will employ 1 or more inspectors who will provide special inspections during construction.

1.04 INSPECTION

A. Duties of Special Inspector:
   1. General: Required duties of the Special Inspector are described in CBC.

1.05 TESTS

A. Selection of the material required to be tested shall be by the Owner's Testing Laboratory and not the Contractor.

1.06 SPECIAL TESTING AND INSPECTIONS

A. Testing laboratory: Special tests will be performed by the Owner's testing laboratory as specified in Section 01450.

B. Owner reserves the right to positive material identification tests:
   1. Contractor must make materials available for testing.

C. The following types of work require special inspection as described in CBC, Refer to the following verification, testing and inspection schedules:
   1. Appendix A, Cast-In-Place Concrete Special Inspection Schedule.
   2. Appendix B, Essential Architectural, Mechanical And Electrical Inspection Schedule.
   3. Appendix C, Soils Verification And Inspection Schedule.
   4. Appendix D, Structural Steel Special Inspection Schedule.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 SCHEDULE

A. The Contractor shall allow time necessary for Special Inspections as listed above.

B. Sufficient notice shall be given so that the Special Inspections can be performed. This includes time for off-site Special Inspectors to plan the inspection and travel to site.

3.02 PROCEDURE

A. The Special Inspector will immediately notify the Engineer of any corrections required and follow notification with appropriate documentation.

B. The Contractor shall not proceed until the work is satisfactory to the Engineer.

END OF SECTION

APPENDIX A
CAST-IN-PLACE CONCRETE CONSTRUCTION SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Inspect of reinforcing steel, including prestressing tendons, and verify placement.	ACI 318 Ch. 20, 25.2, 25.3, 26.5.1-26.5.3	–	X
2. Reinforcing bar welding: a. Verify weldability of reinforcing bars others than ASTM A70. b. Inspect single-pass fillet welds, maximum 5/16". c. Inspect all other welds.	AWS D1.4 ACI 318: 26.5.4	– – –	X X X
3. Inspect anchors cast in concrete.	ACI 318:17.8.2	–	X
4. Inspect anchors post-installed in hardened concrete members. a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads. Verify weldability of reinforcing bars others than ASTM A706; b. Mechanical anchors and adhesive anchors not defined in 4.a.	ACI 318:17.8.2.4 ACI 318:17.8.2	X	X
5. Verifying use of required design mix.	ACI 318: Ch. 19, 26.4.3, 26.4.4	–	X
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	ASTM C172 ASTM C31 ACI 318: 26.4.5, 26.12	X	–
7. Inspect of concrete and shotcrete placement for proper application techniques.	ACI 318: 26.4.5	X	–
8. Verify maintenance of specified curing temperature and techniques.	ACI 318: 26.4.7-26.4.9	–	X
9. Inspect formwork for shape, location and dimensions of the concrete being formed.	ACI 318: 26.10.1(b)	–	X

APPENDIX B
ESSENTIAL ARCHITECTURAL, MECHANICAL AND ELECTRICAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Suspended ceiling system including anchorage.		–	X
2. Anchorage of electrical equipment for emergency and standby power system.		–	X
4. Installation and anchorage of ductwork designed to carry hazardous materials.		–	X
5. Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units.		–	X
6. Anchorage of steel storage racks that are 8 feet or greater in height.		–	X

APPENDIX C
SOILS VERIFICATION AND INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Verify materials below footings are adequate to achieve the design bearing capacity.		–	X
2. Verify excavations are extended to proper depth and have reached proper material.		–	X
3. Perform classification and testing of controlled fill materials.		–	X
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of controlled fill.		X	–
5. Prior to placement of controlled fill, observe subgrade and verify that site has been prepared properly.		–	X

APPENDIX D
STRUCTURAL STEEL SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Material verification of high-strength bolts, nuts and washers:			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.		–	X
b. Manufacturer's certificate of compliance required.		–	X
2. Inspection of high-strength bolting:			
a. Bearing-type connections.		–	X
b. Slip-critical connections.		X	X
3. Material verification of structural steel:			
a. Identification markings to conform to AISC 360.		–	X
b. Manufacturers' certified mill test reports.		X	–
4. Material verification of weld filler materials:			
a. Identification markings to conform to AWS specification in the approved construction documents.		–	X
b. Manufacturer's certificate of compliance required.		–	X
5. Inspection of welding:			
a. Structural steel:		–	–
1) Complete and partial penetration groove welds.		X	–
2) Multi-pass fillet welds.		X	–
3) Single-pass fillet welds > 5/16".		X	–
4) Single-pass fillet welds ≤ 5/16".		–	X
5) Floor and deck welds.		–	X
b. Reinforcing steel:		–	–
1) Verification of weldability of reinforcing steel other than ASTM A706.		–	X
2) Reinforcing steel-resisting flexural and axial forces in boundary elements of special reinforced concrete shear walls and shear reinforcement.		X	–
3) Shear reinforcement.		X	–
4) "Form Saver" (reinforcing couplers).		X	–
5) Other reinforcing steel.		–	X
6. Inspection of steel frame joint details for compliance with approved construction documents:			X
a. Details such as bracing and stiffening.		X	–
b. Member locations.		X	–
c. Application of joint details at each connection.		X	
7. Seismic force resisting systems identified on structural plans.		X	–

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.

B. Related sections:
   1. Section 01140 - Work Restrictions.

1.02 REFERENCE

A. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. General: For products specified to be furnished under this Section, submit product data as specified in Section 01330.

B. For temporary piping systems:
   1. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
   2. Submit product data for piping, fittings, appurtenances, restraints, supports, and all other components of the temporary piping system.
   3. Submit all information at least 28 days prior to when each temporary piping system is scheduled to be installed and allow 14 days for review and comment.

1.04 TEMPORARY UTILITIES

A. Temporary electrical power:
   1. Arrange with Owner to provide adequate temporary electrical service. Owner will provide temporary power provided power use is reasonable and use is confined to construction of the Work.
   2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.

B. Temporary electrical lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.

2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
    a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by Contractor for lighting.

C. Temporary heating, cooling, and ventilating:
1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.

D. Temporary water:
1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.
3. Pay for water used for construction prior to Substantial Completion. Owner will provide water for 7 day operational testing.
4. Development of potable water supply:
    a. Potable water is not available at construction site.
    b. Provide potable water for human consumption during construction period.
    c. Furnish potable water that meets requirements of Laws and Regulations.
5. Development of non-potable water supply:
    a. Post ample signs throughout the work area warning that plant water is not potable.
    b. Non-potable water is available from hydrants or hose valves within plant without cost. When combined demand of the Work and plant exceeds plant supply capacity, provide additional temporary supply capacity.

E. Temporary sanitary facilities:
1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
2. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

F. Temporary fire protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.

G. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

H. Utilities in existing facilities: As specified in Section 01140.

1.05 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to assure adequate load bearing capability:
    1. When requested, submit design calculations by professional registered engineer prior to application of loads.
    2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:
    1. Exercise precautions throughout construction for protection of persons and property.
    2. Observe safety provisions of applicable Laws and Regulations.
    3. Guard machinery and equipment, and eliminate other hazards.
    4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
    5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Barricades:
    1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
    2. Provide barriers with flashing lights after dark.
    3. Keep barriers in place until excavations are entirely backfilled and compacted.
    4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
    1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in public right-of-way:
    1. Comply with local jurisdiction standards and requirements for right-of-way barricades and other safety devices.
    2. Mark at reasonable intervals, trenches, and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
        a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
    3. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
        a. During hours of darkness, provide warning lights at close intervals.

H. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

I. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

J. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or

other agents with substantial barricades or other devices commensurate with hazards.

K. Fences:
   1. Enclose site of the Work with fence adequate to protect the Work against acts of theft, violence, and vandalism.
   2. Enclose temporary offices and storage areas with fence adequate to protect temporary facilities against acts of theft, violence, and vandalism.
   3. When entire or part of site is to be permanently fenced, permanent fence may be built to serve for both permanent and temporary protection of the work site, provided that damaged or defaced fencing is replaced prior to final completion.
   4. Protect temporary and permanent openings and close openings in existing fences to prevent intrusion by unauthorized persons.
      a. Bear responsibility for protection of plant and material on site of the Work when openings in existing fences are not closed.
   5. During night hours, weekends, holidays, and other times when no work is performed at site, provide temporary closures or enlist services of security guards to protect temporary openings.
   6. Fence temporary openings when openings are no longer necessary.

1.06 SECURITY

A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.07 ACCESS ROADS

A. General:
   1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
   2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.

B. Off-site access roads:
   1. Build and maintain graded earth roads.
   2. Build roads only in public right-of-way or easements obtained by Owner.
   3. Obtain rights-of-way or easements when electing to build along other alignment.

C. On-site access roads:
   1. Maintain access roads to storage areas and other areas to which frequent access is required.
   2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
   3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
   4. Maintain on-site access roads free of mud. Under no circumstances shall vehicles leaving the site track mud off the site onto the public right-of-way.

1.08 TEMPORARY CONTROLS

A. Dust control:
   1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:
   1. Comply with noise and work hours regulations by local jurisdiction.
   2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
   3. In residential areas, take special measures to suppress noise during night hours.

C. Mud control:
   1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.09 PROJECT SIGN

A. Provide and maintain Project identification sign consisting of painted 8-foot wide by 4-foot high exterior grade plywood and minimum 10-foot long, 4 by 4 lumber posts, set in ground at least 3 feet, with exhibit lettering by professional sign painter using no more than 5 sign colors:
   1. List at least the title of the Project, and names of the Owner, Engineer, and Contractor.
   2. Contractor’s, Engineer’s and Construction Manager's names shall be identified in upper right hand corner underneath the bid number.

B. Erect Project identification sign where directed.

1.10 FIELD OFFICES AND SHEDS

A. Contractor's field office:
   1. Maintain on Project Site weather tight space in which to keep copies of Contract Documents, progress schedule, shop drawings, and other relevant documents.
   2. Provide field office with adequate space to examine documents, and provide lighting and telephone service in that space.

B. Engineer's field office:
   1. Engineer will use office space inside the existing maintenance building at the project site, as provided by the Owner.
   2. Provide weekly janitorial service, including dusting, floor cleaning (sweeping and mopping), trash removal, and monthly comprehensive cleaning.
   3. Potable water dispenser with water for duration of project with both hot and cold water.
   4. Contractor shall furnish the following equipment and furnishing for the Engineer's and Construction Manager's office, as follows:
      a. 2 Office desks: 36 inches by 72 inches or 30 inches by 60 inches, with 6 drawers (2 with locks).
      b. Plan/conference table: 1, not less than 36 inches by 96 inches.

c. Drafting table: 1, not less than 36 inches by 72 inches.
d. Metal drafting stools with backs: 1.
e. Straight chairs (fully padded): 12.
f. Swivel chairs (adjustable and fully padded): 2.
g. Metal filing cabinet: 2, 18 inches by 30 inches by 52 inches, 4 drawers with locks.
h. Supply cabinet: 1, with not less than 15 square feet of shelves.
i. Bookcases: 3, with not less than 12 linear feet of shelves for each bookcase.
j. Wastebaskets: 3.
k. Dry erase board 96 by 48 inches, magnetic: 1.
l. Refrigerator, 15.0 cubic feet capacity.
m. Microwave oven, 1.0 cubic feet.
n. K-Cup coffee maker.
o. One 2.4 GHz digital spread spectrum cordless telephone set featuring one base with speaker phone, and two handsets with rechargeable bases and intercom capabilities between the sets.

5. Field office data service and network equipment:
   a. Provide the following data services for the duration of the project.
   b. Contractor is responsible for all maintenance of service and hardware.
   c. Data service will be dedicated to the Engineer and not shared with any other party.
   d. The Contractor shall provide a durable and weather tight system for connecting the Engineer to the service provider's facilities at the jobsite boundary.
   e. Contractor is responsible for all maintenance of service and hardware:
      1) Provide high-speed Internet access (DSL or cable modem):
         a) Requirements: Minimum 6 Gb per second download/ upload. This access must have a minimum of 8 (5 usable) IP address. In addition, it must provide an average round-trip delay of less than 150 ms to the Engineer Internet gateway.
         b) Equipment: Provide appropriate DSL or cable modem device. In addition, provide the following:
            (1) Cisco ASA 5505 firewall with 3DES software, part number ASA5505-SEC-BUN-K9 and Cisco 4 hour response onsite Smartnet Maintenance for duration of project.
            (2) Cisco Aironet 3500 Series Wireless Access Point Model No. AIR-CAP3502I-A-K9.
      2) Provide private line or frame-relay Internet access:
         a) Requirements: T1 speed. This access must have a minimum of 8 (5 usable) IP address. In addition, it must provide an average round-trip delay of less than 150 ms to the Engineer Internet gateway.
         b) Equipment:
            (1) Visual Networks IP Enterprise central office T1 drop-and-insert CSU/DSU.
            (2) Cisco 2911 router bundle, Cisco part number 2911/K9 and Cisco 4 hour response onsite Smartnet Maintenance for duration of project.
            (3) Serial interface card, Cisco part number HWIC-1T.
            (4) Serial cable, Cisco part number CAB-SS-V35MT.
            (5) Security license, Cisco part number SL29-SEC-K9.

(6) Cisco Aironet 3500 Series Wireless Access Point Model No. AIR-CAP3502I-A-K9.

f. Field office local area network: Provide the following to create a local area network for the Engineer:
   1) Install Category 5e cabling to support all specified computers, printers, and other network device. This cabling should be home-run to a patch panel and meet all applicable installation standards for CAT5e. Patch panel and jack locations to be coordinated with Engineer.
   2) Provide 10/100/1000 Ethernet Switch sized to support all specified network devices for Engineer with an allowance for 50 percent growth/spare ports.
   3) Provide APC SmartUPS RT 1500 uninterruptable power supply, model SURTA1500XL.
   4) Provide Category 5e patch cables for all networking equipment; both for patch panel to switch connection and for wall jack to network device connection.

6. Field office computer systems:
   a. Furnish and install (2) two new complete computer systems. Contractor is responsible for all maintenance of hardware.Each system shall consist of, as a minimum:
      1) Docking Station for laptop computer, model as provided by ENGINEER.
      2) 2 LCD Monitors 22-inch widescreen 1680 by 1050 with VGA interface. Brand should be LG or Engineer-approved equivalent.
      3) Wireless Keyboard: 101 key
      4) Mouse: Wireless with mouse pad.
      5) Speakers.
      6) Cables, connectors, and controller cards, as necessary, to provide a functioning dual monitor system, including computer accessories.
      7) A/C surge suppressor sized for computer system.
      8) 1 TB external hard drive storage device
   b. Peripheral hardware:
      1) HP LaserJet Color Multifunction printer or equal:
         a) Capable of printing and scanning 11 by 17 and smaller paper size.
         b) Able to send and receive Fax.
         c) Able to scan PDF to onsite laptops
         d) Onsite HP maintenance for duration of project.
         e) Paper, toner, and other supplies for duration of project.
7. Have field office ready for occupancy within 2 weeks after start of the Work.

1.11 REMOVAL

A. Remove temporary buildings and furnishings before inspection for Substantial Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Product requirements; product selection; product options and substitutions; quality assurance; delivery, handling, and storage; and manufacturer's instructions.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01610 - Seismic Design Criteria.
   3. Section 01612 - Seismic Design Criteria.
   4. Section 01756 - Commissioning.
   5. Section 01782 - Operation and Maintenance Data.
   6. Section 09960 - High-Performance Coatings.

1.02 DEFINITIONS

A. Products: Inclusive of material, equipment, systems, shop fabrications, source quality control.

1.03 REFERENCES

A. American National Standards Institute (ANSI).

1.04 PRODUCT REQUIREMENTS

A. Comply with Specifications and referenced standards as minimum requirements.

B. Product design as specified in Section 01612:
   1. Provide equipment and parts that are suitable for stresses, which may occur during fabrication, transportation, erection, and operation.
   2. Calculations shall be signed and stamped by a civil or structural engineer registered to practice in the state where the Project is located.

C. Provide products by same manufacturer when products are of similar nature, unless otherwise specified.

D. Provide like parts of duplicate units that are interchangeable.

E. Provide equipment that has not been in service prior to delivery, except as required by tests.

F. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings and contained in Laws and Regulations.

G. Material requirements:
   1. Materials: Provide corrosion resistance suitable for project conditions as specified in Section 01610.
   2. Dissimilar metals: Separate contacting surfaces with dielectric material.

H. Require each equipment manufacturer to have maintenance facilities meeting the following requirements:
   1. Minimum 3 years operational experience.
   2. Location in continental United States.
   3. Equipment and tools capable of making repairs.
   4. Staff qualified to make repairs.
   5. Inventory of maintenance spare parts.

PART 2 PRODUCTS

2.01 PRODUCT SELECTION

A. When products are specified by standard or specification designations of technical societies, organizations, or associations only, provide products that meet or exceed reference standard and Specifications.

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide:
   1. Products by one of named manufacturers that meet or exceed Specifications.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide:
   1. Products with model numbers or catalog designations by one of named manufacturers.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
   1. Products specified by brand or trade name, model number, or catalog designation.
   2. Products by one of named manufacturers proven in accordance with requirements for or equals to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.
   3. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

E. When Products are specified with only one manufacturer followed by "or Equal," provide:
   1. Products meeting or exceeding Specifications by specified manufacturer.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

2.02 SUBSTITUTIONS

A. Formal substitution request procedure:
   1. Submit a written formal substitution request to Engineer for each proposed substitution within 30 days of effective date of Contract.
   2. Engineer will return initial opinion and request for additional information within 30 days.
   3. Engineer will notify Contractor in writing of decision to accept or reject the substitution request within 30 days of receiving required information.

B. Formal substitution request contents:
   1. Provide Substitution Request Form as specified in this Section.
   2. Manufacturer's literature including:
      a. Manufacturer's name and address.
      b. Product name.
      c. Product description.
      d. Reference standards.
      e. Certified performance and test data.
      f. Operation and maintenance data.
   3. Samples, if applicable.
   4. Shop drawings, if applicable.
   5. Reference projects where the product has been successfully used:
      a. Name and address of project.
      b. Year of installation.
      c. Year placed in operation.
      d. Name of product installed.
      e. Point of contact: Name and phone number.
   6. Itemized comparison of the proposed substitution with product specified including a list of significant variations:
      a. Design features.
      b. Design dimensions.
      c. Installation requirements.
      d. Operations and maintenance requirements.
   7. Define impacts:
      a. Impacts to construction schedule.
      b. Impacts to other contracts.
      c. Impacts to other work or products.
      d. Impact to Contract Sum:
         1) Do not include costs under separate contracts.
         2) Do not include Engineer's costs for redesign or revision of Contract Documents.
         3) Required license fees or royalties.
      e. Availability of maintenance services and sources of replacement materials.
   8. Contractor represents the following:
      a. Contractor will pay associated costs for the Engineer to evaluate the substitution.
      b. Contractor bears the burden of proof of the equivalency of the proposed substitution.
      c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
      d. Proposed substitution is equal or superior to the specified product.

e. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless Owner requires a Special Warranty.
f. Contractor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
g. Contractor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.

C. Substitutions will not be considered for acceptance under the following conditions:
1. No formal substitution request is made.
2. The substitution is simply implied or indicated on shop drawings or product data submittals.
3. The formal substitution request is submitted by a subcontractor or supplier.

D. Substitution requests submitted after the deadline will not be considered unless the following evidence is submitted to the Engineer:
1. Proof that the specified product is unavailable for reasons beyond the control of the Contractor:
a. Reasons may include manufacturing discontinued, bankruptcy, labor strikes, or acts of God.
b. Contractor placed or attempted to place orders for the specified products within 10 days after the effective date of the Agreement.
c. The formal substitution request is submitted to Engineer within 10 days of the Contractor discovering the specified product cannot be obtained.

E. Engineer's decision on a substitution requests will be final and binding:
1. Approved substitutions will be incorporated into the Contract Documents with a Change Order.
2. Requests for time extensions and additional costs based on submission of, approval of, or rejection of substitutions will not be allowed.

2.03 QUALITY ASSURANCE

A. Employ entities that meet or exceed specified qualifications to execute the Work.

B. Inspect conditions before executing subsequent portions of the Work. Accept responsibility for correcting unsatisfactory conditions upon executing subsequent portions of the Work.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

2.04 SHIPMENT, HANDLING, STORAGE, AND PROTECTION

A. Shipment:
1. Mandatory requirements prior to shipment of equipment:
a. Engineer approved shop drawings.
b. Engineer approved Manufacturer's Certificate of Source Testing as specified in Section 01756.
c. Submit draft operations and maintenance manuals, as specified in Section 01782.

2. Prepare products for shipment by:
    a. Applying grease and lubricating oil to bearings and similar items.
    b. Tagging or marking products to agree with delivery schedule or shop drawings.
    c. Including complete packing lists and bills of material with each shipment.
    d. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.
    e. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.
3. Transport products by methods that avoid product damage.

B. Receiving:
1. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

C. Handling:
1. Handle equipment in accordance with manufacturer's instructions.
2. Provide equipment and personnel to handle products by methods to prevent soiling or damage.
3. Upon delivery, promptly inspect shipments:
    a. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products.
    b. Acceptance of shipment does not constitute final acceptance of equipment.

D. Storage:
1. Immediately store and protect products and materials until installed in Work.
2. Store products with seals and legible labels intact.
3. Maintain products within temperature and humidity ranges required or recommended by manufacturer.
4. Protect painted surfaces against impact, abrasion, discoloration, and other damage:
    a. Repaint damaged painted surfaces.
5. Exterior storage of fabricated products:
    a. Place on aboveground supports that allow for drainage.
    b. Cover products subject to deterioration with impervious sheet covering.
    c. Provide ventilation to prevent condensation under covering.
6. Store moisture sensitive products in watertight enclosures.
7. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for all mechanical equipment, valves, architectural items, electrical and instrumentation equipment and special equipment to be incorporated into this project:
    a. Storage of equipment shall be in strict accordance with the “instructions for storage” of each equipment supplier and manufacturer including connection of heaters, placing of storage lubricants in equipment, etc.
    b. The Contractor shall furnish a copy of the manufacturer’s instructions for storage to the Engineer prior to storage of all equipment and materials.
8. Store loose granular materials on solid surfaces in well-drained area. Prevent materials mixing with foreign matter. Provide access for inspection.
9. Payment will not be made for improperly stored equipment and materials.
10. Provide equipment log including, as a minimum, the equipment identification, date stored, date of inspection/maintenance, date removed from storage, copy

of manufacturer's recommended storage guidelines, description of inspection/maintenance activities performed, and signature of party performing inspection/maintenance.

E. Protection after installation:
   1. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations:
      a. Remove covering when no longer needed.
      b. Corroded, damaged, or deteriorated equipment and parts shall be replaced before acceptance of the project.
   2. Update equipment log on a monthly basis with description of maintenance activities performed in accordance with the manufacturer's recommendation and industry standards and signature of party performing maintenance.

2.05 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. Provide spare parts, maintenance products, and special tools as required by Specifications.

B. Box, tag, and clearly mark items.

C. Contractor is responsible for spare parts, maintenance products, and special tools until acceptance by Owner.

D. Store spare parts, maintenance products, and special tools in enclosed, weather-proof, and lighted facility during the construction period:
   1. Contractor is responsible for spare parts and special tools until acceptance by Owner.
   2. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.

E. Spare parts and special tools inventory list, see Appendix A:
   1. Equipment tag number.
   2. Equipment manufacturer.
   3. Subassembly component, if appropriate.
   4. Quantity.
   5. Storage location.

F. Large items:
   1. Weight: Greater than 50 pounds.
   2. Size: Greater than 24 inches wide by 18 inches high by 36 inches long.
   3. Stored individually.
   4. Clearly labeled:
      a. Equipment tag number.
      b. Equipment manufacturer.
      c. Subassembly component, if appropriate.

G. Smaller items:
   1. Weight: Less than 50 pounds.
   2. Size: Less than 24 inches wide by 18 inches high by 36 inches long.
   3. Stored in spare parts box.

4. Clearly labeled:
    a. Equipment tag number.
    b. Equipment manufacturer.
    c. Subassembly component, if appropriate.

H. Spare parts and special tools box:
1. Wooden box:
    a. Size: 24 inches wide by 18 inches high by 36 inches long.
2. Hinged wooden cover:
    a. Strap type hinges.
    b. Locking hasp.
    c. Spare parts inventory list taped to underside of cover.
3. Coating: As specified in Section 09960.
4. Clearly labeled:
    a. The words “Spare Parts and/or Special Tools”.
    b. Equipment tag number.
    c. Equipment manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect components for shipping damage and conformance to Contract Documents.

3.02 COMMISSIONING

A. As specified in Section 01756.

3.03 CLOSEOUT ACTIVITIES

A. Owner may request advanced delivery of spare parts, maintenance products, and special tools:
1. Deduct the delivered items from inventory and provide transmittal documentation.

B. Immediately prior to the date of Substantial Completion, arrange to deliver spare parts, maintenance products, and special tools to Owner at a location on site chosen by the Owner:
1. Provide itemized list of spare parts and special tools that matches the identification tag attached to each item.
2. Owner and Engineer will review the inventory and the itemized list to confirm it is complete and in good condition prior to signing for acceptance.

3.04 ATTACHMENTS

A. Appendix A - Spare Parts, Maintenance Products, and Special Tools Inventory List.

B. Appendix B - Sample Substitution Request Form.

END OF SECTION

APPENDIX A
SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

Inventory List				
Spec Number: _____		Spec Title _____		
Equipment Tag No.: _____		Equipment Manufacturer: _____		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**

APPENDIX B

SUBSTITUTION REQUEST FORM

DOCUMENT 01600(01_60_00)
SUBSTITUTION REQUEST FORM

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

To: _____ **From:** _____

Re: _____

Contract For: _____

Engineering Project Number: _____ **Substitution Request Number:** _____

Specification Information
Title: _____
Number: _____ Page: _____ Article/Paragraph: _____
Description: _____

Proposed Substitution
Product: _____
Manufacturer: _____
Address: _____ Phone: _____
Trade Name: _____ Model No.: _____
Installer: _____
Address: _____ Phone: _____
History: New Product 2-5 years old 5-10 years old More than 10 years old
Differences between proposed substitution and specified product:
Point-by-point comparative data and impacts attached – REQUIRED BY ENGINEER

Reason For Not Providing Specified Item
Reason: _____
Similar Installation: _____
Project: _____
Address: _____ Date Installed: _____
Owner: _____ Architect: _____
Proposed substitution affects other parts of Work:
____ No ____ Yes, Explain: _____

Benefit to Owner For Accepting Substitution
Savings: _____ ($) _____
Proposed substitution changes Contract Time::
_____ No _____ Yes **[Add]** **[Deduct]** _____ days

Supporting Data Attached
____ Drawings ____ Product Data ____ Samples ____ Tests ____ Reports
____ Reference Projects Other: _____

Certifications
The undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product, unless Owner requires a Special Warranty.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost data as stated above is complete. Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including Engineer design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Certifications	
Submitted by:	
Signed by:	
Firm Name	
Firm Address:	
Phone:	
Attachments:	

Engineer's Review And Action

___ Substitution accepted - Make submittals in accordance with Specification Section 01330.

___ Substitution accepted as noted - Make submittals in accordance with Specification Section 01330.

___ Substitution rejected - Use specified materials.

___ Substitution Request received too late - Use specified materials.

Signed by: _____ Date: _____

Additional Comments

Additional Comments:

____ Contractor ____ Subcontractor ____ Supplier ____ Manufacturer ____ Engineer

Other: _____

Comments:

SECTION 01610

PROJECT DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Project design criteria such as temperature and site elevation.

1.02 PROJECT DESIGN CRITERIA

A. All equipment and materials for the project are to be suitable for performance in wastewater treatment plant environment and under following conditions:
   1. Design temperatures are:
      a. Outdoor temperatures: 20 to 115 degrees Fahrenheit.
   2. Freeze-thaw conditions.
   3. Moisture conditions: Defined in individual equipment sections.
   4. Site elevation: Approximately 97 feet above mean sea level.
   5. Design groundwater elevation: Approximately 87 feet above mean sea level.
   6. Wastewater temperature:
      a. Maximum 80 degrees Fahrenheit.
      b. Minimum 60 degrees Fahrenheit.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01612

SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment.
   2. Seismic design and design of anchorage for small tanks fabricated off site and shipped to the Project site.
   3. Other structures or items as specified or indicated on the Drawings.

B. Related sections:
   1. Section 01410 - Regulatory Requirements.
   2. Section 03055 - Adhesive-Bonded Reinforcing Bars and All-Thread Rods.
   3. Section 05190 - Mechanical Anchoring And Fastening To Concrete And Masonry.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 7-10 - Minimum Design Loads for Buildings and Other Structures.

1.03 SYSTEM DESCRIPTION

A. Design in accordance with the requirements of the building code as specified in Section 01410.

B. Design spectral acceleration at short period, S_{DS}: 0.689.

C. Design of non-structural components and their connections to structures:
   1. Component amplification factor, a_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.
   2. Component response modification factor, R_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.
   3. Component importance factor, I_p:

Table 1: Component Importance Factor, Ip		
Component	**Description**	**Ip**
Electrical	Equipment and appurtenances provided and installed under Division 16.	1.5

D. Seismic Design Category (SDC): D.

E. Design requirements: Anchorage of equipment to structures:
   1. Do not use friction to resist sliding due to seismic forces. Do not design or provide connections that use friction to resist seismic loads. Resist seismic forces through direct tension and/or shear on anchors and fasteners.

2. Do not use more than 60 percent of the weight of the mechanical and electrical equipment for designing anchors for resisting overturning due to seismic forces.
3. Do not use more than 60 percent of the weight of the tank for resisting overturning due to seismic forces.
4. Anchoring and fastening to concrete and masonry:
    a. Provide anchors specified in Sections 03055 and 05190.
    b. Use only cast-in anchors (anchor bolts or welded studs) for anchors at connections that resist seismic forces.
    c. Do not use concrete anchors, flush shells, sleeve anchors, screw anchors, powder actuated fasteners, or other types of post-installed mechanical anchors unless indicated on the Drawings or accepted in writing by the Engineer.

1.04 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and seismic calculations.

B. Calculations shall be signed and stamped by a civil or structural engineer licensed in California.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01614

WIND DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wind design criteria.

B. Related section:
   1. Section 01410 - Regulatory Requirements.
   2. Section 03055 - Adhesive-Bonded Reinforcing Bars and All-Thread Rods.
   3. Section 05190 - Mechanical Anchoring And Fastening To Concrete And Masonry.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Building code criteria: Design for wind in accordance with building code as specified in Section 01410:
      a. Occupancy category: III.
      b. Basic wind speed: 115 miles per hour.
      c. Exposure category: D.
      d. Topographic factor, K_{zt}: 1.0.
      e. Wind importance factor, I_w: 1.15.
   2. Resist wind forces through direct bearing on anchors and fasteners. Do not design or provide connections that use friction to resist wind loads.
   3. Anchoring and fastening to concrete and masonry:
      a. Provide anchors specified in Sections 03055 and 05190.
      b. Use only cast-in and built-in anchors (anchor bolts and welded studs) for anchors at connections that resist wind forces.
      c. Do not use concrete anchors, flush shells, sleeve anchors, flush shells, screw anchors, powder actuated fasteners, or other types of post-installed mechanical anchors unless indicated on the Drawings or accepted in writing by the Engineer.

1.03 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and wind design calculations.

B. Calculations shall be signed and stamped by a civil or structural engineer licensed in the state of California.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01722

FIELD ENGINEERING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Field engineering to establish lines and grades for the Work.

1.02 QUALITY ASSURANCE

A. Qualifications of surveyor or Engineer: Registered civil engineer or land surveyor in state where Project is located.

B. Accuracy of stakes, alignments, and grades may be checked randomly by Engineer:
   1. Notice of when checking will be conducted will be given.
   2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
   3. Do not assume that Engineer's check substitutes or complements required field quality control procedures.

1.03 CONSTRUCTION STAKES, LINES, AND GRADES

A. Execute the Work in accordance with the lines and grades indicated.

B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

1.04 SURVEY REFERENCE POINTS

A. Basic reference line, a beginning point on basic reference line, and a benchmark will be provided by Owner.

B. From these reference points, establish other control and reference points as required to properly lay out the Work.

C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
   1. Make no changes or relocations without prior written notice.
   2. Replace Project control point, when lost or destroyed, in accordance with original survey control.

D. Set monuments for principal control points and protect them from being disturbed and displaced:
   1. Re-establish disturbed monuments.
   2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.

1.05 PROJECT SITE SURVEY REQUIREMENTS

A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.

B. Record permanent benchmark locations with horizontal and vertical data on Project Record Documents.

C. Assume responsibility for accuracy of stakes, alignments, and grades by performing verifications and checking in accordance with standard surveying practice.

D. Maintain complete, accurate log of control points and survey.

E. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01738

SELECTIVE ALTERATIONS AND DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cutting or modifying of existing and new work.
   2. Partial demolition of structures.

B. Related sections:
   1. Section 01140 - Work Restrictions.
   2. Section 01330 - Submittal Procedures.
   3. Section 02300 - Earthwork.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A10.6 - Safety and Health Program Requirements for Demolition Operations.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
   2. Guideline No. 310.3R - Guide for the Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods.

1.03 DEFINITIONS

A. Chipping hammer: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight of less than 15 pounds and an impact frequency of greater than 2,000 blows/minute.

B. Concrete breaker: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight greater or impact frequency less than the limits defined for a chipping hammer.

C. Coring equipment: Non-impact rotary drill with diamond cutting edges.

D. Heavy abrasive blast: Cleaning procedure by which various abrasives materials, or steel shot, are forcibly propelled by high pressure against a surface to remove loose material and produce a concrete surface roughened to ICRI Surface Profile CSP-7, or higher, as specified in ICRI 301.3R.

1.04 DESCRIPTION OF WORK

A. The work includes partial demolition, cutting, and modifying of existing facilities, utilities, and/or structures.

B. These facilities may be occupied and/or operational. Satisfactory completion of the work will require that the Contractor plan activities carefully to work around unavoidable obstacles and to maintain overall stability of structures and structural elements. It will further require restoration of existing facilities, utilities, and structures that are to remain in place and that are damaged by demolition or removal operations.

1.05 SUBMITTALS

A. General:
   1. Submit specified in Section 01330.

B. Shop drawings: Include:
   1. The location of all embedded items shall be documented using diagrams and/or other media that clearly show dimensions and locations of existing structural elements, existing embedded items and any new embedded items and their relationship to each other.

C. Submittals for information only:
   1. Permits and notices authorizing demolition.
   2. Certificates of severance of utility services.
   3. Permit for transport and disposal of debris.
   4. Selective Demolition Plan.

D. Quality assurance submittals:
   1. Qualifications of non-destructive testing agency/agencies.

E. Project record documents:

F. Drawings and/or other media documenting locations of service lines and capped utilities.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Assign relocation, removal, cutting, coring and patching to trades and workers qualified to perform the Work in manner that causes the least damage and that provides means of returning surfaces to an appearance at least equal to that of the surrounding areas unaffected by the Work.
   2. Non-destructive testing agencies: Minimum of 5 years' experience performing non-destructive testing for location of steel reinforcement in existing concrete under conditions similar to that required for this Work.

1.07 SEQUENCING

A. Perform Work in sequences and within times specified in Section 01140.

B. If the facility or utility to be modified cannot be removed from service, perform the Work while the facility is in operation using procedures and equipment that do not jeopardize operation or materially reduce the efficiency of that facility.

C. Coordinate the Work with operation of the facility:
   1. Do not begin alterations of designated portions of the Work until specific permission for activities in each area has been granted by Owner in writing.
   2. Engineer will coordinate the planned procedure with facility manager.
   3. Complete Work as quickly and with as little delay as possible.

D. Operational functions of the facility that are required to be performed to facilitate the Work will be performed by facility personnel only.

E. Owner will cooperate in every way practicable to assist in expediting the Work.

F. When necessary for the proper operation or maintenance of portions of the facility, reschedule operations so the Work will not conflict with required operations or maintenance.

1.08 REGULATORY REQUIREMENTS

A. Dispose of debris in accordance with governing regulatory agencies.

B. Comply with applicable air pollution control regulations.

C. Obtain permits for building demolition, transportation of debris to disposal site and dust control.

1.09 PREPARATION

A. Non-destructive evaluation of existing concrete and masonry:
   1. Prior to cutting, drilling, coring, and/or any other procedure that penetrates existing concreteor masonry, retain and pay for the services of a qualified non-destructive testing agency to perform investigations to determine the location of existing steel reinforcement, plumbing, conduit, and/or other embedments in the concrete.
   2. Submit documentation of the investigations to the Engineer for review and approval as specified in Section 01330 before any work involving penetration of existing concrete is initiated.

1.10 PROJECT CONDITIONS

A. Do not interfere with use of adjacent structures and elements of the facility not subject to the Work described in this Section. Maintain free and safe passage to and from such facilities.

B. Provide erect and maintain barricades, lighting, guardrails, and protective devices as required to protect building occupants, general public, workers, and adjoining property:
   1. Do not close or obstruct roadways without permits.
   2. Conduct operations with minimum interference to public or private roadways.

C. Prevent movement, settlement, or collapse of structures adjacent services, sidewalks, driveways and trees:
   1. Provide and place bracing or shoring.

2. Cease operations and notify Engineer immediately when safety of structures appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.
3. Assume liability for movement, settlement, or collapse. Promptly repair damage.

D. Arrange and pay for capping and plugging utility services. Disconnect and stub off:
1. Notify affected utility company in advance and obtain approval before starting demolition.
2. Place markers to indicate location of disconnected services.

E. Unknown conditions:
1. The drawings may not represent all conditions at the site and adjoining areas. Compare actual conditions with drawings before commencement of Work.
2. Existing utilities and drainage systems below grade are located from existing documents and from surface facilities such as manholes, valve boxes, area drains, and other surface fixtures.
3. If existing active services encountered are not indicated or otherwise made known to the Contractor and interfere with the permanent facilities under construction, notify the Engineer in writing, requesting instructions on their disposition. Take immediate steps to ensure that the service provided is not interrupted, and do not proceed with the Work until written instructions are received from the Engineer.

PART 2 PRODUCTS

2.01 SALVAGE MATERIALS

A. Salvage materials: Materials removed from existing facility.

B. Materials designated for salvage:
1. Hoist at Biotower Pump Station.

C. Handling and storage:
1. Prevent damage to salvaged materials during removal, handling, and transportation of salvaged materials.
2. Prepare salvaged materials for storage.
3. Store salvaged materials on the treatment plant site at the locations designated by the Owner.

D. Pay costs associated with salvaging materials, including handling, transporting, and storage.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to beginning selective demolition operations, perform a thorough inspection of the facility and site, and report to the Engineer defects and structural damage to or deterioration of existing construction to remain.

B. Examine areas affected by the Work and verify the following conditions prior to commencing demolition:
   1. Disconnection of utilities as required.
   2. That utilities serving occupied or active portions of surrounding facilities will not be disturbed, except as otherwise indicated.

C. If unsatisfactory conditions exist, notify the Engineer, and do not begin demolition operations until such conditions have been corrected.

3.02 PREPARATION

A. Selective Demolition Plan:
   1. Prepare and submit a comprehensive selective demolition plan for the Work. Describe, at a minimum, the following elements:
      a. Proposed sequence, methods, temporary support, and equipment for demolition, removal, and disposal of portions of structure(s).
      b. Provisions and procedures for salvage and delivery to Owner of salvaged items, if required.
      c. Detailed drawings showing proposed weatherproof closures and dustproof partitions.
   2. Plan shall be signed and sealed by a Professional Structural Engineer registered in the state where Project is located.
   3. Submit plan a minimum 4 weeks before demolition is scheduled to begin.

B. Protection:
   1. Erect weatherproof closures to protect the interior of facilities and elements or equipment that are not designed for exposure to the weather. Provide temporary heat, cooling, and humidity control as necessary to prevent damage to existing and new construction. Maintain existing exiting paths and/or provide new paths in compliance with Building Code requirements.
   2. Erect and maintain dustproof partitions as required to prevent spread of dust, to other parts of building. Maintain negative pressure in the area where the Work is being performed to prevent the accidental spread of dust and to minimize the spread of fumes related to the Work.
   3. Upon completion of Work, remove weatherproof closures and dustproof partitions, and repair damaged surfaces to match adjacent surfaces.
   4. Provide and maintain protective devices to prevent injury from falling objects.
   5. Locate guardrails in stairwells and around open shafts to protect workers. Post clearly visible warning signs.
   6. Cause as little inconvenience to adjacent building areas as possible.
   7. Protect landscaping, benchmarks and existing construction to remain from damage or displacement.
   8. Carefully remove designated materials and equipment to be salvaged by Owner or reinstalled.
   9. Store and protect materials and equipment to be reinstalled.

C. Layout:
   1. The limits of selective demolition are indicated on the Drawings. Confine demolition operations within the limits indicated on the Drawings.
   2. Lay out demolition and removal work at the site and coordinate with related Work for which demolition and removal is required. Clearly mark the extent of structural elements to be removed on the actual surfaces that will be removed.

3. Arrange for Engineer's inspection of the lay out extents.
4. Do not begin demolition/removal operations until the lay out markings have been reviewed by the Engineer.

3.03 DEMOLITION

A. General:
   1. Perform demolition work in accordance with ANSI A10.6.
   2. Demolish designated portions of structures and appurtenances in orderly and careful manner in accordance with the Selective Demolition Plan.
   3. Conduct demolition and removal work in a manner that will minimize dust and flying particles:
      a. Use water or dust palliative when necessary to prevent airborne dust.
      b. Provide and maintain hoses and connections to water main or hydrant.
   4. Demolish concrete and masonry in small sections. Perform demolition with small tools as much as possible. Blasting with explosive charges is not permitted.
   5. Sawcut concrete to establish the edges of demolition, wherever possible:
      a. Do not use a concrete breaker within 6 inches of reinforcing or structural metals that are designated to remain.
      b. At edges that are not sawcut, remove the final 6 inches of material with a chipping hammer as defined herein. At surfaces where material is removed with a chipping hammer, follow with a heavy abrasive blast to remove all loose material and microcracking.
      c. Alternate techniques to remove concrete may be used if acceptable to the Engineer; however, techniques other than those deemed by ICRI Guideline No. 310.2R to provide a low risk of introducing microcracking will require a subsequent procedure to remove loose material.
      d. Provide final surface preparation for repairs as specified in Division 03 sections.
   6. At locations indicated on the Drawings that the existing reinforcing is to be preserved, remove concrete using methods that do not damage the reinforcing. Use one of the following techniques:
      a. Hydrodemolition techniques as outlined in ICRI Guideline No. 310.3R.
      b. Chipping hammer, as defined herein, followed by heavy abrasive blast to remove all loose material and microcracking at remaining surfaces impacted by the chipping hammer.
      c. Alternate methods may be used, only if acceptable to the Engineer.
      d. For all methods, provide a small completed area for Engineer's review and acceptance. If the proposed method, in the opinion of the Engineer, damages the reinforcing, revise the removal method to remove the concrete with a less aggressive technique to protect the reinforcing.
   7. Remove materials carefully, to the extent indicated and as required:
      a. Provide neat and orderly junctions between existing and new materials.
      b. Use methods that terminate surfaces in straight lines at natural points of division.
   8. Do not remove anything beyond the limits of Work indicated without prior written authorization of the Engineer. If in doubt about whether to remove an item, obtain written authorization of the Engineer prior to proceeding.
   9. Perform work so as to provide the least interference and most protection to existing facilities to remain.

10. Assume possession of demolished materials, unless otherwise indicated on the Drawings or specified:
    a. Remove demolished materials from site at least weekly and dispose of in accordance with Laws and Regulations.
    b. Do not burn materials on site.

B. Sizing of openings in existing concrete or masonry:
    1. Make openings large enough to permit final alignment of pipe and fittings without deflections, but without oversizing.
    2. Allow adequate space for packing around pipes and conduit to ensure watertightness.
    3. If the Engineer deems the opening to be insufficient in size to accomplish this criteria, remove additional material using the procedures outlined in this Section.

C. Cutting openings in existing concrete or masonry:
    1. Do not allow saw cuts to extend beyond limits of openings.
    2. Create openings by the following method or other means acceptable to the Engineer that prevents over-cutting of member at corners:
        a. Core-drill through slab or wall at corners, being careful not to damage materials beyond the area to be removed.
        b. Saw cut completely through the member, between the core holes at the corners.
        c. As an alternate to sawcutting through the member, score the edges of the opening with a saw to a 1-inch depth on both surfaces (when accessible):
            1) Remove concrete or masonry to within 6 inches of material to remain with a concrete breaker.
            2) Remove the remaining material with a chipping hammer.
        d. Remove the remaining material at the corners left by the core-drilling with a chipping hammer.
    3. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.

D. Pump out buried tanks and remove tanks and service piping from site.

E. Immediately upon discovery, remove and dispose of contaminated, vermin-infested, or dangerous materials using safe means that will not endanger health of workers and public.

F. Remove trees and shrubs within marked areas; clear undergrowth and dead plant material as specified in Section 02300.

G. Backfill open pits and holes caused by demolition as specified in Section 02300.

H. Rough grade areas affected by demolition.

I. Remove demolished materials, tools, and equipment upon completion of demolition.

3.04 RESTORATION

A. General:
   1. Repair damage caused by demolition to a conditions equal to those that existing prior to beginning of demolition:
      a. Patch and replace portions of existing finished surfaces that are damaged, lifted, and discolored with matching material. Refinish patched portion surfaces in a manner which produces uniform color and texture to entire surface.
      b. When existing finish cannot be matched, refinish entire surface to nearest change of plane where angle of change exceeds 45 degrees.
   2. The cost of repairs shall be at the Contractor's expense at no increase in the Contract Price.
   3. When new construction abuts or finishes flush with existing construction, make smooth transitions. Match finish of existing construction.
   4. Where partitions are removed, patch floors, walls, and ceilings with finish materials that match existing materials.
   5. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth planes without breaks, steps, or bulkheads.
   6. Where changes of plane exceed 2 inches, request instructions for making transition.
   7. Trim and refinish existing doors as necessary to clear new floors.
   8. Match patched construction with adjacent construction in texture and appearance so that patch or transition is invisible at 5-foot distance.
   9. When finished surfaces are cut so that smooth transition is impossible, terminate existing surface in neat manner along straight line at natural line of division and provide appropriate trim.

B. Restore existing concrete reinforcement as follows:
   1. Where existing reinforcement is to be incorporated into the new Work, protect, clean, and extend into new concrete.
   2. Where existing reinforcement is not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

C. Restore areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, and conduits such that little or no evidence of the previous installation remains:
   1. Fill areas in existing floors, walls, and ceilings from removed piping, conduit, and fasteners with non-shrink grout and finish smooth.
   2. Remove concrete bases for equipment and supports by:
      a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface:
         1) Do not cut existing reinforcement on floors.
      b. Chip concrete within scored lines and cut exposed reinforcing steel and anchor bolts.
      c. Patch with non-shrink grout to match adjacent grade and finish.
   3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.

3.05 FIELD QUALITY CONTROL

A. Do not proceed with demolition without Engineer's inspection of lay out.

B. Do not deviate from the submitted demolition plan without notifying the Engineer prior to Work.

END OF SECTION

SECTION 01756

COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for each Commissioning phase of, the Project equipment/system and/or facility.

B. Related sections:
1. Section 01140 - Work Restrictions.
2. Section 01782 - Operation and Maintenance Data.
3. Section 09960 - High-Performance Coatings.
4. Section 15050 - Common Work Results for Mechanical Equipment.
5. Section 15954 - HVAC Systems Testing, Adjusting, and Balancing.
6. Section 15956 - Piping Systems Testing.
7. Section 15958 - Mechanical Equipment Testing.
8. Section 16305 - Electrical System Studies.
9. Section 16950 - Field Electrical Acceptance Tests.
10. Section 17950 - Testing, Calibration, and Commissioning.

1.02 DEFINITIONS

A. Clean Water Facility Testing – Testing of complete facility utilizing clean water for purposes of confirming extended equipment/system operation prior to Process Start-up Phase.

B. Commissioning – The process of planning, testing, and process start-up of the installation for compliance with contract requirements and demonstrating, through documented verification, that the project has successfully met the Contractual requirements. It includes training the Owner's staff to operate the facility.

C. Commissioning Phases – The work activities of facility commissioning are grouped into the phases defined in the table below:

Commissioning		
Planning Phase	**Testing and Training Phase**	**Process Start-Up Phase**
Owner Training Plan and Schedule	Source Testing	Process Start-up
Commissioning Schedule	Owner Training	Process Operational Period
Subsystem Testing Plan	Installation Testing	Instrumentation and Controls Fine-Tuning
Clean Water Facility	Functional	

Commissioning		
Planning Phase	**Testing and Training Phase**	**Process Start-Up Phase**
Testing Plan	Testing	
	Clean Water Facility Testing	
	Closeout Documentation	

D. Component – A basic building block of equipment, subsystems, and systems that requires installation or functional testing but does not have an electrical connection or internal electronics. (Examples: filter effluent piping and manual isolation valves).

E. Device – A basic building block of equipment, subsystems, and systems that requires installation or functional testing and does have an electrical connection or internal electronics. (Examples: filter level transmitter or water pump pressure transmitter).

F. Equipment – An assembly of component(s) and devices(s) that requires installation or functional testing. (Examples: Pump, motor, VFD, Ozone Generator, UV Disinfection System, etc.).

G. Facility – A grouping of process areas, systems, subsystems, equipment, components, and devices (Examples: treatment plant, pump station, etc.).

H. Functional Testing – Testing performed on a completed subsystem to demonstrate that equipment/system meets manufacturers' calibration and adjustment requirements and other requirements as specified. Functional testing includes operating equipment/system manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).

I. Installation Testing – Testing to demonstrate that subsystem component (piping, power, networks, devices, etc.) is ready and meets the project requirements in advance of functional testing. Installation testing also includes manufacturers' certification of installation and other requirements as specified to prepare equipment/system for Functional Testing. Also referred to as Field Acceptance Testing.

J. Instrumentation and Controls Fine-Tuning – Improving the performance of the Instrumentation Process Control system by operating for an extended time period.

K. Manufacturer's Certificate of Source Testing – When applicable, the form is used during Source Testing for the manufacturer to confirm that the applicable source tests have been performed and results conform to the Contract Documents. The form is provided at the end of this Section.

L. Manufacturer's Certificate of Installation and Functionality Compliance – The form is used during Installation Testing and Functional Testing. It is submitted at the end of Functional Testing to confirm that the equipment/system is installed in conformance

with the Contract Documents and that it meets the Functional Testing requirements defined in the Contract Documents. The form is provided at the end of this Section.

M. Process Area – A grouping of systems, subsystems, equipment, components, and devices that divide a facility into functional areas. (Examples: Filter Process Area or Chemical Area).

N. Process Operational Period – A period of time after completion of the process start-up set aside for final Operational Testing to verify facility performance meets the Contract Document requirements. This period may specifically limit other construction activities.

O. Process Start-up Phase – Operating the facility to verify performance meets the Contract Document requirements.

P. Process Start-Up – Activities conducted after the testing and training phase that are necessary to place systems or process areas into operational service.

Q. Product – A system, subsystem or component.

R. Subsystem – A building block of systems made up from a grouping of components, devices, and equipment that perform a definable function. (Examples: Filter No. 1 Backwash Subsystem, Sedimentation Basin No. 1 Hoseless Sludge Removal Subsystem).

S. System – A grouping of subsystems, equipment, components, and devices that perform a definable function. (Examples: Filter No. 1, Sedimentation Basin).

1.03 COMMISSIONING COORDINATOR (CC)

A. Designate and provide a CC for this project.

B. Submit summary of the CC's qualifications within 30 days of NTP:
   1. Include description of previous experience as a CC on similar projects for the designated CC with a list of references including phone numbers for review and Owner approval.

C. CC responsibilities include the following:
   1. Lead efforts relating to Commissioning.
   2. Be thoroughly familiar with commissioning requirements in the Contract Documents.
   3. Be regularly engaged and experienced in all aspects of commissioning.
   4. Provide technical instruction for commissioning.
   5. Provide primary interface with Engineer and Owner for efforts relating to Commissioning of Project facilities.
   6. Coordinate training efforts.

D. CC on-site:
   1. Testing and Training Phase: Full-time.
   2. Process Start-up Phase: Full-time.

E. Designate and provide CC assistants, as needed.

1.04 SERVICES OF MANUFACTURER'S REPRESENTATIVES

A. Qualification of manufacturer's representative as specified in the Contract Documents technical Sections include the following:
   1. Authorized representative of the manufacturer, factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment/system with full authority by the equipment/system manufacturer to issue the certifications required of the manufacturer.
   2. Competent, experienced technical representatives of equipment/system manufacturer for assembly, installation, testing guidance, and training.
   3. Additional qualifications may be specified in the individual Sections.
   4. Submit qualifications of the manufacturer's representative no later than 30 days in advance of required observations.
   5. Representative subject to approval by Owner and Engineer.
   6. No substitute representatives will be allowed until written approval by Owner and Engineer has been obtained.

B. Completion of manufacturer on-site services: Engineer approval required.

C. Manufacturer is responsible for determining the time required to perform the specified services:
   1. Minimum times specified in the Contract Documents are estimates.
   2. No additional costs associated with performing the required services will be approved.
   3. Manufacturer required to schedule services in accordance with the Contractor's project schedule up to and including making multiple trips to project site when there are separate milestones associated with installation of each occurrence of manufacturer's equipment.

D. Manufacturer's on-site services as specified in the Contract Documents include the following:
   1. Assistance during Commissioning Phase and Process Start-Up Phase.
   2. Provide daily copies of manufacturer's representatives' field notes and data to Engineer.
   3. Other requirements as specified in the Contract Documents.

1.05 PLANNING PHASE

A. Overview of Planning Phase:
   1. Define approach and timing for Commissioning.

B. Owner training plan and schedule:
   1. Training outcomes:
      a. Owner's operations, maintenance, and engineering staff have the information needed to safely operate, maintain, and repair the equipment/systems provided under this Contract.
   2. Training objectives:
      a. To instruct personnel in the operation and maintenance of the equipment/system. Instruction shall include step-by-step troubleshooting procedures with all necessary test equipment/system.

b. To instruct personnel in the removal, inspection, and cleaning of equipment/system as needed.
c. Training tailored to the skills and job classifications of the staff attending the classes (e.g., plant superintendent, treatment plant operator, maintenance technician, electrician, etc.).
d. Provide supporting documentation, such as vendor operation and maintenance manuals.

3. Training schedule:
   a. Schedule Owner's staff training within the constraints of their workloads. Those who will participate in this training have existing full-time work assignments, and training is an additional assigned work task, therefore, scheduling is imperative. Owner staff work schedules regularly shift, as treatment facilities are typically operated on an around-the-clock basis.
4. Training plan:
   a. Coordinate and arrange for manufacturer's representatives to provide both classroom-based learning and field (hands-on) training, based on training module content and stated learning objectives.
   b. Conduct classroom training at location designated by Owner.
   c. Scope and sequence:
      1) Plan and schedule training in the correct sequence to provide prerequisite knowledge and skills to trainees:
         a) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
5. Training scheduling coordination:
   a. CC is responsible for the following:
      1) Coordinate schedule for training periods with the Owner's personnel and manufacturer's representatives (instructors).
   b. Complete Owner training no sooner than 15 calendar days prior to start of process start-up of each system.
6. Meetings:
   a. CC is responsible for setting commissioning coordination meeting dates and times, as well as preparing the agendas and meeting minutes.
   b. CC shall meet with Engineer and Owner's designated training coordinator to develop list of personnel to be trained and to establish expected training outcomes and objectives at least 60 calendar days prior to commissioning of equipment/system.
   c. CC shall conduct commissioning progress meetings throughout construction, to plan, scope, coordinate, and schedule future activities, resolve problems, etc.:
      1) Frequency: Monthly minimum. Increase frequency as needed based on complexity and quantity of commissioning activities.
7. Submittals:
   a. Submit Training Plan Schedule 60 calendar days before the first scheduled training session, including but not limited to lesson plans, participant materials, instructor's resumes, and training delivery schedules.
   b. Submit training documentation including the following:
      1) Training plan:
         a) Training modules.
         b) Scope and sequence statement.

c) Contact information for manufacturer's instructors including name, phone, and e-mail address.
d) Instructor qualifications.

2) Training program schedule:
a) Format: Bar chart:
(1) Additionally include in the Project Progress Schedule.
b) Contents:
(1) Training modules and classes.

8. Training sessions:
a. Provide training sessions for equipment/system as specified in the individual equipment/system Section.

C. Commissioning Schedule:
1. Commissioning overview:
a. Comply with Commissioning Roles and Responsibilities Matrix specified at the end of this Section.
2. Submittal due date:
a. Submit Commissioning Schedule not less than 60 calendar days prior to planned initial commissioning of each subsystem or system.
3. Schedule requirements:
a. Schedule durations and float for commissioning activities to ensure Work does not fall behind schedule due to complications or delays during commissioning.
b. Time-scaled network diagram detailing the work to take place in the period between 90 calendar days prior to planned initial commissioning of equipment and systems, and the date of Substantial Completion, together with supporting narrative.
c. Provide detailed schedule of commissioning activities including durations and sequencing requirements:
1) Identify the following activities:
a) Testing and Training Phase:
(1) Source Testing.
(2) Owner Training.
(3) Installation Testing.
(4) Functional Testing.
(5) Clean Water Facility Testing.
(6) Closeout Documentation.
b) Process Start-Up Phase:
(1) Process Start-Up.
(2) Process Operational Period.
(3) Instrumentation and Controls Fine-Tuning.
d. Schedule manufacturer's services to avoid conflict with other on-site testing or other manufacturers' on-site services.
e. Verify that conditions necessary to allow successful testing have been met before scheduling services.

D. Subsystem testing plans:
1. Provide separate testing plans for each individual subsystem and system that include the following:
a. Approach to testing including procedures, schedule, and recirculation requirements.

b. Test objective: Demonstrate subsystem meets the design requirements as specified in the technical Sections.
c. Test descriptions, forms, temporary systems (pumps, piping, etc.), shutdown requirements for existing systems, test forms, test logs, witness forms, and checklists to be used to control and document the required tests.
d. Test forms: Include, but not limited to, the following information:
    1) Tag and name of equipment/system to be tested.
    2) Test date.
    3) Names of persons conducting the test.
    4) Names of persons witnessing the test, where applicable.
    5) Test data.
    6) Applicable project requirements.
    7) Check offs for each completed test or test step.
    8) Place for signature of person conducting tests and for the witnessing person, as applicable.
e. Define start-up sequencing of unit processes:
    1) Include testing of alarms, interlocks, permissives, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
    2) Provide detailed test procedures setting forth step-by-step descriptions of the procedures for systematic testing of equipment/system.
    3) Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration:
        a) Perform initial checks in the presence of and with the assistance of the manufacturer's representative.
    4) Demonstrate proper operation of each control loop function including mechanical, electrical, alarms, local and remote controls, instrumentation, and other equipment/system functions:
        a) Generate signals with test equipment/system to simulate operating conditions in each control mode.

2. Engineer approval of test plan is required prior to performing test:
    a. Revise and update test plans based on review comments, actual progress, or to accommodate changes in the sequence of activities.
    b. Submit test reports for each phase of testing for each equipment/system.
    c. Engineer approval of preceding test reports is required prior to start of next test.
    d. Tests will be rescheduled if test plan is not approved by the required deadline:
        1) Contractor is responsible for any resulting delay.
3. Contractor is responsible to reproduce and distribute final test procedures:
    a. Provide 3 copies for Engineer.
4. Tests may commence only after Engineer has received approved test plan copies.
5. Submittals:
    a. Submit test plans not less than 60 calendar days prior to planned installation testing of subsystem or system.
    b. Completed Manufacturer's Certificate of Installation and Functionality Compliance.

c. Test procedures and forms: Provide signed-off copy of test forms and test reports upon completion of the test.
d. Test reports:
1) Submit preliminary copies within 1 day after testing completion.
2) Submit final copies and report within 14 days after testing completion.

E. Clean Water Facility Testing Plan:
1. Submit a Clean Water Facility Testing Plan equivalent to the requirements of the subsystem test plans a minimum of 60 calendar days prior to Clean Water Facility Testing.

1.06 TESTING AND TRAINING PHASE

A. Overview of Testing And Training Phase:
1. General:
a. Include specified Source Testing, Owner Training, Installation Testing, Functional Testing, Clean Water Facility Testing, and Closeout Documentation required by this Section and the technical Sections.
2. Contractor responsibilities:
a. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing commissioning activities in accordance with the approved Commissioning Plans.
b. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.
c. Acceptable tests: Demonstrate the equipment/system performance meets the requirements stated in the Contract Documents:
1) When the equipment/system fails to meet the specified requirements, perform additional, more detailed, testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.

B. Source Testing:
1. Also referred to as factory testing or factory acceptance testing (FAT).
2. Test components, devices, and equipment/system for proper performance at point of manufacture or assembly as specified in the technical Sections.
3. Notify the Engineer in writing when the equipment/system is ready for source inspection and testing.
4. Source Test Plan:
a. As specified in this Section and other technical Sections.
b. Source Testing requirements as specified in technical Sections:
1) Non-witnessed: Provide Manufacturer’s Certificate of Source Testing.
2) Witnessed: 1 Owner's representative and 1 Engineer’s representative present during testing, unless otherwise specified, and provide Manufacturer’s Certificate of Source Testing.
c. Prepared by Contractor as a result of discussions and planning emerging from regularly conducted commissioning meetings for source tests as specified in the Contract Documents.
d. Provide the following items for each Source Test:
1) Purpose and goals of the test.
2) Identification of each item of equipment/system, including system designation, location, tag number, control loop identifier, etc.

3) Description of the pass/fail criteria that will be used.
4) Listing of pertinent reference documents (Contract Documents and industry standards or Sections applicable to the testing).
5) Complete description, including drawings or photographs, of test stands and/or test apparatus.
6) Credentials of test personnel.
7) Descriptions of test equipment to be used, product information, and all appropriate calibration records for the test equipment.
8) Test set-up procedures.
9) Detailed step-by-step test procedures:
    a) The level of detail shall be sufficient for any witness with a rudimentary technical aptitude to be able to follow the steps and develop confidence that the tests were being performed as planned.
    b) All steps are significant, and all steps shall be included in the procedures.
10) Sample data logs and data recording forms.
11) Sample computations or analyses with the results in the same format as the final report to demonstrate how data collected will be used to generate final results:
    a) Complete disclosure of the calculation methodologies.
    b) Include a sample for each type of computation required for the test and analysis of the results.
12) Detailed outline of the Source Test report.
13) Sample test reports.

e. Submit Source Test Plan and forms as specified in the technical Sections:
    1) Submit a copy of the Source Test Plan at least 21 days before any scheduled test date.
    2) Engineer approval of Source Test Plan required prior to beginning source testing.
    3) Schedule the testing after approval of the test procedures submittal.
f. Indicate the desired dates for source inspection and testing:
    1) Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.

5. Test results:
    a. Prepare and submit test results with collected data attached.
6. Contractor is responsible for costs associated with Owner's representatives and Engineer’s representative witnessing Source Tests:
    a. Include costs for at least the following:
        1) Transportation costs:
            a) Travel 1 day on commercial airline to site including air flight costs.
            b) Travel 1 day on commercial airline from site including air flight costs.
            c) Mid-size rental car or taxi services from hotel to and from the test site plus fuel, tolls, and airport parking at the departing airport.
            d) International travel: Per diem rates as established by the US Department of State for the specific location and dates of travel. Travel expenses may include the direct cost of securing passports, visas, language interpreters, document translators, communications and internet access.

2) Hotel costs at a facility with an American Automobile Association 3 diamond rating or better for single occupancy room per person per day.
3) Meal allowance of $61 per person per day.
4) Only actual costs will be documented and billed.

b. If Source Test is not ready when the witnesses arrive or if the Source Test fails, the witnesses will return home with Contractor responsible for costs associated with the trip including costs described above. Contractor is responsible for rescheduling the Source Test and witnesses' costs associated with the second trip including costs described above.

c. Fees incurred such as airline reservation change fees, loss of fare due to purchase of nonrefundable tickets, hotel cancellation/rebooking fees, and similar expenses incurred as a result of OSS-requested changes to the inspection schedule after the initial notification shall be borne by the Contractor.

d. Contractor is responsible for witnesses' costs associated with retests including costs described above.

7. Contractor is responsible for providing fuel, chemicals, and other consumables needed for Source Testing.

C. Owner training:

1. Training instruction format:
   a. The training for operations and maintenance personnel shall be provided as one entity.
   b. Instructors shall apply adult education best practices, emphasizing learner participation and activity.
   c. Training delivery may include problem solving, question/answer, hands-on instruction, practice, evaluation/feedback tools, and lecture.
   d. Visual aids and hands-on practice sessions must support training objectives.
   e. Lecturing should be less than 30 percent of class time.
   f. Conduct hands-on instruction according to the following descriptions:
      1) Present hands-on demonstrations of at least the following tasks:
         a) Proper start-up, shutdown, and normal and alternative operating strategies.
         b) Common corrective maintenance repairs for each group.
         c) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.
      2) Use tools and equipment provided by manufacturer to conduct the demonstrations:
         a) Submit requests for supplemental assistance and facilities with the Contractor's proposed lesson plans.
      3) Contractor remains responsible for equipment disassembly or assembly during hands-on training situations involving equipment disassembly or assembly by Owner's personnel:
         a) Provide written certification of proper equipment/system operation to Engineer after completion of hands-on training.
2. Class agenda:
   a. Include the following information in the agenda:
      1) Instructor name.
      2) Listing of subjects to be discussed.

3) Time estimated for each subject.
4) Allocation of time for Owner staff to ask questions and discuss the subject matter.
5) List of documentation to be used or provided to support training.

b. Owner may request that particular subjects be emphasized and the agenda be adjusted to accommodate these requests.
c. Distribute copies of the agenda to each student at the beginning of each training class.

3. Number of students:
   a. Estimated maximum class size: 10 persons:
      1) Owner will determine the actual number of students.
      2) Engineer will provide an estimated headcount 1 week prior to the class, so that the instructor can provide the correct number of training aids for students.
4. Instructor qualifications:
   a. Provide instructors completely knowledgeable in the equipment/system for which they are training.
   b. Provide instructors experienced in conducting classes.
   c. Provide instructor's technical preparation and instructional technology skills and experience.
   d. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.
   e. If, in the opinion of the Owner, an appropriately knowledgeable person did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor.
5. Training aids:
   a. Instructors are encouraged to use audio-visual devices, P&IDs, models, charts, and so forth to increase the transfer of knowledge.
   b. Instructors shall provide such equipment (televisions, video recorder/player, computer, projectors, screens, easels, etc.), models, charts, and so forth for each class.
   c. Instructor is responsible for confirming with Engineer and Owner in advance of each class that the classroom will be appropriate for the types of audiovisual equipment to be employed.
6. Classroom documentation:
   a. Trainees will keep training materials and documentation after the session.
   b. Operations and maintenance manuals, as specified in technical Sections:
      1) Provide a minimum of 2 copies of final Engineer-approved operations and maintenance manuals as specified in Section 01782 for use during the classroom instruction.
      2) Owner reserves the right to delay training for a particular equipment item if the operations and maintenance manuals for that equipment are incomplete, inaccurate, or otherwise unsuitable for use by the Owner's staff.
      3) No contract extensions or extra costs will be allowed for training delays due to operations and maintenance manual submittal delays.
   c. Provide supplemental documentation handouts to support instruction.
   d. Digitally record audio and video of each training class:
      1) Include classroom and field instruction with question and answering periods.

2) Engineer approval required for producer of video materials from one of the following options:
    a) Qualified, professional video production company.
    b) Contractor demonstrates satisfactory skill.
3) Record in digital format and recording shall become property of the Owner:
    a) Provide audio quality that is not degraded during the recording of the field sessions due to background noise, space, distance or other factors.
4) Video files shall be file format and delivery medium as directed and approved by Owner.
5) Provide 2 complete sets of video materials fully indexed and cataloged with printed labels stating session content and dates recorded.
6) The Contractor shall provide a written release from all claims to the recorded training material produced, if required.

e. Training modules:
1) Provide a training module for each equipment category.
2) Divide each training module's instructional content into discrete lesson plans.

f. Lesson plans:
1) Provide performance-based learning objectives.
2) State learning objectives in terms of what the trainees will be able to do at the end of the lesson.
3) Define student conditions of performance and criteria for evaluating instructional success:
    a) Provide the following information:
4) Instruction lesson plan outlines for each craft.
    a) Provide specific components and procedures.
5) Minimum requirements:
    a) Hands-on demonstrations planned for the instructions.
    b) Cross-reference training aids.
    c) Planned training strategies such as whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies.
    d) Attach handouts cross-referenced by section or topic in the lesson plan.
    e) Indicate duration of outlined training segments.
6) Provide maintenance instruction lesson plans including mechanical, instrumentation, and electrical aspects:
    a) Equipment operation:
        (1) Describe equipment's operating (process) function and system theory.
        (2) Describe equipment's fundamental operating principles and dynamics.
        (3) Identify equipment's mechanical, electrical, and electronic components and features.
        (4) Identify support equipment associated with the operation of subject equipment.
        (5) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process.

(6) Cite hazards associated with the operations, exposure to chemicals associated with the component, or the waste stream handled by the component.
(7) Specify appropriate safety precautions, equipment, and procedures to eliminate, reduce, or overcome hazards.

b) Detailed component description:
(1) Define Preventative Maintenance (PM) inspection procedures required on equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance):
(a) Review preventive maintenance frequency and task analysis table.
(2) Identify each component function and describe in detail.
(3) Where applicable, group relative components into subsystems.
(4) Identify and describe in detail equipment safety features, permissive and controls interlocks.

7) Provide the following information in equipment troubleshooting lesson plans:
a) Define recommended systematic troubleshooting procedures as they relate to specific craft problems.
b) Provide component specific troubleshooting checklists as they relate to specific craft problems.

8) Provide the following information in equipment Corrective Maintenance (CM) troubleshooting lesson:
a) Describe recommended equipment preparation requirements as they relate to specific craft problems.
b) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.
c) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.
d) Perform at least 2 hands-on demonstrations of common corrective maintenance repairs:
(1) Additional demonstrations may be required by the Owner.
e) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

7. Class logistics:
a. Delivery time minimum: 2 hours.
b. Delivery time maximum: 4 hours:
1) Longer time requires Engineer approval.
c. Class agenda:
1) Refreshment break: One 10-minute break:
a) Provide refreshments such as coffee, tea, juice, cold soft drinks, a selection of bakery items, and fresh fruit.
2) Meal break: One 45-minute break, unless otherwise specified.
3) Schedule refreshment breaks and meal breaks to meet the class needs and Owner work rules.

d. Schedule specific sessions:
    1) Minimum of 30 days in advance to allow Owner staffing arrangements to take place.
    2) At the times indicated below unless otherwise requested by the Owner:
        a) Times scheduled will be at Owner's discretion.
        b) Training sessions shall be scheduled for Wednesdays at 7:30 am and repeated at 2:00 pm.
    3) Owner approval and confirmation required for session schedules.
    4) Provide minimum of 2 sessions for each class unless otherwise noted:
        a) The purpose of having multiple sessions on each class is to accommodate the attendance of as many Owner personnel working different shifts as possible.
        b) There are 3 work shifts. Shift 1 is from 10:00 pm to 8:00 am; Shift 2 is from 6:00 am to 4:00 pm and Shift 3 is from 2:00 pm to 12:00 am.

8. Distribute Training Evaluation Form following each training session:
    a. Training Evaluation Form is included in this Section.
    b. Return completed Training Evaluation Forms to Owner's designated training coordinator immediately after session is completed.
    c. Revise training sessions judged "Unsatisfactory" by a majority of attendees:
        1) Conduct training sessions again until a satisfactory rating is achieved at no additional cost to Owner. The Contractor shall be responsible for all costs associated with repeated training sessions including costs for trainee time.
9. Submittals:
    a. Prior to the training session:
        1) Instructor qualifications: 30 calendar days prior to initial training session.
        2) Training course materials: 14 calendar days prior to initial training session:
            a) Training agenda, lesson plan, presentation, and handouts.
            b) Other audio-visual aids utilized during each training course.
            c) Format: 2 electronic copies and 3 hard copies organized in notebooks.
    b. Post training session:
        1) Training course materials: Due 14 calendar days after class completion:
            a) Video recordings.
            b) Class attendance sheet.
            c) Training agenda, final lesson plan, presentation, and handouts.
            d) Other audio-visual aids utilized during each training course.
            e) Provide materials for all sessions of the class in a single transmittal.
            f) Format: 2 electronic copies and 3 hard copies organized in notebooks.

D. Installation Testing:
   1. Perform subsystem testing according to approved Subsystem Testing Plans.
   2. Initiate the Manufacturer's Certificate of Installation and Functionality Compliance for all equipment:
      a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
      b. Manufacturer's Certificate of Installation and Functionality Compliance certifies the equipment meets the following requirements:
         1) Has been properly installed, adjusted, aligned, and lubricated.
         2) Is free of any stresses imposed by connecting piping or anchor bolts.
         3) Is able to be operated as necessary for Functional Testing.
      c. Form shall be submitted after completion of Functional Testing, as specified in this Section.
   3. Coordinate Installation Testing with restrictions and requirements as specified in Section 01140.
   4. Perform coating holiday testing as specified in Section 09960.
   5. Perform pressure and leakage testing as specified in individual component Sections and Section 15956.
   6. Perform mechanical equipment Installation Testing: As specified below and in individual equipment Sections, such as Sections 15050, 15954, and 15958:
      a. Remove rust preventatives and oils applied to protect equipment during construction.
      b. Flush lubrication systems and dispose of flushing oils:
         1) Recharge lubrication system with lubricant recommended by manufacturer.
      c. Flush fuel system and provide fuel for testing and start-up.
      d. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
      e. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
      f. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
      g. Perform cold alignment and hot alignment to manufacturer's tolerances.
      h. Adjust V-belt tension and variable pitch sheaves.
      i. Inspect hand and motorized valves for proper adjustment:
         1) Tighten packing glands to ensure no leakage, but permit valve stems to rotate without galling.
         2) Verify valve seats are positioned for proper flow direction.
      j. Tighten leaking flanges or replace flange gasket:
         1) Inspect screwed joints for leakage.
      k. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.
   7. Electrical devices and subsystems Installation Testing: As specified in Section 16950, and the technical Sections.
   8. Instrumentation devices and subsystems Installation Testing: As specified in Section 17950, and technical Sections.
   9. Heating, ventilating, and air conditioning systems Installation Testing: As specified below, in Section 15954, and technical Sections:
      a. Perform testing of heating, ventilating, and air conditioning equipment, balancing of distribution systems, and adjusting of ductwork accessories.
      b. Test hydronic systems, if required by technical Sections.

E. Functional Testing:
   1. Perform subsystem testing according to approved Subsystem Testing Plan.
   2. Notify the Engineer 5 days prior to when the Work is ready for Functional Testing:
      a. Perform testing in the presence of the Engineer.
   3. Determine Functional Testing durations with Owner's input:
      a. Durations will vary depending on the availability of water for testing.
      b. Target minimum Functional Test duration: 8 hours:
         1) Identify equipment/system that cannot be tested for a minimum of 8 hours as specified in technical Sections.
   4. Perform Functional Testing as specified in technical Sections:
      a. Perform Functional Testing in addition to the other tests specified in the technical Sections.
      b. Perform Functional Testing to demonstrate that the component equipment functions as an entire system in accordance with the design requirements.
      c. Perform Functional Testing to demonstrate that the unit process has operated in a manner necessary to demonstrate equipment/system functions manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).
      d. Perform testing with Contractor-provided water.
      e. Repair or replace parts that operate improperly and retest.
      f. Submit testing results as specified in the technical Sections to the Owner and Engineer for approval of Functional Testing results.
   5. Provide completed Manufacturer's Certificate of Installation and Functionality Compliance forms for all equipment:
      a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
      b. Manufacturer's Certificate of Installation and Functionality Compliance certifies the equipment/system meets the following requirements:
         1) Is suitable for satisfactory full-time operation under full-load conditions.
         2) Operates within the allowable limits for vibration and noise.
         3) Electrical and instrumentation requirements:
            a) Electrical equipment, instrumentation, and control panels are properly installed, calibrated, and functioning.
            b) Electrical Installation Testing is complete, and test results have been approved by the Engineer:
               (1) Noted deficiencies have been corrected.
               (2) Relays, circuit breakers, and other protective devices are set.
            c) Control logic for start-up, shutdown, sequencing, interlocks, control, and emergency shutdown has been tested and is properly functioning.
            d) Motor control is calibrated and tested.

F. Clean Water Facility Testing:
   1. Utilize plant utility (2W) water.
   2. Do not begin Clean Water Facility Testing until Engineer has approved submittals for Functional Testing requirements.
   3. Test all facilities with recirculating water supply at the design flow for the largest single process or system train to ensure proper complete facility (equipment/system) hydraulic performance.

4. Perform testing in the presence of the Engineer unless such presence is expressly waived in writing.
5. Provide necessary temporary piping and pumping equipment to complete Clean Water Facility Testing.
6. The purpose of Clean Water Facility Testing is to confirm extended equipment/system operation prior to process start-up:
    a. Testing shall occur for a minimum of 7 days with all systems operational to the extent possible.
7. Conduct a Clean Water Facility Test for the process facilities described below:
    a. Secondary Clarifier No. 5 and RAS Pump Station No. 2:
        1) Recirculate flow from RAS Pump Station No. 2 to the outlet of Mixed Liquor Flume No. 5.
        2) Provide temporary discharge piping to accommodate flow conditions specified in Section 11352.
    b. Each aeration basin:
        1) Utilize mixed liquor return pumps to recirculate flow within each basin.

G. Closeout documentation:
1. Submittals:
    a. Provide records generated during Commissioning Phase of Project:
        1) Required documents include but are not limited to:
            a) Training documentation.
            b) Manufacturer’s Certificate of Source Testing.
            c) Manufacturer’s Certificate of Installation and Functionality Compliance.
            d) Daily logs of equipment/system testing identifying tests conducted and outcome.
            e) Test forms and documentation.
            f) Functional Testing results.
            g) Logs of time spent by manufacturer's representatives performing services on the job site.
            h) Equipment lubrication records.
            i) Electrical phase, voltage, and amperage measurements.
            j) Insulation resistance measurements.
            k) Bearing temperature measurements.
        2) Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints. Format: 2 electronic copies and 3 hard copies organized in notebooks.
        3) Due date: Within 14 calendar days of Substantial Completion.

1.07 PROCESS START-UP PHASE

A. Overview of Process Start-Up Phase:
1. Operating the facility to verify performance meets the Contract Document requirements.

B. Process Start-Up:
1. Perform process start-up in the presence of the Engineer.
2. Pre-start-up activities:
    a. Commissioning Documentation and Data Review.
    b. Start-Up Go/No-Go Decision Criteria.

c. Building and Fire Inspection Compliance Check.
d. Process Start-Up Sequence Review:
    1) Submit a Process Start-Up plan for review by Engineer not less than 60 calendar days prior to planned commencement of process start-up activities.
    2) Include the following:
        a) Pre-start-up activities.
        b) Process Start-Up.
        c) Process Operational Period.
e. Description of Temporary Testing Arrangement, if applicable.
f. Final Process Start-Up Forms and Documentations.
g. Final Operational Testing Plan.

3. Control loop tuning:
    a. Perform control loop tuning during system testing with water to the extent possible.
4. Process area start-ups:
    a. Process start-up individual process areas comprised of multiple interdependent systems where possible and beneficial to reduce complexity and risk of complete facility testing.
    b. Process area test flows may be limited by upstream and downstream process constraints (i.e., tank and basin volumes) and/or localized recirculation capabilities.
5. Facility-wide process start-up:
    a. Upon approved completion of pre-start-up activities, perform process start-up for each facility:
        1) Complete control loop tuning during this phase of process start-up.
        2) Continue process start-up operations until facility meets or exceeds the Contract requirements.
    b. Process control systems testing:
        1) Test complete system instrumentation, controls and PLC, HMI, and LOI programming for the facility.
    c. HVAC systems start-up and testing:
        1) Test complete HVAC system for each facility.
    d. Ancillary systems start-up and testing:
        1) Test complete security system, phone system, fire alarm system, etc. for the facility.
    e. Remaining equipment/system tests:
        1) Conduct remaining specified equipment/system performance tests that could not be performed during the Testing and Training Phase due to inter-system and/or treatment process dependencies.

C. Process Operational Period:
1. Prior to beginning the Process Operational Period:
    a. Conformance with treatment standards is required prior to Operational Testing, if applicable:
        1) Biological processes require time to build up the necessary population of organisms to meet treatment standards, as specified in Section 01140.
    b. Correct any outstanding punchlist items prior to the Operational Testing.
2. Duration: 7 calendar days.
3. Engineer will be present for process operational period unless such presence is expressly waived in writing.

4. Prove facility conformance with Contract Document requirements.
5. Contractor to provide:
    a. Specified start-up materials and operating supplies.
    b. Necessary craft of labor assistance, in the event of an emergency equipment failure requiring immediate attention (emergency is defined as a failure of function which precludes the further operation of a critical segment of or the whole of the Work) with a response time of not more than 4 hours from the time of notification.
    c. Manufacturer's authorized representative to supervise placing equipment/systems in operation and provide guidance during Operational Testing per applicable Section.
    d. Necessary manufacturer's representatives and operating supplies for retesting systems that fail to pass the initial Operational Testing due to deficiencies in products of workmanship at no additional cost to the Owner.
    e. List of 24-hour "on-call" representative supervisory persons who will monitor the Operational Testing and serve as liaison for the Engineer and Owner.
6. Owner will provide:
    a. Operations personnel for duration of test.
7. Prior to date of Substantial Completion of Installation, the Contractor's CC shall oversee Process Operational Period:
    a. Owner staff will operate the completed Project construction.
    b. Entire system shall continuously meet performance requirements and shall operate without fault, failure, or defect for a continuous period.
    c. Individual equipment/system failures that are corrected within 24 hours and do not prevent the entire project from continuously satisfying the established operational requirements shall not require the consecutive day test to be restarted unless the failure recurs.
    d. Restart the consecutive test period for any of the following conditions:
        1) Any failure of the complete Project construction to meet operational requirements.
        2) When malfunctions or deficiencies cause shutdown or partial operation of the facility, or results in failure of the complete Project construction to meet operational requirements.
        3) Any individual equipment/system failure that meets any of the following conditions:
            a) Requires more than 24 hours to correct, unless otherwise specified in Section 17950.
            b) Recurs within the 24-hour correction period requiring further correction.
        4) Immediately correct defects in material, workmanship, or equipment/system which became evident during Operational Testing.

1.08 INSTRUMENTATION AND CONTROLS FINE-TUNING

A. After the Process Operational Period, test PCIS system for additional 60 days as specified in Section 17950 to identify issues and make corrections, as needed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

Comments: _____

_____

_____

_____

_____

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract Documents, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____, 20____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

_____
(Authorized Signature)

If applicable, Witness Name *(print)*: _____

_____
(Witness Signature)

MANUFACTURER'S CERTIFICATE OF INSTALLATION AND FUNCTIONALITY COMPLIANCE

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify that the above-referenced equipment/system has been: (Check Applicable)

- ☐ Installed in accordance with manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical/instrumentation and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functionally tested.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements.

NOTES:
Attach test results with collected data and test report.

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

_____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20 ____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

COMMISSIONING

TRAINING EVALUATION FORM

EQUIPMENT/SYSTEM ITEM: _____

VENDOR/MANUFACTURER: _____

DATE: _____ NAME OF REPRESENTATIVE: _____

1.	Was representative prepared?	Acceptable	Unacceptable	or	N/A
2.	Was an overview description presented?	Acceptable	Unacceptable	or	N/A
3.	Were specific details presented for system components?	Acceptable	Unacceptable	or	N/A
4.	Were alarm and shutdown conditions clearly presented?	Acceptable	Unacceptable	or	N/A
5.	Were step-by-step procedures for starting, stopping, and troubleshooting presented?	Acceptable	Unacceptable	or	N/A
6.	Were routine/preventative maintenance items clearly identified?	Acceptable	Unacceptable	or	N/A
7.	Was the lubrication schedule (if any) discussed?	Acceptable	Unacceptable	or	N/A
8.	Was the representative able to answer all questions?	Acceptable	Unacceptable	or	N/A
9.	Did the representative agree to research and answer unanswered questions?	Acceptable	Unacceptable	or	N/A

10. Comments: _____

_____

_____

_____

11. Overall Rating: Satisfactory Unsatisfactory

Note:

Sessions judged “Unsatisfactory” by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
Testing and Training Phase				
Source Testing				
1	Source Testing	Witness	Lead	Witness, Review
Installation Testing				
2	Electrical Conductor Testing	No Action	Lead	Witness
3	Electrical Field Acceptance Tests	No Action	Lead	Witness
4	Instrument Field Calibration	No Action	Lead	Witness
5	Network Installation Testing	Witness	Lead	Witness
6	Loop Testing	No Action	Lead	Witness
7	Pressure Testing	No Action	Lead	Witness
8	Leak Testing	No Action	Lead	Witness
9	Holiday Testing	No Action	Lead	Witness
10	HVAC Testing	No Action	Lead	Witness
11	Motor Electrical Testing	No Action	Lead	Witness
Functional Testing				
12	Network Operational Testing	Witness	Lead	Witness, Review
13	Preliminary Run Testing Local/Manual Control	Witness	Lead	Witness, Review
14	PCIS Functional Demonstration Testing - Local/Auto Control Testing - Remote/Manual Contact Testing - Alarm Testing - Control Loop Testing	No Action	Lead	Witness, Review
15	Subsystem Start-Up and Testing	Witness	Lead	Witness, Review
16	Equipment/System Start-Up and Testing	Witness	Lead	Witness, Review
17	HVAC Start-Up and Testing	Witness	Lead	Witness, Review
18	Corrosion Control Start-Up and Testing	N/A	N/A	N/A
19	Wide Area Network Communications Testing	Support	Lead	Witness, Review
20	Manufacturer's Certificate of Installation and Functionality Compliance	No Action	Lead	Witness, Review
Clean Water Facility Testing				
21	Test Water Management Plan Finalization	Support	Lead	Review
22	Clean Water Facility Testing	Witness	Lead	Witness, Review

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
Process Start-Up Phase				
Process Start-Up				
23	Commissioning Documentation and Data Review	Review	Lead	Review
24	Start-Up Go/No-Go Decision Criteria	Lead	Support	Review
25	Building and Fire Inspection Compliance Check	No Action	Lead	Witness
26	HVAC Functionality Check	No Action	Lead	Witness
27	Start-Up Sequence Review	Support	Lead	Review
28	Temporary Testing Arrangement Finalization	Support	Lead	Support
29	Start-Up Forms Finalization	Support	Lead	Support
30	Operation Testing Plan Finalization	Review	Lead	Review
31	Test Water Management Plan Finalization	Support	Lead	Review
32	System Testing	Support	Lead	Witness
33	Control Loop Tuning	Support	Lead	Witness
34	Process Area Start-Ups	Support	Lead	Witness
35	Facility-Wide Start-Up	Support	Lead	Witness
36	Process Control Systems Testing	Support	Lead	Witness
38	HVAC Final Testing, Adjust, and Balancing	Witness	Lead	Witness, Review
Process Operational Period				
39	Operational Testing	Lead	Support	Support
40	Final Testing Reports	Lead	Support	Support
41	Water Quality Testing and Documentation	Lead	Support	Support
Instrumentation and Controls Reliability Phase				
Instrumentation and Controls Reliability Period				
42	As specified in Section 17950	Support	Lead	Review

Legend:
Lead: Primarily responsible for organization, coordination, and execution of task work product or result.
Support: Assist the lead with organization, coordination, and execution of task work product or result.
Witness: Observe and document completion of task work product or result.
Review: As necessary to accept task work product result.
No Action: Limited or no involvement.

SECTION 01759

WATER LEAKAGE TEST FOR CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydrostatic leakage test for concrete water-holding structures.

B. Related sections:
   1. Section 02300 - Earthwork.
   2. Section 03300 - Cast-in-Place Concrete.

1.02 REFERENCES

A. Abbreviations and acronyms.

B. Definitions:
   1. Damp spots: Surfaces where visible moisture can be picked up by a dry hand.
   2. Containment structure, lined: Liquid-containing structure with barrier coating or membrane applied to the inside surfaces to prevent leaking of contents to the outside.
   3. Containment structure, unlined: Liquid containing structure where only the concrete structure itself is used to prevent leaking of contents to the outside.

C. Reference standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination.

B. Pre-installation meetings.

C. Sequencing.

D. Scheduling.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings:
   1. Description and details of each evaporation/precipitation-measuring device anticipated for use during the test.

C. Samples.

D. Certificates.

E. Delegated design submittals.

F. Tests and evaluation reports:
    1. Results of water leakage test for each structure and for each portion of a structure designated for testing.

G. Manufacturer instructions.

H. Source quality control submittals.

I. Field/site quality control submittals.

J. Manufacturer reports.

K. Sustainable design submittals.

L. Special procedure submittals:
    1. Testing plan for each structure, or portion thereof, required to be tested:
        a. Describe methods of obtaining water for testing and of releasing water for disposal, including provisions for dechlorination if required.
        b. Include plans showing locations where measurements will be made and locations of evaporation/precipitation-measuring device.
        c. Indicate plans for filling and draining structure(s).
        d. Include schedule showing duration of test for each structure or cell to be tested, date and time for start of each test, dates and times of observations and measurements during the test, dates and times for closeout of testing procedures, and date for submittal of final results.
    2. Proposed procedures and products for repair of leaks.

M. Qualifications statements.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL

A. Test structures and portions of structures listed in the following paragraphs for water leakage:
    1. Unless otherwise specified, the Contractor shall:
        a. Obtain all required permits for discharging testing water.
        b. Provide dechlorination of such water if required by the permits.
        c. Prepare and fill the structures.
        d. Provide access and equipment required for testing and for recording test results.
        e. Take measurements and make observations required for testing.
    2. At all times during testing, the Engineer shall have access to observe measurements by others or to make independent measurements.

B. Test the following concrete structures for water leakage:
   1. Secondary Clarifier No. 5.

C. Required preparation for testing is designated in this Section. Waiver of, or failure to complete preparations shall not change the testing criteria or approval criteria for the areas tested.

D. Retest structures and portions of structures until the evaluation criteria are satisfied.

3.02 TEST WATER SOURCE AND DISPOSAL

A. Water used for the first filling of the tank will be furnished by Owner:
   1. Contractor shall obtain water for leakage testing from on-site Utility Water system.
   2. Flow rate of the Utility Water system is limited by on-site uses. Coordinate with Owner plan staff.

B. In the event that retesting is required, Contractor shall bear the cost of refilling the tank for subsequent tests.

C. After leakage testing is complete, Contractor shall dispose of water by pumping it to the Primary Flotator influent flumes or other location directed by the Owner.

3.03 PREPARATION

A. For each structure to be tested, prepare and submit a plan showing schedule and sequence of activities, method of filling, and methods of disposing of test water.

B. Sequencing requirements:
   1. Complete construction of concrete structure and cure concrete to obtain minimum specified 28-day compressive strength as specified in Section 03300:
      a. Do not begin tests until all portions of structure are complete and have reached their minimum specified 28-day compressive strength.
      b. Do not begin tests until at least 14 days have passed since completion of the last concrete placement.
   2. Complete tests before:
      a. Covering any surface of the structure with materials that might mask the location of leaks or obscure damp concrete surfaces. Such coverings include, but are not limited to basin bottom grout, masonry veneer, stucco, plaster, and other coatings.
      b. Installation of equipment, unless otherwise approved by the Engineer.
      c. Backfilling structures to elevations above the limits indicated in the following paragraphs.
   3. Liners and coatings:
      a. Install liners that are mechanically locked to the concrete surface during placement of plastic concrete and before leakage testing:
         1) Examine liners for pinholes, tears, and partially fused splices, complete all required liner integrity testing, and make required repairs before commencing leakage testing.
      b. Unless otherwise specified, do not install surface-applied protective or decorative coatings and linings until leakage tests have been completed.

C. Weather requirements:
   1. Tests on structures with tops open to the atmosphere shall not be scheduled for periods when the 10-day weather forecast indicates a substantial change in weather patterns.
   2. Measurements of water surface levels in the structure shall not be scheduled for periods when the weather forecast indicates a difference of more than 35 degrees Fahrenheit between the ambient temperature readings at the times of initial and final measurements.
   3. Tests shall not be scheduled for periods when the 10-day weather forecast indicates that the water surface may freeze before the test is complete.

D. Groundwater requirements:
   1. Bring groundwater to a level below the low point of the underdrain system and maintain at that level for the duration of the test.

E. Clean interior of structure:
   1. Remove dirt, contaminants, and construction debris.
   2. Flush floors and sumps to provide clean surfaces.
   3. Remove standing water that would interfere with examination of surfaces, cracks, or joints.

F. Observe the structure, or portions of the structure being tested, for potential leak locations:
   1. Give particular attention to cracks, open joints, voids, and honeycombed and repaired surfaces.
   2. Visually observe openings, fitting, and pipe penetrations in the structure at both faces, if possible.
   3. Repair potential leak locations in accordance with these Specifications and as approved by the Engineer.
   4. Backfill excavations to the top of the structure foundation. Do not place backfill against water-bearing walls or over footings unless approved in advance by the Engineer:
      a. If requesting backfilling of walls before testing, include a description of methods that will be used to detect leakage in the backfilled areas.
      b. Engineer's approval of backfilling before testing shall not relieve Contractor of the responsibility to conduct leakage tests, to satisfy the leakage acceptance criteria for the structure, or to repair leaking portions of the structure, including those portions below or behind the backfill.
   5. See Drawings and Section 02300 for requirements to provide wall stability before backfilling.

G. Inlets to/outlets from the structure:
   1. Make inlets to and outlets from the structure watertight:
      a. Include valves; stop, sluice, and slide gates; and temporary bulkheads as required.
      b. Inlets and outlets not required to be operable may be temporarily sealed before testing of the compartments to which they open.
      c. Secure inlets used to fill the structure for testing to ensure that no water is entering or leaving the structure once it has been filled to the test level.

2. Adjustments to measured leakage at inlets and outlets based on manufacturer's or Contractor's estimates will not be allowed:
    a. Adjustments to measured leakage may be permitted by the Engineer, and, at his/her discretion, only when the Contractor makes specific measurements of leakage at each individual inlet and outlet using methods approved by the Engineer.

3.04 HYDROSTATIC LEAKAGE TEST FOR OPEN OR COVERED CONTAINMENT STRUCTURES ("HST-100")

A. Isolate sections of water-holding structures that can be isolated in actual operation. Fill and test sections for leakage separately:
    1. Fill structures and sections of structures scheduled for testing to the normal operating water level indicated on the Hydraulic Profile indicated on the Drawings.

B. Initial rate for filling of structures shall not exceed 4 feet per hour.

C. HST-100 testing includes 2 parts, "Qualitative Testing," and "Quantitative Testing," as described in the following paragraphs:
    1. HST-100, Part 1 - Qualitative Testing:
        a. During the first 24 hours after structures are filled, examine exposed concrete surfaces for damp spots or flowing water:
            1) Make observations in early morning, at midday, and in late afternoon.
            2) Continue observations through the duration of the Quantitative Testing period.
            3) Pay particular attention to conditions at joints, honeycombed areas, cracks, and repaired portions of the structure.
        b. Evaluation criteria:
            1) The structure shall be considered to have failed these Qualitative Testing requirements if any of the following conditions are observed:
                a) Water droplets or moist areas on an outside surface that could only have originated inside the structure.
                b) Water is flowing or seeping from joints, cracks, or surfaces:
                    (1) Exception: Dampness or wetness on top of a footing, in the absence of flowing water, shall not be considered as failure to meet this criterion.
                c) Moisture can be transferred to a dry hand from the outside surfaces of the filled area.
        c. Repairs and retesting:
            1) Where damp spots or flowing water as described in the preceding paragraphs are observed, mark locations, provide repairs, and retest the structure as specified in subsequent paragraphs.
    2. HST-100 - Part 2: Quantitative Testing:
        a. If approved by the Engineer, Quantitative Testing may begin before repairs are made to areas failing Part 1 of this test; however:
            1) Adjustments to volume loss calculations of Quantitative Testing based on observed leakage will not be permitted.
            2) All defects identified for repair during Qualitative Testing shall be repaired to the satisfaction of the Engineer before approval of the structure.

b. Report the results of Quantitative Testing on “Leakage Test Report” included as Figure A at the end of this Section, or similar form prepared by the Contractor and containing at least the information included in Figure A.

c. Unlined concrete structures:
   1) Fill to the designated water surface elevation. Maintain that level for at least 72 hours before recording initial water levels for leakage test.
   2) Duration of test:
      a) Theoretical time required to lower the water surface in the structure by 3/8 inch when leakage is occurring at the maximum allowable rate specified in subsequent paragraphs of this Section.
      b) The duration (“D”) of the test in days is determined by the following equation:

$$D = \frac{0.375 \text{ inches}}{(0.005 \text{ in/in/day} \times H \text{ ft.} \times 12 \text{ in/ft.})}$$

Where: H = maximum liquid depth

      (1) Round results upward to the next full 24-hour period (day).
      (2) Minimum duration of test: 24 hours (1 day).
      (3) Maximum duration of test: 120 hours (5 days).

d. Lined concrete structures and secondary containment areas:
   1) Fill to the designated water surface elevation. Recording of water levels for leakage tests may begin as soon as the designated water surface level is reached and the water surface is calm.
   2) Duration of test: 72 hours (3 days).

e. Measurements: Water level:
   1) Record water levels at 24-hour intervals for the full duration of the test period.
   2) Measure water levels at not less than 2 locations on opposite ends of the structure, and preferably at 4 locations spaced equally around the structure. Mark locations on the structure and take measurements at the same locations throughout the duration of the test.
   3) Measure, to an accuracy of 1/16 inch, the vertical distance to the water surface from a fixed point on the structure above.

f. Measurements: Temperatures:
   1) As part of the first and last sets of level measurements, record water temperature at a depth of 18 inches below the water surface. Measure temperature at the same locations where level measurements are taken.
   2) Record ambient temperature at the time of each water level measurement.

g. Measurements: Evaporation and precipitation:
   1) Measure evaporation and precipitation by floating pans inside the structures during testing:
      a) For uncovered structures, measure both evaporation and precipitation.
      b) For covered structures that are well ventilated, measure evaporation.

2) Measure using specially constructed clear containers:
   a) Provide clear plastic, calibrated, open-top containers not less than 18 inches in diameter and 18-inches deep.
   b) Partially fill containers with water and float inside the structure. Make provisions to hold containers in place at each measurement location, but away from structure walls and items passing overhead, such as beams or pipes.
   c) Measure initial depth of water in each device. Measure changes in water level in each device at the same time measurements of the water level inside the structure are taken.

h. Restart of test:
   1) The Engineer may order a restart of the test when, in the Engineer's opinion, measurements have become unreliable due to unusual precipitation or other factors.
   2) If measurements or observed leakage during the testing period indicate that the allowable leakage requirements will be exceeded, the test may be terminated before completion of the full test period. Take appropriate actions to correct problems before restarting the test.

i. Calculations of leakage test results:
   1) For each section of the structure tested, use water surface level records to calculate average loss of volume per 24-hour interval:
      a) For each 24-hour interval during the test, calculate the average of all measured drops in water level around the structure.
      b) Use the average drop thus determined to calculate an average loss of volume for each 24-hour interval.
   2) Adjustments to leakage calculations:
      a) For uncovered basins, calculations shall be corrected for precipitation added to the structure.
      b) Calculations may be corrected for evaporation and water temperature.

j. Evaluation criteria:
   1) Unless otherwise specified, the average loss of volume during any 24-hour interval shall not exceed the limits shown in Table A:

Table – Loss of Volume Criteria for Leakage Tests

Structure Type	Maximum Loss of Water Volume
• Structure fully lined prior to leakage test. • Secondary containment areas.	No measurable loss over 72-hour test period.
• Structure with monolithically placed membrane floor slab.	0.0125 percent of volume per 24-hour period.
• Concrete paved canals, drying beds, lagoons, and similar structures.	0.100 percent of volume per 24-hour period.
• Other containment structures.	0.050 percent of volume per 24-hour period.

k. Repairs and retesting:
   1) Structures and portions of structures that have satisfied the qualitative requirements of HST-100, but have failed to satisfy the quantitative requirements of HST-100 may be immediately retested for volume loss.

a) If the structure fails the second test for volume loss, the structure shall be drained, and the Contractor shall observe the interior for probable areas of leakage.
b) The structure shall not be retested until repairs to the probable areas of leakage are complete.

3.05 REPAIRS FOR RETESTING

A. Locations showing damp spots or flowing water:
   1. Mark locations of visible leaks and damp spots.
   2. Drain structures for repair.
   3. Repair defects causing damp spots and flowing water using methods specified in Section 03300 and approved by the Engineer:
      a. Repair both interior and exterior surfaces and make structures watertight.
      b. Submit proposed repair products and procedures for Engineer's review.
      c. Refill structures for retesting.
   4. Repeat filling, observations, and repairs until no leaks or damp spots appear.

B. Structures for which loss of water volume loss exceeds the limits specified after adjustments for evaporation, and precipitation:
   1. Determine cause of volume loss.
   2. Drain structures of water.
   3. Repair defects causing loss of water volume using methods specified in Section 03300 and approved by the Engineer.
      a. Submit proposed repair products and procedures for Engineer's review.
   4. Refill water-holding structures.
   5. Repeat testing and repairs until volume loss does not exceed specified limits.

END OF SECTION

FIGURE A

WATERTIGHTNESS TEST REPORT

PROJECT:		SUBMITTED BY:	
STRUCTURE:		WITNESSED BY:	
AREA:		TEST DATES:	
TEST DURATION:		TEST DURATION:	

Surface area of structure tested:		(square feet)
Volume of structure tested:		(cubic feet)
Volume of structure tested:		(gallons)
Measured loss through gates, etc.:		(gallons / day)
Allowable loss of water volume:		(per day)
Allowable loss of water volume:		(% in 24 hours)
Allowable measured loss over test duration (inches):		
Measured loss of water:		(gallons / day – From E below)
Measured loss of water volume (%):		(in 24 hours – From E below)

Water Temperature: Start of test: °F End of test: °F

			Water Surface Elevation (top of structure to top of water)				
			Location #1	Location #2	Location #3	Location #4	Initials**
Day	Date	Time	(inches)	(inches)	(inches)	(inches)	
1							
2							
3							
4							
5							
Changes in Level:							

A. Average change in level (feet): _____ (Average of total charges for all locations)

B. Correction for precipitation: _____ (Measured from pan)

C. Correction for evaporation: _____ (Measured from pan)

D. Corrected change in level (CL): _____

E. Total days tested: _____

F. Average measured % water loss in 24 hours: _____ = $\frac{\text{(CL) x (surface area) x 100}}{\text{(initial water volume) x (number of test days)}}$

Notes and field observations**

** Place date and initials at the beginning of each entry.

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Contract closeout requirements including:
   1. Final cleaning.
   2. Waste disposal.
   3. Touch-up and repair.
   4. Disinfection of systems.
   5. Preparation and submittal of closeout documents.
   6. Certificate of Substantial Completion.

B. Related sections:
   1. Section 01324A - Progress Schedules and Reports.

1.02 REFERENCES

A. American Water Works Association (AWWA).

1.03 FINAL CLEANING

A. Perform final cleaning prior to inspections for Substantial Completion.

B. Employ skilled workers who are experienced in cleaning operations.

C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

E. Clean roofs, gutters, downspouts, and drainage systems.

F. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
   1. Police yards and grounds to keep clean.

G. Remove dust, cobwebs, and traces of insects and dirt.

H. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

I. Remove non-permanent protection and labels.

J. Polish waxed woodwork and finish hardware.

K. Wash tile.

L. Wax and buff hard floors, as applicable.

M. Wash and polish glass, inside and outside.

N. Wash and shine mirrors.

O. Polish glossy surfaces to clear shine.

P. Vacuum carpeted and soft surfaces.

Q. Clean permanent filters and replace disposable filters when heating, ventilation, and air conditioning units were operated during construction.

R. Clean ducts, blowers and coils when units were operated without filters during construction.

S. Clean light fixtures and replace burned-out or dim lamps.

T. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

1.04 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
   1. Prior to making disposal on private property, obtain written permission from Owner of such property.

B. Do not fill ditches, washes, or drainage ways which may create drainage problems.

C. Do not create unsightly or unsanitary nuisances during disposal operations.

D. Maintain disposal site in safe condition and good appearance.

E. Complete leveling and cleanup prior to Final Completion of the Work.

1.05 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Substantial Completion.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.06 CLOSEOUT DOCUMENTS

A. Submit following Closeout Submittals before Substantial Completion:
   1. Punchlist of items to be completed or corrected with the request for issuance of Substantial Completion.
   2. Evidence of Compliance with Requirements of Governing Authorities.
   3. Project Record Documents.
   4. Approved Operation and Maintenance Manuals.
   5. Approved Warranties and Bonds.

6. Keys and Keying Schedule.
7. Completed contract requirements for commissioning and process start-up.

B. Submit following Closeout Submittals before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Punchlist of items have been completed and Engineer and Owner are satisfied that all deficiencies are corrected.
   2. Evidence of Payment and Release of Liens or Stop Payment Notices as outlined in Conditions of the Contract.
   3. Release of claims as outlined in Conditions of the Contract.
   4. Submit certification of insurance for products and completed operations, as specified in the General Conditions.
   5. Final statement of accounting.

1.07 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

A. Submit the following:
   1. Certificate of Occupancy.
   2. Certificates of Inspection:
      a. Mechanical:
         1) Monorail: OSHA certificate for field load testing.

1.08 PROJECT RECORD DOCUMENTS

A. Maintain at Project site, available to Owner and Engineer, 1 copy of the Contract Documents, shop drawings, and other submittals in good order:
   1. Mark and record field changes and detailed information contained in submittals and change orders.
   2. Record actual depths, horizontal and vertical location of underground pipes, duct banks, and other buried utilities. Reference dimensions to permanent surface features.
   3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
   4. Identify location of spare conduits including beginning, ending, and routing through pull boxes and manholes. Record spare conductors, including number and size, within spare conduits and filled conduits.
   5. Provide schedules, lists, layout drawings, and wiring diagrams.
   6. Make annotations in electronic format and hardcopy format with erasable colored pencil conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments	Blue
Dimensions:	Graphite

B. Maintain documents separate from those used for construction:
   1. Label documents "RECORD DOCUMENTS."

C. Keep documents current:
   1. Record required information at the time the material and equipment is installed and before permanently concealing.
   2. Engineer will review Record Documents weekly to ascertain that changes have been recorded.

D. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

E. Deliver Record Documents with transmittal letter containing date, Project title, Contractor's name and address, list of documents, and signature of Contractor.

F. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.

G. Updated Record Documents are a condition for Engineer’s recommendation for progress payment.

H. Final Schedule Submittal as specified in Section 01324A.

1.09 MAINTENANCE SERVICE

A. Maintenance service as specified in technical specifications.

1.10 SUBSTANTIAL COMPLETION

A. Obtain Certificate of Substantial Completion.

1.11 FINAL COMPLETION

A. When Contractor considers the Work is complete, submit written certification that:
   1. Work has been completed in accordance with the Contract Document.
   2. Punch list items have been completed or corrected.
   3. Work is ready for final inspection.

B. Engineer will make an inspection to verify the status of completion with reasonable promptness.

C. Should the Engineer consider that the Work is incomplete or defective:
   1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.
   2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to the Engineer that the Work is complete.
   3. Engineer shall re-inspect the Work.

1.12 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer at least 7 days prior to final Application for Payment.

B. Statement shall reflect all adjustments to the Contract amount:
   1. The original Contract amount.

2. Additions and deductions resulting from:
    a. Change Orders.
    b. Units installed and unit prices.
    c. Set-offs for uncorrected or incomplete Work.
    d. Set-offs for liquidated damages.
    e. Set-offs for reinspection payments.
    f. Extended engineering and/or inspection services and inspection overtime.
    g. Excessive shop drawings review cost by the Engineer.
    h. Other adjustments.
3. Total Contract amount, as adjusted.
4. Previous payments.
5. Remaining payment due.

C. Engineer will prepare a final Change Order reflecting approved adjustments to the Contract amount which were not previously made by Change Orders.

1.13 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment reflecting the agreed upon information provided in the final statement of accounting.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01782

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preparation and submittal of Operation and Maintenance Manuals.

B. Related section:
   1. Section 15958 - Mechanical Equipment Testing.

1.02 SUBMITTALS

A. Submit Operation and Maintenance Manuals before field quality control testing and before training of each piece of equipment or system.

B. Submit 4 hardcopy Manuals for each piece of equipment or system.

C. Submit 2 electronic copy manuals for each piece of equipment of system in Acrobat.pdf format.

D. Make manuals available at project site for use by construction personnel and Engineer.

E. Make additions and revisions to the Manuals in accordance with Engineer's review comments.

1.03 OPERATION AND MAINTENANCE MANUALS

A. Preparation:
   1. Provide Operations and Maintenance Manuals in 3-ring binders with rigid covers. Utilize numbered tab sheets to organize information.
   2. Provide original and clear text on reproducible non-colored paper.
   3. Provide all dimensions in English units.

B. Contents of Operation and Maintenance Manuals:
   1. Cover page: Equipment name, equipment tag number, project name, Owner's name, appropriate date.
   2. Table of Contents: General description of information provided within each tab section.
   3. Equipment Summary Form: Completed form in the format shown in Appendix A. The manufacturer's standard form will not be acceptable.
   4. Lubrication information: Required lubricants and lubrication schedules.
   5. Control diagrams:
      a. Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer based systems, and connections between existing systems and new additions, and

adjustments such as calibrations and set points for relays, and control or alarm contact settings.
    b. Complete set of 11-inch by 17-inch drawings of the control system.
    c. Complete set of control schematics.
6. Programming: Copies of all Contractor furnished programming.
7. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.
8. Operating procedures:
    a. Step-by-step procedures for starting, operating, and stopping equipment under specified modes of operation.
    b. Include safety precautions and emergency operating shutdown instructions.
9. Preventative maintenance procedures: Recommended steps and schedules for maintaining equipment.
10. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.
11. Parts list:
    a. Complete parts list for all equipment being provided.
    Catalog data for all products or equipment furnished including generic title and identification number of each component part of equipment:
        1) Include bearing manufacturer, model and ball or roller pass frequencies for every bearing.
12. Spare parts list: Recommended number of parts to be stored at the site and special storage precautions.
13. Drawings:
    a. Exploded view or plan and section views with detailed callouts.
    b. Complete set of 11-inch by 17-inch drawings of equipment.
    c. Provide electrical and instrumentation schematic record drawings.
14. Source (factory) quality control test results: Provide copies of factory test reports as specified in Section 15958 or the equipment section.
15. Field quality control test results: After field-testing is completed, insert field test reports as specified in Section 15958 or the equipment section.
16. Equipment Summary Form:
    a. Completed form in the format attached at the end of this Section.
    b. Insert Equipment Summary Form after the tab sheet of each equipment section.
    c. The manufacturer's standard form will not be acceptable.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A
EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT IDENTIFICATION NUMBER(S) _____
(maps equipment number)

4. LOCATION OF EQUIPMENT _____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

_____

_____

_____

NAMEPLATE DATA -

Horsepower _____
Amperage _____
Voltage _____
Service Factor (S.F.) _____
Speed _____
ENC Type _____
Capacity _____
Other _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE

Name _____

Address _____

Telephone Number _____

8. MAINTENANCE REQUIREMENTS _____

_____

_____

9. LUBRICANT LIST _____

_____

10. SPARE PARTS (recommendations) _____

_____

11. COMMENTS _____

SECTION 01783

WARRANTIES AND BONDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Warranty and bonds requirements.

1.02 SUBMITTALS

A. For each item of material or equipment furnished under the Contract:
   1. Submit form of manufacturer's warranty prior to fabrication and shipment of the item from the manufacturer's facility.
   2. Submit form of manufacturer's special warranty when specified.

B. Provide consolidated warranties and bonds within 15 calendar days of Substantial Completion:
   1. Contents:
      a. Organize warranty and bond documents:
         1) Include Table of Contents organized by specification Section number and the name of the product or work item.
      b. Include each required warranty and bond in proper form, with full information, are certified manufacturer as required, and are properly executed by Contractor, or subcontractor, supplier, or manufacturer.
      c. Provide name, address, phone number, and point of contact of manufacturer, supplier, and installer, as applicable.
   2. Hardcopy format:
      a. Submit 2 copies.
      b. Assemble in 3 D-side ring binders with durable cover.
      c. Identify each binder on the front and spine with typed or printed title "Warranties and Bonds"; Project Name or Title, and the Name Address and Telephone Number of the Contractor.
   3. Electronic copy in PDF format:
      a. Submit 1 copy.

1.03 OWNER'S RIGHTS

A. Owner reserves the right to reject warranties.

B. Owner reserves the right to refuse to accept Work for the project if the required warranties have not been provided.

1.04 RELATIONSHIP TO GENERAL WARRANTY AND CORRECTION PERIOD

A. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, both Contractor's general warranty and the correction period requirements.

B. Disclaimers and limitations in specific materials and equipment warranties do not limit Contractor's general warranty, nor does such affect or limit Contractor's performance obligations under the correction period.

1.05 MANUFACTURER'S WARRANTY MINIMUM REQUIREMENTS

A. Written warranty issued by item's manufacturer.

B. Project-specific information, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Owner.

C. Covers all costs associated with the correction of the defect, including but not limited to removal of defective parts, new parts, labor, and shipping:
   1. When correcting warranted Work that has failed, remove and replace other Work that had been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

D. Provides a timely response to correct the defect:
   1. Manufacturer shall provide, in a timely fashion, temporary equipment as necessary to replace warranted items requiring repair or replacement, when warranted items are in use and are critical to the treatment process, as defined by Owner.
   2. In the case that Owner has to provide temporary equipment to replace function of warranted item requiring repair or replacement, manufacturer shall reimburse Owner for such costs associated with the temporary equipment.

E. Warranty commence running on the date of substantial completion:
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of warranty period.

F. Duration of Warranty: 1 year.

1.06 MANUFACTURER'S SPECIAL WARRANTY

A. Manufacturer's special warranty is a written warranty published by the manufacturer which includes the requirements specified in the Section where the item is specified:
   1. Includes Project-specific information and requirements, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Owner. Technical sections indicate Project-specific requirements that differ from the minimum warranty requirements for that item:
      a. Examples include extending the duration of manufacturer's warranty or to provide increased rights to Owner.
   2. Manufacturer's warranties commence on the date that the associated item is certified by Engineer as substantially complete.

1.07 WARRANTY WORK

A. Contractor's responsibilities:
   1. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the work that incorporates the product, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with Contractor.

B. Replacement cost:
   1. Upon determination that work covered by warranty has failed, replace or rebuild the work to an acceptable condition complying with requirement of the Contract Documents:
      a. Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether Owner has benefited from the use of the work through a portion of its anticipated useful service life.

C. Related damages and losses:
   1. When correcting warranted work that has failed, remove and replace other work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted work.

D. Owner's recourse:
   1. Written warranties are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitation on time in which Owner can enforce such other duties, obligations, rights, or remedies.

E. Reinstatement of warranty:
   1. When work covered by a warranty has failed and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement:
      a. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

1.08 IMPLIED WARRANTIES

A. Warranty of title and intellectual rights:
   1. Except as may be otherwise indicated in the Contract Documents, implied warranty of title required by Laws and Regulations is applicable to the Work and to materials and equipment incorporated therein.
   2. Provisions on intellectual rights, including patent fees and royalties, are in the General Conditions, as may be modified by the Supplementary Conditions.

B. Implied warranties: Duration in accordance with Laws and Regulations.

1.09 BONDS

A. Bond requirements as specified in the technical sections.

B. Bonds commence running on the date of substantial completion:
   1. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of bond period.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 02050

SOILS AND AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Aggregate base course.
   2. Class 2 permeable.
   3. Drain rock.
   4. Gravel.
   5. Suitable native material.
   6. Sand.
   7. Select material.
   8. Stabilization material.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D422 - Standard Test Method for Particle-Size Analysis of Soils.
   5. D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   6. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   7. D4829 - Standard Test Method for Expansion Index of Soils.

B. California Department of Transportation:
   1. Standard Specifications.
   2. California Test 205.
   3. California Test 211.
   4. California Test 217.

1.03 SUBMITTALS

A. Product data:
   1. Material source.
   2. Gradation.
   3. Testing data.

B. Quality control for aggregate base course:
   1. Test reports: Reports for tests required by Sections of Standard Specifications.
   2. Certificates of Compliance: Certificates as required by Sections of Standard Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection: Protect from segregation and excessive moisture during delivery, storage, and handling.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Provide material having maximum particle size not exceeding 4 inches and that is free of trash, lumber, debris, leaves, grass, roots, stumps, and other organic matter.
   2. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

B. Aggregate base course:
   1. Consists of hard, durable particles or fragments of stone or gravel; crushed to required size and grading; and free from vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
   2. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
      a. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
      b. Plasticity index: Shall not be more than 5 when tested in accordance with ASTM D4318.
      c. Liquid limit: Shall not be more than 25 percent when tested in accordance with ASTM D4318.
   3. Aggregate base course for structures:
      a. Consists of crushed or fragmented particles.
   4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Sizes (Square Openings)	**Percent by Weight Passing Sieve**
1-1/8 inch	100
Number 4	38 - 65
Number 8	25 - 60
Number 30	10 - 40
Number 200	3 - 12

C. Class 2 permeable:
   1. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
   2. Consists of hard, durable particles of stone or gravel; screened or crushed to the specified size and gradation; and free from organic matter, lumps or balls of clay, and other deleterious matter.
   3. Sand equivalent: Not less than 75 when tested in accordance with ASTM D2419.

4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent by Weight Passing Sieve
1 inch	100
3/4 inch	90 - 100
3/8 inch	40 - 100
Number 4	25 - 40
Number 8	18 - 33
Number 30	5 - 15
Number 50	0 - 7
Number 200	0 - 3

D. Drain rock:
1. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
2. Consists of hard, durable particles of stone or gravel; screened or crushed to specified size and gradation; and free from organic matter, lumps or balls of clay, or other deleterious matter.
3. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2 inch	100
1-1/2 inch	95 - 100
3/4 inch	50 - 100
3/8 inch	15 - 55
Number 200	0 - 2

E. Gravel:
1. Consists of hard, durable particles of stone or gravel; or crushed to the specified sizes and gradations; and free from organic matter, lumps or balls of clay, and other deleterious matter.
2. Crush or waste coarse material and add or waste fine material in order to meet the specified gradations.
3. Fraction of material passing Number 40 sieve: Material having plasticity index not greater than 5 when tested in accordance with ASTM D4318.
4. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.

5. Conform to sizes and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent by Weight Passing Sieve		
	Type A	Type B	Type C
2 inch	100	--	--
1-1/2 inch	95 - 100	100	--
3/4 inch	35 - 60	55 - 85	100
3/8 inch	15 - 40	35 - 65	50 - 100
Number 4	0 - 25	20 - 35	30 - 45
Number 30	--	5 - 15	10 - 20
Number 200	0 - 5	2 - 9	2 - 9

F. Suitable native material:
1. Sound, on-site earthen materials free of debris and suitable for reuse. Soils shall have less than 3 percent organics by weight when tested in accordance with ASTM D 2974.
2. Gradation as follows when tested in accordance with ASTM C 136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
3 inch	100
No. 200	Less than 30

3. Verify that suitable native material is capable of compaction to specified density before placing as fill. If material will not compact to specified density, work material in a manner which will reduce water content to improve compaction or remove the material from the site and replace with Select Imported Material at no additional cost to Owner.

G. Sand:
1. Clean, coarse, natural sand.
2. Non-plastic when tested in accordance with ASTM D4318.
3. 100 percent shall pass a 1/2-inch screen.
4. No more than 20 percent shall pass a Number 200 sieve.

H. Select material:
1. Sound earthen material for which the sum of plasticity index when tested in accordance with ASTM D4318 and the percent of material by weight passing a Number 200 sieve shall not exceed 23 when tested in accordance with ASTM D422.
2. Organic content shall not be greater than 3 percent by volume.

I. Stabilization material:
1. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
2. Consists of clean, hard, durable particles of crushed rock or gravel; screened or crushed to the specified sizes and gradations; and free of any detrimental

quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

3. Shall be free of slaking or decomposition under the action of alternate wetting and drying.
4. The portion of material retained on the 3/8-inch sieve shall contain at least 50 percent of particles having 3 or more fractured faces. Not over 5 percent shall be pieces that show no such faces resulting from crushing. Of that portion which passes the 3/8-inch sieve but is retained on the Number 4 sieve, not more than 10 percent shall be pieces that show no faces resulting from crushing.
5. Conforms to size and grade when tested in accordance with ASTM C117 and ASTM C136:

Sieve Size (Square Openings)	**Percent by Weight Passing Sieve**
1 inch	100
3/4 inch	90 - 100
Number 4	0 - 10
Number 200	0 - 2

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02084

PRECAST DRAINAGE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Onsite utility structures:
   1. Precast drainage inlets.

B. Related sections:
   1. Section 02318 - Trenching.
   2. Section 03300 - Cast-in-Place Concrete.
   3. Section 05500 - Metal Fabrications.
   4. Section 07900 - Joint Sealants.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C 361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   2. C 478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
   3. C 857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   4. C 858 - Standard Specification for Underground Precast Concrete Utility Structures.

1.03 SUBMITTALS

A. Shop drawings: Submit shop drawings for precast utility structures.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Precast drainage inlets:
   1. Construct precast concrete drainage inlets in accordance with the size, shape, form, details, and at locations indicated on the Drawings and specified.
   2. Base design and manufacture to A-16 (HS 20-44) loading in accordance with ASTM C 857.
   3. In accordance with ASTM C 858.
   4. Construct precast drainage inlets of Class D concrete as specified in Section 03300 to form and dimensions indicated on the Drawings.

2.02 ACCESSORIES

A. Precast drainage inlets:
   1. Covers: As indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Precast drainage inlets:
   1. Excavation and backfill: As specified in Section 02318.

END OF SECTION

SECTION 02200

SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Clearing, grubbing, and stripping project site.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01354 - Hazardous Material Procedures.
      b. Section 02050 - Soils and Aggregates for Earthwork.

1.02 REFERENCES

A. United States Code of Federal Regulations (CFR):
   1. 40 - Protection of Environment:
      a. 503 - Standards for the Use or Disposal of Sewage Sludge.

1.03 DEFINITIONS

A. Clearing: Consists of removal of natural obstructions and existing foundations, buildings, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines, and any other items which interferes with construction operations or are designated for removal.

B. Grubbing: Consists of the removal and disposal of wood or root matter below the ground surface remaining after clearing and includes stumps, trunks, roots, or root systems greater than 1 inch in diameter or thickness to a depth of 6 inches below the ground surface.

C. Stripping: Includes the removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped. The depth of stripping is estimated to be 6 inches, but the required depth of stripping will be determined by the Engineer.

D. Landfill Removal: Refer to section 02300 for removal of landfill.

1.04 QUALITY ASSURANCE

A. Regulatory requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.

B. Pre-construction conference: Meet with Engineer to discuss order and method of work.

1.05 PROJECT CONDITIONS

A. Environmental requirements:
   1. For suspected hazardous materials found: As specified in Section 01354.
   2. Sludge and sludge-entrained soils are not hazardous materials.

B. Existing Conditions:
   1. Verify character and amount of clay, sand, gravel, quicksand, water, rock, hardpan, and other material involved and work to be performed.

1.06 SEQUENCING AND SCHEDULING

A. Clearing and grubbing: Perform clearing and grubbing in advance of grading operations.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine site and verify existing conditions for beginning work.

3.02 PREPARATION

A. Protect existing improvements from damage by site preparation work.

3.03 INSTALLATION

A. Clearing:
   1. Clear areas where construction is to be performed and other areas as indicated on the Drawings, or specified in this Section, of fences, lumber, walls, stumps, brush, roots, weeds, trees, shrubs, rubbish, and other objectionable material of any kind which, if left in place, would interfere with proper performance or completion of the work, would impair its subsequent use, or form obstructions.
   2. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.

3. Contractor's temporary construction facilities: Fill or remove pits, fill, and other earthwork required for erection of facilities, upon completion of the work, and level to meet existing contours of adjacent ground.

B. Grubbing:
   1. From excavated areas: Grub stumps, roots, and other obstructions 3 inches or over in diameter to depth of not less than 18 inches below finish grade.
   2. In embankment areas or other areas to be cleared outside construction area: Do not leave stumps, roots, and other obstructions higher than the following requirements:

Height of Embankment Over Stump	**Depth of Clearing and Grubbing**
0 feet to 2 feet	Grub stumps or roots 3 inches or over in diameter to 18 inches below original grade. Cut others flush with ground.
2 feet to 3 feet	Grub stumps 1 foot and over in diameter to 18 inches below original grade. Cut others flush with ground.
Over 3 feet	Leave no stumps higher than stump top diameter, and in no case more than 18 inches.

   3. Backfill and compact cavities left below subgrade elevation by removal of stumps or roots to density of adjacent undisturbed soil.

C. Stripping:
   1. Remove soil material containing sod, grass, or other vegetation to depth of 6 inches from areas to receive fill or pavement and from area within 5 feet outside foundation walls.
   2. Deposit stripped material in accordance with following requirements:
      a. At locations acceptable to Engineer.
      b. Use accepted material in top 6 inches of areas to be used for future planting.
   3. Replace topsoil where indicated on the Drawings.

D. Material reuse and recycling:
   1. 100 percent of trees, stumps, rocks and associated vegetation and soils resulting primarily from land clearing shall be reused or recycled. For a phased project, such material may be stockpiled on site until project completion.
   2. Contractor shall provide Engineer with list of local markets and salvage sites for reuse of clearing debris.

E. Landfill removal: Refer to section 02300 for removal of landfill material.

END OF SECTION

SECTION 02240

DEWATERING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Installation and maintenance of dewatering systems.
   2. Disposal of water entering excavation or other parts of the work.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 03300 - Cast-in-Place Concrete.
      b. Section 03600 - Grouting.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Keep excavations reasonably free from water. Draw down static groundwater level to minimum of 3 feet below anticipated bottom of excavations before the excavation reaches bottom elevation.
   2. Dewatering design analysis. Include following:
      a. Evaluation of anticipated subsurface conditions.
      b. Required well spacing.
      c. Diameter of wells.
      d. Depth to screen, screen height, and mesh size.
      e. Backfill and filter pack.
      f. Pump size.
      g. Drawdown duration.
      h. Drawdown and steady state flow rates.
      i. Expected settlements.
   3. Include water drawdown curves in dewatering calculations.
   4. Coordinate dewatering design with excavation and shoring design. Excavation and shoring design shall consider changes in groundwater conditions and associated earth pressures.
   5. Do not place concrete or masonry foundations or concrete slabs in water. Do not allow water to rise over these elements until concrete or mortar has set for at least 24 hours.

6. Maintain operation of dewatering system until complete structure -- including walls, slabs, beams, struts, and other structural elements -- has been constructed; concrete has attained its specified compressive strength; and backfill has been completed to 3 feet above normal static groundwater level at the site.
7. Provide standby power to ensure continuous dewatering in case of power failure.

B. Dewatering shored excavations:
   1. Dewater from within shoring.
   2. Use impermeable shoring system to minimize lowering of groundwater outside shoring.
   3. Extend impermeable shoring below bottom of excavation sufficient amount to:
      a. Minimize lowering of groundwater outside shoring.
      b. Prevent unstable excavation due to piping and heave.
   4. To minimize settlement outside shoring due to dewatering, do not lower groundwater outside shoring more than 1 foot. Provide groundwater recharge if required to maintain this groundwater elevation outside of shoring.
   5. Provide monitoring wells located outside shoring for monitoring groundwater elevation.

C. Obtain written permission from Engineer before locating wells, well points, or drain lines for dewatering within the limits of a structure's foundation.

D. Locate dewatering facilities where they will not interfere with utilities and construction work to be performed by others.

E. Discharge:
   1. Open manholes will not be allowed for discharge piping. Approval of each discharge location shall be obtained from the Engineer.
   2. Groundwater at the site may contain leachate from existing material landfill under the site. Sample and test groundwater for the presence of toxins prior to beginning discharge. Submit results to OWNER prior to beginning dewatering.

1.03 SUBMITTALS

A. Dewatering plan:
   1. Dewatering design analysis.
   2. Required permits.
   3. Arrangement, location, and depths of dewatering system components.
   4. Type and sizes of filters.
   5. Identify proposed alignment, support, and protection for discharge pipe. Identify location of discharge and provide details for that location.

B. Well construction logs. Include:
   1. Descriptions of actual materials encountered, categorized in accordance with Unified Soil Classification System.
   2. Construction details.
   3. Well development procedures and results.
   4. Deviations from original design.

C. Qualifications:
   1. Dewatering contractor.
   2. Dewatering design engineer.
   3. Testing laboratory.

1.04 QUALITY ASSURANCE

A. Dewatering plan and dewatering system analysis:
   1. Prepared by a qualified Civil Engineer, licensed in the state where the Project is located:
      a. The dewatering design engineer shall have at least 8 years of experience in designing similar systems.

B. Submit qualifications of Dewatering Contractor, the Dewatering Design Engineer, sampling service, and testing laboratory.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 INSTALLATION

A. During construction, provide and maintain ample means and devices to promptly remove and properly dispose of water entering excavation or other parts of the work, whether water is surface water or underground water.

B. Keep excavations reasonably free of water.

C. Make provisions to maintain continuous dewatering:
   1. Provide standby power to maintain dewatering during power outages and interruptions.
   2. Provide 24-hour monitoring by personnel skilled in operation and maintenance of the system, and capable of providing or obtaining work required to maintain system operation.

D. Monitoring wells:
   1. Provide at least 1 groundwater level monitoring well. If more than 4 dewatering wells or well points are installed, provide 1 additional monitoring well for every 4 dewatering wells or well points.
   2. Locate monitoring wells within 6 feet of excavation and mid-way between dewatering wells or well points.
   3. Provide temporary threaded cap, not less than 2 inches in diameter at the top of wells.
   4. Protect dewatering wells in place during excavation.

E. Intercept and divert precipitation and surface water away from excavations. Use dikes, curb walls, ditches, pipes, sumps, or other means acceptable to Engineer.

F. Disposal of water:
   1. Dispose of water from the work in suitable manner without damage to adjacent property.
   2. Do not drain water into work built or under construction.
   3. Dispose of water in such manner that it will not be a menace to public health or safety.

G. Wells, well points, and drain lines for dewatering:
   1. Provide after receiving Engineer's written acceptance.
   2. Fill dewatering wells, pipes, and french drains to be left in place within structure foundation limits with Class “C” concrete as specified in Section 03300 or grout as specified in Section 03600.

3.02 CONSTRUCTION

A. Prior to release of groundwater to its static level: Confirm that:
   1. All groundwater pressure relief devices for structure are fully operational.
   2. Construction of structure is complete and concrete has reached its specified compressive strength.
   3. Backfill of structure is complete.

B. Control release of groundwater to its static level to prevent disturbance of natural foundation soils or compacted backfills and fills and to prevent flotation or movement of structures, pipelines, or other facilities.

3.03 FIELD QUALITY CONTROL

A. Monitoring wells:
   1. Record groundwater levels at least once a week. Submit readings to Engineer within 1 week.

END OF SECTION

SECTION 02260

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for designing, providing, maintaining, and removing excavation support and protection.

B. Related sections:
   1. Section 01410 - Regulatory Requirements.
   2. Section 02240 - Dewatering.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. Guidelines of Engineering Practice for Braced and Tied-Back Excavations.

B. California Code of Regulations (CCR):
   1. Title 8 - Industrial Relations:
      a. Division 1. Department of Industrial Relations:
         1) Chapter 4. Division of Industrial Safety:
            a) Subchapter 4. Construction Safety Orders:
               (1) Article 6. Excavations.

C. Department of the Navy Naval Facilities Engineering Command (NAVFAC):
   1. Design Manual 7.2 - Foundations and Earth Structures.
   2. Design Manual 7.3 - Soil Dynamics and Special Design Aspects.

D. State of California Department of Transportation (Caltrans):
   1. Caltrans California Trenching and Shoring Manual.

E. United States Steel Corporation (USS):
   1. Steel Sheet Piling Design Manual.

1.03 DEFINITIONS

A. General Engineering Design Practice: General engineering design practice in area of the Project, performed in accordance with recent engineering literature on subject of shoring and stability of excavations.

B. Shoring: A temporary structural system designed to support vertical faces, or nearly vertical faces, of soil or rock for purposes of excavation. Shoring includes internally braced sheet piling, slurry walls, soldier piles and lagging, and other similar shoring systems. Sloping of the soil is not shoring.

C. Support levels: Level of tiebacks, wales, rackers, bottom of excavation, and other types of support.

1.04 SYSTEM DESCRIPTION

A. Where General Engineering Design Practice is specified, provide drawings and calculations that are performed and signed performed by civil or structural engineer registered in State where Project is located:
   1. Clearly disclose assumptions made, criteria followed, and stress values used for materials being used in design calculations.
   2. Submit list of references acceptable to Engineer that substantiating appropriateness of design assumptions, criteria, and stress values.

B. Design requirements:
   1. General:
      a. In accordance with requirements in CCR, Title 8, Chapter 4, Subchapter 4, Article 6 for trench excavations 5 feet or more in depth and for trenches less than 5 feet in depth when there is potential for cave-in:
         1) Where such designs vary from excavation support standards set forth in CCR, Title 8, Chapter 4, Subchapter 4, Article 6, submit design calculations pursuant to general engineering design practice.
         2) Provide means for safe and stable excavations that are not less effective than required in CCR, Title 8, Chapter 4, Subchapter 4, Article 6.
         3) The preceding requirements do not apply to trench excavation support conforming to standards set forth CCR, Title 8, Chapter 4, Subchapter 4, Article 6.
      b. Dewatering:
         1) Dewater soil inside shoring as specified in Section 02240.
         2) Do not lower groundwater outside of shoring more than 1 foot.
         3) Recharge groundwater outside shoring to limit groundwater draw down outside of shoring to amount specified above.
      c. When electing to design with material stresses for temporary construction higher than allowable stresses prescribed in building code as specified in Section 01410, increase in such stresses shall not exceed 10 percent of value of prescribed stresses.
      d. Minimum safety factor used for design shall not be less than 1.5.
      e. The calculated minimum depth of penetration of shoring below bottom of excavation shall be increased not less than 30 percent if full value of allowable passive pressure is used in design.
      f. Maximum height of cantilever shoring above bottom of excavation shall not exceed 15 feet. Use braced shoring when height of shoring above bottom of excavation exceeds 15 feet.
      g. The location of point of fixity for shoring shall not be less than half calculated minimum embedment depth below bottom of excavation.
      h. Generally acceptable references for design of shoring and excavations are as follows:
         1) ASCE Guidelines of Engineering Practice for Braced and Tied-Back Excavations.
         2) Caltrans California Trenching and Shoring Manual.
         3) NAVFAC Design Manual 7.2.
         4) NAVFAC Design Manual 7.3.
         5) USS Steel Sheet Piling Design Manual.
      i. Maximum total deflection of shoring at any point on shoring shall not be more than 1/4 inch.

2. Soldier piles and lagging:
    a. Provide lagging over full face of excavation. Joints between pieces of lagging shall be tight to prevent loss of soil.
    b. Provide full face lagging all around penetrations through lagging.
    c. If the soldier piles are installed in predrilled holes and are not concrete encased, fill predrilled holes with controlled low strength material as specified in Section 02312 after soldiers piles are installed.
    d. Assumed effective width for passive soil resistance:
        1) Effective width of driven soldier piles shall not exceed 2 times width of pile.
        2) Effective width of CLSM encased soldier piles in drilled holes shall not exceed 2 times width of pile.
        3) Effective width of concrete encased soldier piles shall not exceed 2 times width of concrete encasement.
    e. Fill voids behind lagging with gravel or other material acceptable to Engineer.
    f. Apply loads from tie back soil, rock, or deadman anchors concentrically to soldier piles or wales spanning between soldier piles:
        1) Wales shall be back-to-back double channels or other members acceptable to Engineer.
        2) Do not eccentrically load structural section of soldier piles or wales.
    g. Design soldier piles for downward loads including vertical loads from tieback anchors.
3. Soil anchors, rock anchors, and deadman anchors:
    a. Design tieback anchors for a safety factor of not less than 2 times calculated load from shoring.
    b. Proof load all production anchors to 125 percent of calculated load from shoring.
    c. Lock off production anchors at calculated load from shoring.
    d. Length of soil anchors used to calculate resistance to load from shoring shall not include any length within potential active pressure soil failure zone behind face of shoring.
    e. Design tie rods for tieback anchors for 130 percent of calculated load from shoring.
    f. Design tie rods for tieback anchors for 150 percent of the calculated load from shoring when tie rod couplers are used and for other conditions where stress concentrations can develop.
4. Set inside face of shoring back from structure not less than greater of following:
    a. 5 feet from face of wall.
    b. 2 foot 6 inches from edge of foundation.
    c. Depth of excavation below bottom of foundation.

C. Performance requirements:
1. General:
    a. Support faces of excavations and protect structures and improvements in vicinity of excavations from damage and loss of function due to settlement or movement of soils, alterations in ground water level caused by such excavations, and related operations.
    b. Specified provisions:
        1) Complement, but do not substitute or diminish, obligations of Contractor for furnishing of safe place of work pursuant to provisions

of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for protection of Work, structures, and other improvements.

2) Represent minimum requirement for:
   a) Number and types of means needed to maintain soil stability.
   b) Strength of such required means.
   c) Methods and frequency of maintenance and observation of means used for maintaining soil stability.

2. Provide safe and stable excavations by means of sheeting, shoring, bracing, sloping, and other means and procedures, such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain stability of soils and rock.
3. Provide support for trench excavations for protection of workers from hazard of caving ground.
4. Provide shoring:
   a. Where, as result of excavation work and analysis performed pursuant to general engineering design practice, as defined in this Section:
      1) Excavated face or surrounding soil mass may be subject to slides, caving, or other types of failures.
      2) Stability and integrity of structures and other improvements may be compromised by settlement or movement of soils, or changes in soil load on structures and other improvements.
   b. For trenches 5 feet and deeper.
   c. For trenches less than 5 feet in depth, when there is potential for cave-in.
   d. Where indicated on the Drawings.
5. For safe and stable excavations, use appropriate design, construction, and maintenance procedures to minimize settlement of supported ground and to prevent damage to structures and other improvements, including:
   a. Using stiff shoring systems.
   b. Following appropriate construction sequence.
   c. Using shoring system that is tight enough to prevent soil loss through the shoring.
   d. Using shoring system that extends far enough below bottom of excavation to prevent piping, heave, or flow of soil under shoring.
   e. Design for safety factor of not less than 1.50.
   f. Providing surface runoff routing and discharge away from excavations.
   g. Where dewatering inside shoring is necessary, recharge groundwater outside shoring as necessary to prevent settlement in area surrounding shored excavation.
   h. Where sheet piling is used, use interlocking type sheets:
      1) Sheet piles shall be continuous and driven in interlock.
      2) If bottom of the excavation is located below the water table, use “ball and socket” or "thumb and finger" type interlock.
   i. Not applying shoring loads to existing structures and other improvements.
   j. Not changing existing soil loading on existing structures and other improvements.
   k. Provide welded steel packing between soil retaining members such as sheet piles and wales and similar members when gap exceeds 1/2 inch before wales are loaded.

1.05 SUBMITTALS

A. Shop drawings and calculations:
   1. Calculations for different load, support, and other conditions that occur during the sequence of installation of shoring, construction of facilities protected by shoring, and sequence of removal of shoring.
   2. Sketches showing the condition at various stages of installation and removal of shoring.
   3. Show on plan shoring, structures, pipelines, and other improvements located near shoring.
   4. When utilities penetrate shoring, show location of penetrations on elevation of all sides of shoring.
   5. Show details for ground support and sealing around utility penetrations.
   6. Indicate method used for installing driven shoring.

B. Written geotechnical report with soil characteristics and design recommendations.

C. Control points and schedule of measurements:
   1. Submit location and details of control points and method and schedule of measurements.
   2. Survey data.

D. Detailed sequence of installation and removal of shoring:
   1. Consider effects of ground settlement in sequence of installation and removal of shoring.
   2. Provide sketches showing conditions at various stages in sequence of installation and removal of shoring.

E. Submit submittals for excavation support and protection as complete package and include all items required in this Section:
   1. Incomplete submittals will not be reviewed and will be returned for resubmittal as complete package.

F. Submit dewatering submittals as specified in Section 02240 with submittals for excavation support and protection.

1.06 SEQUENCING

A. Do not begin construction of any shoring or excavation operations until:
   1. Submittals for shoring and dewatering have been accepted.
   2. Control points as specified in this Section and on existing structures and other improvements as indicated on the Drawings have been established and surveyed to document initial elevations and locations.
   3. Materials necessary for installation are on site.

B. Submit submittals minimum of 60 days prior to scheduled date to begin excavation work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Installation of shoring:
   1. Install means for providing safe and stable excavations as indicated in submittals.

B. Removal of shoring:
   1. Except for concrete encased soldier piles, slurry walls, and similar shoring systems, remove shoring by completion of Work.
   2. Select shoring system and method of removal, which will minimize soil that sticks to shoring from creating voids and causing settlement.
   3. To prevent settlement caused by pulling shoring, fill voids with pressure injected grout:
      a. Inject grout starting at bottom of void and progressively fill void to grade.
      b. Minimize length of shoring removed ahead of grouting operation and limit time void is left ungrouted to prevent void from closing up before being grouted.
   4. Pressure preservative treated wood lagging may be left in place if acceptable to Engineer.

C. Control points:
   1. Establish control points on shoring and on structures and other improvements in vicinity of excavation for measurement of horizontal and vertical movement:
      a. Set control points on shoring support system:
         1) Set points at distances not exceeding 25 feet at each support level.
   2. Promptly upon completion of construction of control points survey control points. Submit copy of field notes with measurement.
   3. Perform horizontal and vertical survey and measurement of control points at least once every week:
      a. Field notes shall show current measurement and change in measurement from first measurement taken.
   4. Set control points on corners of existing structures and on curbs, manholes, and other improvements at the locations indicated on the Drawings.
   5. Provide plumb bobs with horizontal targets indicating original position of plumb bobs in relation to shoring at control points.

D. Maintenance:
   1. Where loss of soil occurs, plug gap in shoring and replace lost soil with fill material acceptable to Engineer.
   2. Where measurements and observations indicate possibility of failure or excessive movement of excavation support, determined in accordance with general engineering design practice, take appropriate action immediately.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to site grading for buildings, basins, reservoirs, boxes, roads, and other facilities.
   2. Backfilling and compacting under and around structures.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01354 - Hazardous Material Procedures.
      b. Section 01355A - Stormwater Pollution Prevention Construction Activities: Best Management Practices.
      c. Section 02050 - Soils and Aggregates for Earthwork.
      d. Section 02240 - Dewatering.
      e. Section 02312 - Controlled Low Strength Materials (CLSM).
      f. Section 02620 - Filter Fabric.
      g. Section 02621 - Stabilization Fabric.
      h. Section 03300 - Cast-In-Place Concrete.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
   2. D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN m/m^3)).
   3. D 6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 DEFINITIONS

A. Backfill adjacent to structure: Backfill within volume bounded by the exterior surfaces of structure, the surface of undisturbed soil in the excavation around structure, and finish grade around structure.

B. Embankments: Dikes, levees, berms, and similar facilities.

C. Excavation: Consists of loosening, removing, loading, transporting, depositing, and compacting in final location, wet and dry materials, necessary to be removed for purposes of construction of structures, ditches, grading, roads, and such other purposes as are indicated on the Drawings.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Where mud or other soft or unstable material is encountered, remove such material and refill space with stabilization material. Wrap stabilization material with stabilization fabric.
   2. Obtain acceptable import material from other sources if surplus obtained within Project site does not conform to specified requirements or are not sufficient in quantity.
   3. No extra compensation will be made for hauling of fill materials nor for water required for compaction.

1.05 SUBMITTALS

A. Copy of Property Owner’s Agreement allowing placement of surplus soil material on their property.

B. Excavation plan.

C. Testing lab: Submit Contractor's proposed testing laboratory capabilities and equipment.

D. Test reports:
   1. Submit certified test reports of all tests specified to be performed by the Contractor.
   2. Sign and seal test reports by a registered Geotechnical Engineer registered in the State of California.

1.06 QUALITY ASSURANCE

A. Initial compaction demonstration:
   1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
      a. 50 cubic yards of backfill adjacent to structures.
      b. 100 cubic yards of embankment work.
      c. 100 cubic yards of fill.
      d. 50 cubic yards of roadway base material.
      e. 100 cubic yards of road fill.
   2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.
   3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under "FIELD QUALITY CONTROL."

B. Contractor shall perform all work related to this Section in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP) and as specified in Section 01355A.

1.07 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements specified in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it at specified locations.

C. Excavation, backfilling, and filling: Perform excavation, backfilling, and filling during construction in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water for compacting: Use water from source acceptable to Engineer.

B. Soil and rock materials:
   1. General:
      a. Provide aggregate base course, Class 2 permeable, controlled low-strength material, drain rock, gravel, suitable native material, sand, select material, and stabilization material where specified or indicated on the Drawings.
      b. If suitable surplus materials are available, obtain suitable native material and select material from cut sections or excavations.
   2. Aggregate base course materials: As specified in Section 02050.
   3. Class 2 permeable: As specified in Section 02050.
   4. Drain rock: As specified in Section 02050.
   5. Gravel: As specified in Section 02050.
   6. Suitable native material: As specified in Section 02050.
   7. Sand: As specified in Section 02050.
   8. Select material: As specified in Section 02050.
   9. Stabilization material: As specified in Section 02050.

C. Controlled low-strength material: As specified in Section 02312.

D. Geotextile fabrics:
   1. Filter fabric: As specified in Section 02620.
   2. Stabilization fabric: As specified in Section 02621.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Character and quantity of material:
      a. Verify character and quantity of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in work to be performed.

b. Determine gradation, shrinkage, and swelling of soil, and suitability of material for use intended in work to be performed.
c. Determine quantity of material, and cost thereof, required for construction of backfills, cuts, embankments, excavations, fills, and roadway fills, whether from onsite excavations. Include in cost of work to be performed.
d. Include wasting of excess material, if required, in cost of work to be performed.

3.02 PREPARATION

A. Backfills:
1. After clearing and excavation are completed, scarify entire areas that underlie backfills or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified before placing backfill material or concrete.
3. Do not place backfill against walls until:
   a. Walls have been cast full height of structure and concrete has reached the specified strength.
   b. Connecting slabs and beams have been cast, and concrete has reached the specified strength.
4. Prior to backfilling:
   a. Remove all forms.
   b. Clean all trash and debris from the excavation site.
5. After inspection of foundation, walls, and pipes, place backfill symmetrically around structures to prevent eccentric loading of structures.

B. Embankments:
1. After clearing is completed, scarify entire areas that underlie embankments to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for embankments before placing of embankment material.

C. Fills:
1. After clearing is completed, scarify entire areas that underlie fill sections or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for compacted fills before placing of fill material or concrete.

D. Roadway fills:
1. After clearing is completed, scarify entire areas that underlie roadway fills to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for roadway fills before placing of roadway fill material.

E. Sloped surfaces for fill or foundations:
   1. Foundations for fill having slopes in excess of 1 vertical to 4 horizontal:
      a. Bench or terrace to adequately key existing ground and fill built thereon.
   2. Slopes of original hillsides and old fills: Bench minimum of 10 feet horizontally as fill is placed.
   3. Provision of new benches:
      a. Start new bench wherever vertical cut of next lower bench intersects existing grade.
      b. Recompact material thus cut out along with new embankment material at no additional cost to the Owner.

3.03 INSTALLATION

A. General:
   1. Dispose of excavated materials that are not required or are unsuitable for fill and backfill in lawful manner.
   2. Dispose of surplus material on private property only when written permission agreement is furnished by owner of property. Submit copies of such agreements.
   3. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension: Remove from project site at no additional cost to the Owner.
   4. Stabilization of subgrade: Provide materials used, or perform work required, to stabilize subgrade so it can withstand loads that may be placed upon it by Contractor's equipment.

B. Removal of landfill material:
   1. Buried landfill material exists under the sites of many of the new structures, pavement, piping, ductbanks and other utilities. Landfill material generally consists of rubbish, including glass, metals, pieces of concrete, paving, bricks, plastics, woods, and tires. Structural drawings for each facility indicate estimated depth from existing grades, through landfill materials and to firm native soils material in the area of the facility. If not otherwise indicated on the drawings, assume a landfill material depth from the existing ground surface down to elevation 86.00. This information is based on information obtained from the geotechnical investigations for this project. See Instructions to Bidders for information on obtaining copies of these investigations.
      a. For bidding purposes, assume that all landfill material is Class III material.
      b. Any hazardous material encountered shall be handled as specified in Section 01354.
      c. Costs of handling hazardous materials excavated from landfill shall be made in accordance with Article 11 of the General Conditions.
   2. Excavation and sampling of landfill material shall be as follows:
      a. Provide 3 weeks' notice to Engineer before beginning excavation of landfill material.
      b. Excavate landfill material and stockpile at the location designated on the Drawings.
      c. Excavate landfill material in lots of 500 cubic yards each. Stockpile the 500 cubic yard lots of landfill material in separate piles. Provide a sign indicating lot number and date excavated.
      d. For every 500 cubic yards, the Owner will sample the soil immediately beneath the landfill material. The sample will be tested by the Owner

using the wet extraction test to determine if the material from the corresponding 500 cubic yard lot is suitable for Class III disposal.

e. Assume that all excavated landfill material must be stockpiled at the site within the contract time prior to disposal pending Owner's sampling results.

3. Disposal of excavated materials from areas identified to be within the limits of existing debris fill shall be as follows:
   a. Base bid:
      1) After the Owner has completed all testing and reviewed the testing results, remove all excavated materials not required by the Contract Documents for fill or backfill from the project site and dispose of them in a lawful manner.
   b. Bid Alternative B:
      1) After the Owner has completed all testing and reviewed the testing results, scavenge the landfill material for recyclable materials.
      2) Screen all excavated materials to segregate 3/4-inch minus soils from landfill debris.
      3) Stockpile screened materials meeting the requirements of suitable native materials on the project site at a location approximately 300 feet south of Secondary Effluent Equalization Basin No. 2. Coordinate exact stockpile location with Owner.
      4) Remove and dispose off-site all recyclable materials, remaining debris, and soils that do not meet the definition of suitable native material.
   c. For bidding purposes, assume the excavated materials from areas identified to be within the limits of the existing debris fill on the Drawings and between the ground surface and elevation 86.00 can be characterized as follows:
      1) 10% of the excavated volume will consist of debris that will need to be disposed at a Class III landfill.
      2) 5% of the excavated volume will consist of concrete and rubble.
      3) The remaining 85% of the excavated volume will be 3/4-inch minus soil material.
4. Disposal of existing landfill debris stockpiles:
   a. Contractor shall dispose of the existing landfill debris and other material stockpiles located at the western boundary line of the site as indicated on the Drawings.
   b. Existing stockpiled materials generally consists of rubbish, including glass, metals, pieces of concrete, paving, bricks, plastics, woods, and tires intermixed with soils.
   c. The Contractor is responsible for estimating the total quantity of existing stockpiled material requiring disposal during the bid period and including this work in the base bid price.

C. Borrow area: There is no borrow area on Project site:
   1. Where material is required, import material from source located off Project site selected by the Contractor and subject to acceptance by the Engineer.
   2. There will be no additional cost to the Owner for use of imported material.

D. Compaction:
   1. Provide specified compaction for backfills, cuts, embankments, fills, roadway fills, and other earthwork.

2. Perform confirmation tests to verify and confirm that work has complied, and is complying at all times, with compaction requirements specified in this Section for initial compaction demonstration and field quality control testing.
3. In-place density of compacted backfills, cuts, embankments, fills, and roadway fills determined in accordance with ASTM D 1556, or with ASTM D 6938.
4. Maximum density obtained in laboratory when tested in accordance with ASTM D 1557.
5. To prevent damage to structures due to backfilling operations, place backfill with equipment that does not exceed H-20 loading, within a distance from the face of the structure of not less than 1/2 the depth of backfill. The depth of backfill is the distance between the level being compacted and the bottom of the excavation. Outside this distance, heavier compaction equipment may be used.
6. Compact to percentage of maximum density as follows:
    a. Backfill adjacent to structures: 95 percent.
    b. Backfilling voids: 95 percent.
    c. Embankments: 95 percent.
    d. Other areas: 85 percent.
    e. Spoil areas indicated on the Drawings: No minimum required.
    f. Under present and future structures: 95 percent.
    g. Under roadways, parking and storage areas, curbs, and sidewalks: 95 percent.
    h. Upper 6 inches of cuts: 95 percent.
    i. Fills: 95 percent.

E. Dewatering: As specified in Section 02240.

F. Excavation:
1. Blasting: Not permitted.
2. Excavations in Landfill Areas:
    a. Buried landfill material exists under the sites of many new structures, pavement, piping, ductbanks, basins, ditches, gutters, and other items.
    b. At a minimum, provide excavations conforming to dimensions and elevations indicated on the Drawings and required by the Specifications.
    c. Where landfill material is encountered, continue excavation to at least 1 foot below the bottom of any landfill material layer:
        1) Unless otherwise approved by the Engineer, provide uniform depth of engineered fill below bearing level of a structure or other facility.
3. Excavations for structures:
    a. Provide excavations conforming to dimensions and elevations indicated on the Drawings for each structure, including trenching for piping and all work incidental thereto.
    b. After clearing is complete, excavate for the structure, down to the elevation indicated on the Drawings. Unless directed by Engineer, do not carry excavations below elevation indicated on the Drawings.
    c. Where soil is encountered having unsuitable bearing value, Engineer may direct in writing that excavation be carried to elevations below those indicated on the Drawings.
    d. Where excavations are made below elevations indicated on the Drawings, adjust elevations of excavations in accordance with the following requirements:

1) Under slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
2) Under footings: Restore to the proper elevation using one of the following:
a) Aggregate base course.
b) Controlled low-strength material.

e. Excavation width:
1) Extend excavations at least 2 feet clear from walls and foundations of structures to allow for placing and removal of forms, installation of services, and inspection.
a) In areas where landfill debris is encountered, extend excavations at least 5 feet clear of walls and foundations.
2) Do not undercut slopes.

f. Difficulty of excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.

4. Excavation of lined channels:
a. Excavations in open cut for lined channels may be made so as to place concrete directly against excavated surfaces providing faces of excavations are:
1) Firm and unyielding.
2) Will stand or can be made to stand without sloughing.
b. Excavations to provide subgrade for lined channel or subdrainage material: Excavate to lines and grades indicated on the Drawings.

5. Excavation of unlined channels and basins:
a. Excavate to lines and grades indicated on the Drawings.
b. Perform excavation and grading so that finish surfaces are in uniform planes with no abrupt breaks in surface.

6. Excavation of ditches and gutters:
a. Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.
b. Take care not to excavate ditches and gutters below grades indicated on the Drawings.
c. Backfill excessive ditch and gutter excavations to grade with suitable material acceptable to the Engineer.
d. Do not deposit any material within 3 feet of edge of ditch unless otherwise indicated on the Drawings.

7. Necessary over excavation:
a. Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified in backfilling of voids below, or as acceptable to the Engineer.
b. Backfill voids with material acceptable to the Engineer:
1) With acceptance of the Engineer, backfill with one of the following:
a) Aggregate base course.
b) Controlled low-strength material.

G. Materials for backfills, embankments, fills, and roadway fills:
1. General:
a. Obtain import material from other sources if surplus materials from cuts and excavations obtained from within Project site do not conform to specified requirements or are not sufficient in quantity for construction of Project.

2. Backfills:
    a. Backfill adjacent to structures, slabs, or walls: Suitable native material or imported material meeting the requirements of select material, unless otherwise specified or indicated on the Drawings.
    b. Backfill material under concrete structures: Aggregate base course material, except in areas where controlled low-strength material or concrete encasement are indicated on the Drawings.
    c. Extend backfill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
3. Embankments:
    a. Suitable native material or imported material meeting the requirements of select material, unless otherwise specified or indicated on the Drawings.
4. Fills:
    a. Suitable native material or imported material meeting the requirements of select material, unless otherwise specified or indicated on the Drawings.
    b. Extend fill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
5. Roadway fills: One of the following, unless otherwise specified or indicated on the Drawings:
    a. Aggregate base course material.
    b. Suitable native material or imported material meeting the requirements of select material.

H. Placement:
1. General:
    a. Lines and grades:
        1) Construct backfills, embankments, fills, and road fills, at locations and to lines and grades indicated on the Drawings.
        2) Overbuild all permanent fill slopes by at least 1 foot and then cut to final grade to provide adequate compaction of the remaining fill.
2. Backfills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 4 percent above optimum moisture content before compacting.
    c. Defective compacted backfills: Remove and recompact.
3. Fills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 4 percent above optimum moisture content before compacting.
    c. Defective compacted fills: Remove and recompact.
4. Coarse fill:
    a. When materials are coarsely graded so that performance of field density tests are impossible:
        1) Placement and compaction: Place material in lifts so as to obtain compacted thickness of 6 inches and roll with pneumatic roller or power roller.
        2) Moisture content: Provide moisture content of fraction of material passing 3/4-inch sieve within plus or minus 2.0 percent of optimum moisture as determined in accordance with ASTM D 1557, Method C.

5. Embankments:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 4 percent above optimum moisture content before compacting.
    c. Defective compacted embankments: Remove and recompact.
6. Roadway fills:
    a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
    b. Bring each layer to a moisture content between optimum moisture content and 4 percent above optimum moisture content before compacting.
    c. Defective compacted roadway fills: Remove and recompact.
7. Loose fill:
    a. In disposal areas: In disposal areas as indicated on the Drawings, bring fill up in an essentially level layer over entire spoil area indicated:
        1) Continue filling spoil area until disposal of surplus excavated material is completed.
        2) Slope edges of fill area at between 1 and 2 horizontal to 1 vertical to the intersection with existing grade.
        3) Provide slopes that are smooth and uniform.
        4) Level finished surface of disposal area to within 4 inches of elevation indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Tests:
    1. Confirmation tests:
        a. Contractor's responsibilities:
            1) Accomplish specified compaction for backfills, fills, and other earthwork.
            2) Control operations by confirmation tests to verify that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.
        b. Frequency of confirmation testing:
            1) Perform testing not less than the following:
                a) In-place density:
                    (1) Backfill: 1 test every 50 cubic yards.
                    (2) Embankments: 1 test every 200 cubic yards.
                    (3) Fills: 1 test every 200 cubic yards.
                    (4) Roadway Fills: 1 test every 50 cubic yards.
                b) Maximum dry density versus moisture:
                    (1) Backfill: 1 test every 500 cubic yards.
                    (2) Embankments: 1 test every 1,000 cubic yards.
                    (3) Fills: 1 test every 500 cubic yards.
                    (4) Roadway Fills: 1 test every 500 cubic yards.
    2. Compliance tests:
        a. Periodic compliance tests will be made by the Engineer to verify that compaction is meeting requirements previously specified.
        b. Remove overburden above level at which the Engineer wishes to test. Backfill and recompact excavation after testing is completed.
        c. If compaction fails to meet specified requirements, perform remedial work by one of the following methods:

1) Remove and replace materials at proper density.
2) Bring density up to specified level by other means acceptable to the Engineer.

d. Retesting:
1) Contractor bears the costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements.
2) Contractor's confirmation tests during performance of remedial work: Double the normal rate specified.

B. Tolerances:
1. Finish grading of backfills, cuts, embankments, fills, and roadway fills:
a. Perform fine grading under concrete structures such that finish surfaces are never above the grade or cross section indicated on the Drawings and are never more than 0.10 feet below.
b. Provide finish surface for areas outside of structures that are within 0.10 feet of grade or cross section indicated on the Drawings.
2. Unlined channels and basins:
a. In both cut and fill, and levee and access road side slopes in cut: Vertical tolerance of none above and 3 inches below grade indicated on the Drawings on bottom and side slopes.
b. On top surface of levee and access road in both cut and fill, and levee and access road side slopes in fill: Vertical tolerance of none below and 3 inches above grade indicated on the Drawings.
3. Areas which are not under structures, concrete, asphalt, roads, pavements, sidewalks, dikes, and similar facilities:
a. Provide finish graded surfaces of either undisturbed soil, or cohesive material not less than 6 inches deep.
b. Intent of proceeding is to avoid sandy or gravelly areas.
4. Finish grading of surfaces:
a. Reasonably smooth, compacted, and free from irregular surface changes.
b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
c. Uniformly grade areas that are not under concrete.
d. Finish ditches and gutters so that they drain readily.

3.05 ADJUSTING

A. Finish grades of excavations, backfills, and fills:
1. Repair and reestablish grades to required elevations and slopes due to any settlement or erosion that may occur from action of the elements or any other cause prior to final acceptance.

3.06 PROTECTION

A. Finish grades of backfills, cuts, excavations, and fills:
1. Protect newly graded areas from erosion and deterioration by action of the elements.

B. Ditches and gutters:
1. Maintain ditches and gutters free from detrimental quantities of debris that might inhibit drainage until final acceptance.

END OF SECTION

SECTION 02318

TRENCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Trench excavation, fine grading, pipe bedding, backfilling, and compaction for the following, including requirements for ditch crossings:
   1. Pipes.
   2. Direct buried electrical and control conduits.
   3. Electrical and control duct banks.
   4. Manholes, valves, or other accessories.
   5. Potable water pipe appurtenances.

B. Related sections:
   1. Section 02050 - Soils and Aggregates for Earthwork.
   2. Section 02240 - Dewatering.
   3. Section 02260 - Excavation Support and Protection.
   4. Section 02300 - Earthwork.
   5. Section 15956 - Piping Systems Testing.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
   2. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   3. D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

A. Lab certification.

B. Confirmation test reports.

1.04 QUALITY ASSURANCE

A. Initial compaction demonstration:
   1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
      a. 200 linear feet of trench backfill.
   2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.

3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under "FIELD QUALITY CONTROL."

PART 2 PRODUCTS

2.01 MATERIALS

A. Soil and rock materials:
   1. Aggregate base course material: As specified in Section 02050.
   2. Gravel: As specified in Section 02050.
   3. Suitable native material: As specified in Section 02050.
   4. Sand: As specified in Section 02050.
   5. Select material: As specified in Section 02050.

PART 3 EXECUTION

3.01 PREPARATION

A. General:
   1. Embankment condition:
      a. Exists where width of trench exceeds limits specified in this Section.
      b. Before laying pipes in fill, place fill and compact it to not less than 2 feet above top of pipe.
      c. After placing and compacting fill, excavate pipe trench through fill.

B. Protection: Stabilize trench excavations as specified in Section 02260.

3.02 INSTALLATION

A. Trench excavation:
   1. General requirements:
      a. If, because of soil conditions, safety requirements, or other reasons, trench width at top of pipe is increased beyond width specified in this Section, upgrade laying conditions or install stronger pipe designed in conformance with Specifications for increased trench width, without additional cost to Owner.
      b. Excavate bottom of trench to depth indicated on the Drawings. The bottom of the trench excavation shall be firm and dry.
   2. The trench may be excavated by machinery to the grade indicated on the Drawings provided that the soil material remaining in the bottom of the trench is no more than slightly disturbed.
   3. Landfill Excavation and Removal:
      a. Portions of this project will be constructed in landfill. Landfill material generally consists of rubbish including glass, metal, pieces of concrete, paving, bricks, plastics, wood, and tires. Excavate and remove this material as specified in Section 02300.
      b. Landfill material found in trenches outside areas designated on the Drawings for structural excavation and backfill shall be excavated and filled as shown on Typical Detail P002.

c. Where landfill material is found to extend below the trench depth indicted on the drawings, remove material to firm, native soil. Restore trench bottom to proper grade by backfilling with aggregate base course material compacted to 95 percent of maximum density.

4. Rock:
   a. Pipe: If bottom of trench excavation is found to consist of rock or any material that by reason of its hardness cannot be excavated to provide uniform bearing surface, remove such rock or other material to a depth of not less than 4 inches below bottom of fine grading material. Backfill overcut with aggregate base course material compacted to 95 percent of maximum density up to bottom of fine grading material.
   b. Direct buried electrical and control conduits: If bottom of trench excavation is found to consist of rock or any material that by reason of its hardness cannot be excavated to provide uniform bearing surface, remove such rock or other material to a depth of not less than 4 inches below bottom of conduit bedding material. Backfill overcut with aggregate base course material up to bottom of conduit bedding material.
   c. Electrical and control duct banks: If bottom of trench excavation is found to consist of rock or any material that by reason of its hardness cannot be excavated to provide uniform bearing surface, remove such rock or other material to a depth of not less than 4 inches below bottom of concrete duct bank. Backfill overcut with aggregate base course material up to bottom of concrete duct bank.
5. Overcut of trench bottom: Where the bottom of the trench is excavated below the depth indicated on the Drawings, restore trench bottom to proper grade by back filling with aggregate base course material compacted to 95 percent of maximum density, at no additional cost to Owner.
6. Soft or unstable material:
   a. If bottom of excavation is found to consist of soft or unstable material which is incapable of providing proper support, remove such material to a depth and for the length required, as determined by the Engineer. Backfill trench to bottom of fine grading material with aggregate base course material compacted to 90 percent of maximum density.
7. Trench widths:
   a. Minimum clear width of trench for pipe (measured at top of pipe):
      1) For pipe sizes 4 inches to and including 24 inches: Not less than outside diameter of pipe plus 18 inches.
      2) For pipe sizes larger than 24 inches: Not less than outside diameter of pipe plus 24 inches.
   b. Maximum clear width of trench for pipe (measured at top of pipe):
      1) For pipe sizes 4 inches to and including 24 inches: Not to exceed outside diameter of pipe plus 24 inches.
      2) For pipe sizes larger than 24 inches: Not to exceed outside diameter of pipe plus 36 inches.
8. For manholes, valves, or other accessories:
   a. Provide excavations sufficient to leave at least 12 inches clear between their outer surfaces and sides of trench or shoring.
   b. Backfilling of manhole excavation: Conform to backfilling requirements as specified for trenches in this Section.
   c. Backfill under manholes, vaults, tanks, or valves with aggregate base course material. Do not backfill with soil.

d. Fill any unauthorized excess excavation below elevation indicated on the Drawings for foundation of any structure with aggregate base course material at no additional cost to Owner.

9. Potable water pipe appurtenances:
   a. Lay in trenches separate from those used for sewers.
   b. Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 3 feet below surface of ground and located at distance of not less than 10 feet from any parallel sewer trench.
10. At road crossings or existing driveways:
   a. Make provision for trench crossings at these points, either by means of backfills, tunnels, or temporary bridges.

B. Dewatering: As specified in Section 02240.

C. Pipe fine grading:
1. Schedule fine grading material as specified in this Section.
2. For pipes 16 inches in nominal diameter and under:
   a. Place 4 inches of fine grading material below bottom of pipe.
   b. Place fine grading material at uniform density, with minimum possible compaction.
3. For pipe over 16 inches in diameter:
   a. Place 4 inches, or 1/12 the outside diameter of pipe, whichever is greater, of fine grading material below bottom of pipe.
   b. Place fine grading material at uniform density, with minimum possible compaction.
4. Bell or coupling holes:
   a. Dig holes after trench bottom has been graded.
   b. Provide holes of sufficient width to provide ample room for grouting, banding, or welding.
   c. Excavate holes only as necessary for making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.
5. Depressions for joints, other than bell-and-spigot:
   a. Make in accordance with recommendations of joint manufacturer for particular joint used.

D. Pipe bedding:
1. Schedule bedding material as specified in this Section.
2. After pipe laid:
   a. Place bedding material under and around pipe in 6 inch maximum lifts of bedding material, to level 12 inches above top of pipe. Compact to 90 percent of maximum density.
3. Pipe displacement:
   a. Take necessary precautions in placement and compaction of bedding material to prevent displacement of piping.
   b. In event there is movement or floating of the piping, re-excavate, re-lay, and backfill the pipe.

E. Trench backfill above pipe bedding, electrical and control conduit bedding, and electrical and control duct banks:
    1. Under structures:
        a. Backfill trench up to underside of structure with aggregate base course material as specified in Section 02050 compacted to 95 percent of maximum density.
    2. Cuts across roadways and paved streets:
        a. Backfill trench to underside of pavement with aggregate base course material as specified in Section 02050 compacted to 95 percent of maximum density.
    3. Under and parallel to roadways, paved areas, or storage areas:
        a. Backfill trench up to within 2 feet of finish grade with suitable native material or select material as specified in Section 02050 compacted to 95 percent of maximum density.
        b. Then backfill from 2 feet below finish grade to finish grade, or underside of aggregate base course or pavement as indicated on the Drawings with aggregate base course material as specified in Section 02050, compacted to 95 percent of maximum density.
    4. In areas outside the improved section of roadways or in open country:
        a. Backfill to finish grade with suitable native material or select material as specified in Section 02050 compacted to 90 percent of maximum density.
    5. Through earth slopes adjacent to, or supporting structures:
        a. Backfill to finish grade with aggregate base course material or select material compacted to 95 percent of maximum density.

F. Under existing intersecting pipes or conduits larger than 3 inches in diameter:
    1. Backfill from bottom of new pipe trench to spring line of intersecting pipe or conduit with aggregate base course material, as specified in Section 02050, compacted to 90 percent of maximum density.
    2. Extend aggregate base course material as specified in Section 02050 two feet on either side of intersecting pipe or conduit to ensure that material remains in place while other backfill is being placed.
    3. Backfill remainder of trench as specified in “Trench backfill above pipe bedding, electrical and control conduit bedding, and electrical and control duct banks” above.

G. Compaction:
    1. In-place density of compacted trench backfill, and bedding determined in accordance with ASTM D1556, or with ASTM D6938.
    2. Maximum density obtained in laboratory when tested in accordance with ASTM D1557.
    3. Consolidation:
        a. Do not use water settling methods such as flooding, poling, or jetting.

H. Excess material:
    1. Remove excess excavated material from the Project site as specified in Section 02300 and dispose of legally off site.

3.03 FIELD QUALITY CONTROL

A. Tests:
   1. Confirmation tests:
      a. Contractor's responsibilities:
         1) Accomplish specified compaction of trench backfill.
         2) Control operations by confirmation tests to verify and confirm that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.
         3) Cost of confirmation tests: Paid for by the Contractor.
         4) Qualifications of Contractor's testing laboratory: Acceptable to Engineer. Provide lab certification.
         5) Copies of confirmation test reports: Submit promptly to the Engineer.
      b. Frequency of confirmation testing:
         1) Perform testing not less than as follows:
            a) For trenches: At each test location include tests for each type or class of backfill from bedding to finish grade.
            b) In open fields: 2 every 1,000 linear feet.
            c) Along dirt or gravel road or off traveled right-of-way: 2 every 500 linear feet.
            d) Crossing paved roads: 2 locations along each crossing.
            e) Under pavement cuts or within 2 feet of pavement edges: 1 location every 400 linear feet.
   2. Compliance tests:
      a. Frequency of testing: Periodic compliance tests will be made by the Engineer to verify that compaction is meeting requirements previously specified.
      b. If compaction fails to meet specified requirements: Perform remedial work by one of the following methods:
         1) Remove and replace backfill at proper density.
         2) Bring density up to specified level by other means acceptable to the Engineer.
   3. Retesting:
      a. Costs of retesting: Contractor is responsible for the costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements.
      b. Contractor's confirmation tests during performance of remedial work:
         1) Performance: Perform tests in manner acceptable to the Engineer.
         2) Frequency: Double amount specified for initial confirmation tests.

B. Piping system testing:
   1. As specified in Section 15956.

3.04 SCHEDULES

A. Pipe fine grading materials:
   1. Fine grading material shall be the same as bedding material.

B. Bedding materials:
   1. Pipes:
      a. For pipe less than 16-inch nominal size: Except as otherwise specified, use sand or aggregate base course material.
      b. For pipe from 16- inch to 48-inch nominal size: Except as otherwise specified, use sand or aggregate base course material.
      c. For pipe over 48 inches: Aggregate base course material.
      d. For polyvinyl chloride or other plastic pipe less than 2 inches in diameter: Sand.
   2. Direct buried electrical and control conduits: Sand.

END OF SECTION

SECTION 02553

TEMPORARY BYPASS PUMPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for temporary bypass pumping of wastewater flows on plant sites as needed to complete the Work.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

1.03 GENERAL REQUIREMENTS

A. Provide all necessary labor, tools, materials, and supervision to provide temporary bypass pumping and flow control in accordance with the requirements of this Section.

B. Operate and maintain bypass pumping facilities including, but not limited to, pumps, piping, valves, controls, and monitoring until the involved portion(s) of the Work have been completed to the satisfaction of the Engineer.

C. Bypassing wastewater in a way that assures that no wastewater is allowed to leak outside of the bypass system or plant facilities. If leakage does occur, pay all fines and reimburse the Owner for all costs associated with the cleanup of the leakage, as wells as costs associated with legal actions.

D. Accept responsibility for any release of wastewater and for penalties associated with bypass pumping activities, including commissioning, operating, and decommissioning of bypass pumping facilities.

E. Coordinate the placement of the bypass piping and pumping equipment with the Owner.

F. The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities shall be the sole responsibility of the Contractor.

G. Except as otherwise specified or authorized in writing, no interruption of wastewater flow shall be permitted throughout the duration of the project. Contractor is responsible for all wastewater overflows during construction of this work and bypass operations.

H. Take precautions to prevent any potential spillage of wastewater from entering the stormwater system.

I. Temporary bypass pumping operation:
   1. Limited to the months, times, or seasons indicated, unless approved in writing by the Engineer.

J. Continuously monitor temporary bypass pumping.

K. Provide qualified operators continuously during operation of the bypass systems.

L. Maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass system:
   1. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

1.04 SUBMITTALS

A. Prepare and submit a project-specific wastewater bypass pumping plan with completed wastewater bypass pumping checklist:
   1. Be advised that the bypass plan must provide accessibility for pedestrians and vehicular traffic in accordance with Owner requirements.

B. Wastewater bypass pumping plan: Include the following at a minimum:
   1. Capacities and sizes of pumps, standby equipment, and power requirements, if applicable.
   2. Design calculations of the system and selected equipment, including flow, TDH with static head including all friction and minor losses, pump curves showing operating range of flow and TDH at minimum, average, and peak flow.
   3. Standby power generator size and location for electrically-driven bypass pumps.
   4. Downstream discharge plan.
   5. Pipe thrust and restraint types, sizes, and locations.
   6. Temporary pipe supports and anchoring required.
   7. Plans for access to bypass pumping locations.
   8. Schedule that shows duration of temporary bypass pumping including milestones for installation, maintenance, and removal of equipment and accessories.
   9. Means and methods of installing, operating, monitoring, and maintaining the temporary bypass pumping.
   10. Plan indicating bypass pumping line locations:
      a. Include details showing methods used to protect and identify the bypass pumping lines through the length of the bypass route.
   11. Detailed plans of a backup system.
   12. Address access for pedestrians and vehicular traffic.
   13. Mechanical plan showing equipment, valves, pipe sizes and locations, pipe materials, dimensions, vehicle access (where applicable), pedestrian access (where applicable).
   14. Schematic drawings and written description of the control system and its' operating sequence.
   15. Proposed type and location of collection system plugs.
   16. Catalog cut sheets for pumping equipment, pipe and fittings, valves.

17. Emergency response plan.
18. Staffing plan.
19. Spill prevention and cleanup plan.
20. Health and safety plan.
21. Maintenance history of pumps.
22. Operating permits from jurisdictional air quality agency for each engine.

1.05 QUALITY ASSURANCE

A. Contractor's qualifications:
   1. Minimum 5 years experience in performing substantially similar temporary bypass operations.
   2. Submit evidence of satisfactory operation of temporary bypass facilities similar to those specified in at least 5 separate projects in accordance with the specifications, including references.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

PART 2 PRODUCTS

2.01 BYPASSING SYSTEMS

A. System No. 1: Secondary Clarifiers 1 - 3 RAS System:

Bypass Pumping Schedule	**System No. 1**
General Characteristics	
Purpose	RAS piping tie-in at RAS vault near Filter Pump Station
Service	Return activated sludge (RAS)
Pumping Characteristics	
Peak Flow - (mgd)	10.0
Average Flow (mgd)	7.5
Minimum Flow (mgd)	4.0
Piping Characteristics	
Pipe Material	HDPE
Withdrawal Location	RAS Weir Structure Effluent Channel
Withdrawal Location Top of Wall Elevation (ft)	100.7 +/-
Withdrawal Location Invert Elevation (ft)	90.2 +/-
Withdrawal Location Maximum Allowable Water Surface Elevation (ft)	95.7 +/-
Finish Grade Adjacent to Structure (ft)	94.0 +/-
Discharge Location	Biotower Pump Station Influent Box

B. System No. 2: Aeration Basin Nos. 4-7 Splitter Box:

Bypass Pumping Schedule	**System No. 2**
General Characteristics	
Purpose	Installation of new gate at Aeration Basin Nos 4-7 Splitter Box

Bypass Pumping Schedule	System No. 2
Service	Biotower effluent
Pumping Characteristics (1) (2)	
Peak Flow (mgd)	24.0
Average Flow (mgd)	16.0
Minimum Flow (mgd)	8.0
Piping Characteristics	
Pipe Material	HDPE
Withdrawal Location	Aerations Basins 1-3 Influent Distribution Box (south of Aeration Basin No. 2)
Withdrawal Location Top of Wall Elevation (ft)	107.0 +/-
Withdrawal Locations Manhole Invert Elevation (ft)	97.9 +/-
Withdrawal Locations Maximum Allowable Water Surface Elevation (ft)	104.7 +/-
Finish Grade Adjacent to Withdrawal Structure (ft)	103.0 +/-
Discharge Locations	Aeration Basin Nos. 4-7 Splitter Box outlet boxes (3)

Notes:
1) Complete work in Dry Weather Season.
2) Flow rates assume Aeration Basins 4-7 in operation. Verify flow rates with Owner's operations staff.
3) Split discharge to individual outlet boxes (4 total) and provide flow control valving and flow monitoring device at each outlet box to allow flow to apportioned evenly to each aeration basin.

2.02 BYPASS PUMPS

A. Provide a minimum of 3 pumps: 2 duty and 1 standby.

B. Standby pumps shall be manifolded to the system and available at all times for immediate operation in the event that any duty pump becomes inoperable.

C. Pump capacity:
   1. Sufficient to pump the anticipated peak flow with the largest pump out of service.
   2. Sized to provide 100-percent redundancy of the bypass system design peak flow listed.
   3. Sized to provide continuous, uninterrupted operation to flows below the minimum flow rate listed.

D. Pumps:
   1. Packaged units with a skid base or trailer.
   2. Provide one the following:
      a. Electric driven pumps with diesel-powered generators. The Owner's power supply system shall not be used for bypassing pumping.
      b. Diesel powered pumping system.
   3. Fully automatic, self-priming, close-coupled centrifugal units that do not require use of foot valves or vacuum pumps for priming.

4. Non-clog design capable of passing 3-inch diameter solids and rags, rocks, hair, and other debris encountered in municipal wastewater.
5. Equipped with variable speed control capable of providing constant level setpoint control.
6. Provide minimum 24-hour capacity diesel fuel tank as defined by fuel consumption during peak pumping rate.
7. Provide fuel gauge with warning light when tank approaches empty.

E. Pumps shall be capable of dry operation to accommodate large fluctuations in flow.

F. The system shall include the following features:
1. START/STOP operation.
2. Variable flow based on maintaining a constant setpoint water level in suction structure.
3. Instrumentation and controls for operation and monitoring for each pump.

G. Electrical equipment, instrumentation and accessories: Suitable for Class 1 Division 1 service as defined by NFPA 820.

H. Comply with applicable air quality regulations.

2.03 BYPASS PIPING

A. Use HDPE, ductile iron, or steel piping for the temporary bypass pumping system.

B. Piping integrity: 0 leakage.

C. Provide sewage type air release valve at high point in piping and containment spills from valves.

D. Provide temporary ramps constructed over pipelines 6 inches in diameter or less to allow access to driveways:
1. Bury pipelines larger than 6 inches in diameter crossing driveways, a minimum of 6 inches below the existing ground or pavement surface and backfilled with temporary asphalt concrete.
2. No driveway access shall be blocked without the written authorization of the Owner.

E. Piping, fittings, and all accessories shall withstand 2.0 times the maximum pressure.

2.04 PIPE PLUGS IN EXISTING PIPE

A. Pipe diameters 24 inches and smaller: Mechanical plugs with rubber or EPDM gaskets.

B. Pipe diameters larger than 24 inches: Inflatable bag stoppers with 2 or more pieces.

2.05 NOISE CONTROL

A. Pumping equipment: Equipped with devices or enclosures for noise attenuation including but not limited to mufflers and/or acceptable noise panels or enclosures.

B. The noise level: At or below 75 decibels on the A-scale at 50 feet from the pumping equipment.

PART 3 EXECUTION

3.01 GENERAL

A. Notify the Owner a minimum of 60 days prior to the Work and notify the Engineer at least 36 hours prior to bypassing or diverting flow in any of the pipelines or laterals.

B. Place pumps, generators, and other equipment on a plastic tarp to protect against spills of petroleum products used by the equipment.

C. Before taking process or pipeline out of service, verify that bypass system is fully operational and acceptable to Engineer.

3.02 PROTECTION

A. Be responsible for all bypass flows:
   1. Inspect the entire bypass pumping and piping system for leaks or spills at a frequency of not less than 4 times per shift.
   2. Do not shutdown the temporary bypass system between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer.

B. Provide trained and qualified attendants 24 hours per day 7 days per week until the bypassing is no longer required. The attendants shall:
   1. Be capable of performing pump and piping maintenance required.
   2. Have cellular phones for communication with the Contractor and the Owner in the event of emergencies.

C. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted:
   1. In the event of any wastewater spill, be responsible for the prompt cleanup and disinfecting of the spill as called for in the wastewater bypass pumping plan.
   2. Compensate the Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.

D. Implement measures to prevent interference between plant staff and the bypass pumping equipment, pipelines and wastewater.

E. Take precautions to protect all bypass lines from damage:
   1. Clearly identify above ground portions of the bypass lines by flashers, fencing, or other means to warn of their presence.

3.03 FIELD QUALITY CONTROL

A. Hydrostatic pressure test:
   1. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times the maximum operating pressure.
   2. Conduct test for a duration of 2 hours.

3. Test using plant water.
4. The line in service after test if the pressure has been maintained and there are no observable leaks.
5. Notify Engineer at least 48 hours prior to testing.

B. Inspection:
1. Inspect temporary bypass piping system at a minimum of every hour 2 hours per day.
2. An attendant/operator shall be present to monitor the operation of the bypass pumps at all times 24 hours per day.
3. Inspection log: Keep at each pumping location.

3.04 CLEAN-UP

A. The temporary bypass pumping system: Flush, clean and drain prior to dismantling.

B. Dispose of flushing water in approved manner.

C. Disturbed areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including pavement restoration, at least equal to that which existed prior to start of Work.

END OF SECTION

SECTION 02581
PRECAST ELECTRICAL HANDHOLES AND ELECTRICAL MANHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Design, fabricate, and install precast electrical handholes and precast electrical manholes of the size and type indicated on the Drawings and specified.
   1. Construction of cast-in-place concrete electrical structures, including handholes and manholes, are specified in other Sections.

B. Section includes:
   1. Precast portland cement concrete handholes and accessories.
   2. Precast portland cement concrete manholes and accessories.

C. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's work.
   3. The following sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01410 - Regulatory Requirements.
      b. Section 01610 - Project Design Criteria.
      c. Section 01612 - Seismic Design Criteria.
      d. Section 02300 - Earthwork.
      e. Section 03150 - Concrete Accessories.
      f. Section 03300 - Cast-in-Place Concrete.
      g. Section 05500 - Metal Fabrications.
      h. Section 07110 - Dampproofing.
      i. Section 07900 - Joint Sealants.
      j. Section 08320 - Floor Access Doors.
      k. Section 09960 - High-Performance Coatings.
      l. Section 16050 - Common Work Results for Electrical.
      m. Section 16070 - Hangers and Supports.
      n. Section 16133 - Duct Banks.

D. Alternates:
   1. Contractor may propose to construct cast-in-place structures in lieu of the precast structures specified:
      a. Obtain Engineer's acceptance of this alternative before submitting, providing, or installing.
      b. Submit full information on design and detailing of proposed alternatives including design details and drawings of the same types required by this Section for precast structures.

1.02 REFERENCES

A. American Association of State Highway Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International (ASTM):
   1. A 48 - Standard Specification for Gray Iron Castings.
   2. C 857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   3. C 858 - Standard Specification for Underground Precast Concrete Utility Structures.
   4. C 891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
   5. C 1028 - Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
   6. C 1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.

D. Code of Federal Regulations (CFR):
   1. Title 29, Chapter XVII, Part 1910 - Occupational Safety and Health Standards (OSHA).

E. National Fire Protection Association (NFPA):
   1. National Electrical Safety Code (NEC).

F. National Precast Concrete Association (NPCA).

G. Society of Cable Telecommunications Engineers (SCTE):
   1. 77 - Specification for Underground Enclosure Integrity.

H. Underwriters Laboratories (UL).

1.03 DEFINITIONS

A. Handhole: An enclosure for use in underground systems that has been sized and detailed to allow personnel to reach into, but not enter, the enclosure to install, operate, or maintain equipment or wiring or both. (Reference: NEC, Article 100):
   1. As used in this Section, “handhole” will refer to a precast electrical handhole.

B. Manhole: An enclosure for use in underground systems that has been sized and detailed to allow personnel to enter the enclosure to install, operate, or maintain equipment or wiring or both:
   1. As used in this Section, “manhole” will refer to a precast electrical manhole.

C. Polymer concrete: A composite material consisting of an organic polymer binder mixed with embedded aggregate particles. Also known as “resin concrete.”

D. Portland cement concrete: A composite material consisting of a portland cement binder, water, admixtures, and a combination of fine and coarse mineral aggregates.

E. Precast concrete: A concrete fabrication designed by a qualified engineer and subsequently fabricated at a qualified fabrication site, which is usually located some distance from the site where the fabrication will be installed.

1.04 SYSTEM DESCRIPTION

A. General requirements for handholes and manholes:
   1. As specified in Section 16050 for general requirements for electrical work.
   2. Provide structures of the sizes and shapes indicated on the Drawings, with layouts, dimensions, and details as indicated on the Drawings and as specified.
   3. Conform to the requirements of:
      a. NEC.
      b. Project regulatory requirements as specified in Section 01410.

B. Polymer concrete handholes:
   1. Load resistance of boxes and covers:
      a. Conform to all provisions of SCTE 77 for Tier 5, 8, 15, or 22 applications as specified in this Section:
         1) Where multiple “Tiers” are specified, handholes shall adequately support compatible covers while providing the highest Tier rating specified.
         2) Load rating of cover for an assembly shall not exceed the load capability of the box below.
         3) Coefficient of friction between cover and box: Not less than 0.50 when measured in accordance with ASTM C 1028.
   2. Testing and certification:
      a. Each handhole to be installed shall have a report certifying that the design and construction of the unit has successfully passed all tests for materials and product performance required by SCTE 77:
         1) Testing and report shall be by a qualified testing agency, independent of the manufacturer. Test report shall bear the seal of a licensed professional engineer.
         2) Provide evidence of UL listing as required by NEC for products to be provided.

C. Portland cement concrete handholes and manholes:
   1. Load resistance of boxes and covers.
   2. Design requirements: Loads on structures:
      a. In accordance with ASTM C 857, except as modified in this Section.
      b. Loads at the ground surface:
         1) See “Electrical Handhole and Manhole Schedule” indicated on the Drawings for minimum surface loading requirements at each structure. Loads are designated as “sidewalk,” or ”roadway.”
         2) The vehicle and pedestrian loadings in the following paragraphs need not be additive; however, structures designated for “roadway” loading shall also support “sidewalk” loads.

3) “Sidewalk”: Load from regular pedestrian traffic with considerations for occasional non-deliberate vehicular traffic:
    a) Designation A-0.3 in ASTM C 857 Table 1; (300-psf uniform load).
4) ”Roadway”: Load from heavy, frequently repeated vehicle traffic:
    a) Designation A-16 in ASTM C 857 Table 1 (AASHTO HS20-44).

c. Lateral earth pressure loads:
    1) Determine in accordance with the following requirements. Include effects of groundwater and seismic accelerations on earth pressures:
        a) Equivalent lateral pressure: 55 pounds per square foot per foot of depth (triangular distribution) plus backfill-induced live load surcharge of 100 pounds per square foot (rectangular distribution).
        b) Surface surcharge load: In accordance with ASTM C 857 A-16 wheel load if such surcharge exceeds backfill loads described in the preceding paragraph.
        c) Groundwater effects: Include groundwater effects on lateral earth pressure loads using design elevation specified in Section 01610:
            (1) Use equivalent lateral pressure of 90 pounds per square foot per foot of depth (triangular distribution) for soil below the design groundwater elevation.
        d) Seismic acceleration effects:
            (1) As specified in Section 01612 for seismic design criteria.
            (2) On opposite sides of the structure, equivalent lateral fluid pressure type distribution, beginning with a pressure of 0 at the base of the structure, and increasing at a rate of 60 pounds per square foot per foot of rise toward the ground surface. (Inverted fluid pressure distribution.)
            (3) Adding lateral force for soil accelerating toward structure:
                (a) Direct inverted pressure distribution toward the wall, effectively increasing the static lateral soil pressure.
            (4) Reducing lateral force for soil accelerating away from structure:
            (5) Direct inverted pressure distribution away from the wall, effectively reducing the static lateral soil pressure.

d. Groundwater and flood loads, and buoyancy effects:
    1) As specified in Section 01610 for design groundwater and design flood elevations.
    2) Lateral pressure effects: Determine based on groundwater and flood elevations specified.
    3) Buoyancy: For groundwater and flood conditions, provide factor of safety against flotation of at least 1.25:
        a) If the weight of soil overlying footing projections on the structure is considered to resist flotation, use a buoyant unit weight of soil equal to not more than 120 pounds per cubic foot.
        b) Concrete fill may be provided in the bottom section of precast portland cement concrete structures to add weight. Submit proposed details.

e. Soil-bearing pressure at base:
    1) Maximum 1,000 pounds per square foot total pressure on prepared subgrade soils.

f. Lifting and handling loads:
    1) Make provision in the design for the effects of loads or stresses that may be imposed on structures during fabrication, transportation, or erection.
g. Load combinations:
    1) Design structures to sustain the specified loads individually or in combination.

3. Design requirements: Structural analysis, design, and detailing:
    a. General:
        1) Analyze and design structures including the effects of 2-way action ("plate action") and of load transfer around current and future openings.
        2) Where structures include panels designed for future removal ("knockout panels"), design structures for loads and stresses with any combination of any or all such panels in place or removed.
    b. Precast polymer concrete handholes:
        1) Design to resist loads with cover in place or removed.
        2) Detail cover support and top edges to maintain cover in place over walls and to prevent soil from sloughing into the handhole when cover is removed.
    c. Precast portland cement concrete handholes and manholes:
        1) Design structures in accordance with the requirements of ACI 318 and this Section.
        2) Provide reinforcement at all areas subject to tensile stress when loaded with the specified loads and combinations thereof.
        3) Provide temperature and shrinkage reinforcement to equal or exceed ACI 318 requirements in all concrete sections.
        4) Provide minimum clear concrete cover over reinforcement at both interior and exterior faces of all members in accordance with the following:
            a) Handholes: 1.25 inches.
            b) Manholes: 2 inches.
        5) Reinforcement details:
            a) Walls: For structures with wall thickness of 8 inches or less, locate a single mat of reinforcement at the center of the wall.
            b) Slabs: For structures with slab thickness of 7 inches or less, locate a single mat of reinforcement at the center of the slab.
            c) Structures with wall or slab thicknesses exceeding these limits shall have a reinforcement at each face of the member.
        6) Joints:
            a) Provide structures with watertight joints between sections, and detailed to minimize water infiltration at duct bank and conduit penetrations.
            b) Provide structures with non-skid, shiplap or tongue and groove joints between sections.

4. Design requirements: Materials:
    a. Portland cement concrete handholes and manholes:
        1) In accordance with ASTM C 858.

1.05 SUBMITTALS

A. Product data: Manufacturer's catalog data, details, and warranties for the following items:
   1. Polymer concrete handholes:
      a. Materials of construction, and resistance of those materials to water absorption, flammability, sunlight/ultraviolet exposure, and chemicals likely to be found in the area of use.
      b. Available colors.
      c. Details for covers, cover support, and cover attachment to the underlying box.
   2. Portland cement concrete handholes and manholes:
      a. Joint details and joint-sealing materials.
      b. Data for hatches or covers and rings.
      c. Preformed channels and accessories for cable racking.
      d. Drain and sump details, including removable covers.
      e. Pulling iron details.

B. Shop drawings:
   1. Polymer concrete handholes:
      a. Manufacturer's catalog cuts showing dimensions and details of construction.
   2. Portland cement concrete handholes and manholes:
      a. Shop drawings for each structure shall bear the seal and signature of a professional engineer licensed in the state where the structures will be installed.
      b. Dimensioned and "to-scale" plans, sections, and details for each structure including:
         1) Layout plan for that structure.
         2) Sizes, locations, and vertical positions of duct bank windows and knockout panels.
         3) Locations and details for access openings, pulling irons, embedded cable supports and racks, and sumps.
         4) Details of structural reinforcement showing bar size and spacing; true position of reinforcement in structural members with clear concrete cover at both inside and outside faces; location, bar size, and spacing of added reinforcement around openings; and other details relevant to design and fabrication of the structure.
         5) Details of joints between adjacent precast sections, including provisions for overlap and for placement of sealants.

C. Design data:
   1. Portland cement concrete handholes and manholes:
      a. Structural calculations:
         1) Submit complete structural calculations for each structure.
         2) Provide calculations bearing the seal and signature of a professional engineer licensed in the state where the structures will be installed.

b. Manufacturer's statement of materials used for fabrication and construction, in accordance with ASTM C 858, for record. Include the following:
    1) Concrete mix design: For each concrete mix design to be used for the structures, include data describing:
        a) Source and type of cement.
        b) Sources, grading, and specific gravities of aggregates.
        c) Aggregate reactivity data.
        d) Concrete mix proportions and design strength.
        e) Type, name, and dosage of all admixtures included in the concrete mix.
    2) Reinforcing steel: Mill certificates.

D. Test reports:
1. Polymer concrete handholes:
    a. Independent laboratory test reports bearing the seal of a licensed professional engineer and demonstrating compliance with the requirements of SCTE 77 for the loading conditions specified.
2. Portland cement concrete handholes and manholes:
    a. Fabricator's tests for compressive strength of concrete used in structures, made in accordance with recommendations of ASTM C 858.

E. Certificates:
1. Polymer concrete handholes:
    a. Manufacturer's certification that polymer concrete handholes are in accordance with the requirements of SCTE 77.
2. Portland cement concrete handholes and manholes:
    a. Manufacturer's current plant certification under NPCA for the structures to be supplied:
        1) Certification shall be current and in-effect at the time structures are manufactured.
    b. Manufacturer's certification that handholes and manholes are in accordance with the requirements of ASTM C 858.

F. Manufacturer's instructions:
1. Instructions for handling and setting structures in place.
2. Portland cement concrete handholes and manholes.

G. Manufacturer's field reports:
1. Portland cement concrete handholes and manholes:
    a. Manufacturer's inspection reports in accordance with ASTM C 1037.

H. Closeout documents:
1. Project record documents:
    a. Portland cement concrete handholes and manholes:
        1) Final, revised plans and details of as-constructed precast handholes and manholes if requested for record by the Engineer.
2. Warranties:
    a. Manufacturer's standard warranty for:
        1) Polymer concrete handholes.
        2) Portland concrete handholes and manholes and accessories.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Designer:
      a. Portland cement concrete handholes and manholes:
         1) Professional engineer qualified in the design of concrete structures and holding a current license in the state where the structures will be installed.
   2. Manufacturer:
      a. Polymer concrete handholes:
         1) Demonstrating at least 5 years of experience in the design and production of products of the type required for this Work.
         2) Holding product testing records demonstrating load resistance of products to be installed.
      b. Portland cement concrete handholes and manholes:
         1) Holding current NPCA plant certification for the products produced.
         2) Demonstrating at least 5 years of experience in the design, production, and installation of products of the type required for this Work.
         3) Capable of providing structural designs prepared by a professional engineer licensed in the state where the structures will be installed.
         4) Providing inspection during fabrication and handling in accordance with the requirements of ASTM C 1037.
   3. Installer:
      a. Capable of providing equipment of adequate capacity and mobility to handle and set units with proper bearing on the subgrade and without damage to the unit.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, shipping, handling, and unloading:
   1. Package and brace structures to avoid damage during shipping and handling.
   2. Furnish crane or forklift for unloading and setting of portland cement concrete handholes and manholes.

B. Acceptance at site:
   1. Structures delivered to the site with cracks, damage, and damaged or missing accessories shall be removed from the site and replaced at no additional cost to the Owner.

C. Storage and protection:
   1. Store handholes and manholes and their appurtenances in areas protected from damage due to weather and site operations.

1.08 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 01610.

1.09 SEQUENCING

A. Coordinate installation of precast electrical handholes and manholes with duct banks specified in Section 16133.

1.10 WARRANTY

A. Provide manufacturer's standard warranty for precast handhole and manhole structures and accessories.

1.11 SYSTEM START-UP

A. As specified in Section 16050.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cast-in-place concrete for fill at base sections of portland cement concrete manholes with deep sumps or ballast to resist buoyancy shall be "Class A" concrete as specified in Section 03300.

2.02 MANUFACTURED UNITS - PORTLAND CEMENT CONCRETE HANDHOLES AND MANHOLES

A. General:
   1. Provide portland cement concrete handholes and manholes configured and designed as indicated on the Drawings and specified.
   2. In accordance with ASTM C 858 unless otherwise noted.

B. Manufacturers: One of the following, or equal:
   1. Oldcastle Precast.
   2. Jensen Precast.

C. Components:
   1. Floor:
      a. Construct floors as a monolith.
      b. Where sump or low-point drain is included, slope floor to that point.
   2. Roof, walls, and base:
      a. Designed and rated to support vehicle and pedestrian loads at the spans indicated.
      b. See the Electrical Handhole and Manhole Schedule indicated on the Drawings for required load rating by structure location.
   3. Access covers:
      a. Handholes: Aluminum plate hinged floor access door (hatch) as specified in Section 08320:
         1) Load rating:
            a) "Heavy Duty" for covers at locations designated for "Roadway" loads.
            b) "Medium Duty" or stronger for covers at locations designated for "Sidewalk" loads.
         2) Minimum access door size not less than 36 inches square, unless otherwise indicated on the Drawings.
         3) Provide bearing surface with pre-installed continuous elastomeric gasket to minimize water infiltration at lid.
         4) Provide skid-resistant lid with cast-in or machined-in grid pattern and the word "ELECTRICAL" in block letters at least 1.5 inches high.

b. Manholes: Cast iron frame and cover.
    1) Manhole rings and covers:
        a) Gray cast iron in accordance with ASTM A 48, Class 30B with ring and cover machined to fit with flat bearing surfaces.
        b) Cover with word “ELECTRICAL” cast into the top exposed face for electrical manholes.
        c) Manhole riser access:
            (1) Heavy-duty bottom flange frame with solid cover for placement on grade adjustment rings above top slab.
            (2) 36-inch diameter nominal opening.
            (3) Manufacturer: The following or equal:
                (a) Neenah Foundry Company, R1640-D.
        d) Embedded in top slab of structure:
            (1) Heavy-duty top flange frame with solid cover for embedment in top slab of a structure.
            (2) 36-inch diameter nominal opening.
            (3) Manufacturer: The following or equal:
                (a) Neenah Foundry Company, R6095.

D. Accessories:
1. Provide accessories as indicated on the Drawings and specified.
2. Materials at duct bank penetrations:
    a. Joint filler as specified in Section 03150.
    b. Backer rod and sealant as specified in Section 07900.
3. Pulling irons:
    a. Provide non-corroding cable pulling irons located for use with each current duct bank location and additional irons for use with duct banks that may be installed through future knockout panels.
    b. Pulling irons may not be located on the floor.
    c. Where pulling irons are installed on the wall, any pockets surrounding the irons shall have bottom surfaces sloped to drain.
    d. Secure pulling eyes to structure reinforcement.
4. Cable racks and racking hardware:
    a. Materials: Hot-dip galvanized steel as specified in Section 16070.
    b. Embedded slots: Maximum depth of 1.5 inches.
5. Sumps and drains:
    a. Fiberglass or HDPE fabrications including removable lids to prevent tripping hazards.
6. Exterior dampproofing:
    a. As specified in Section 07110.
    b. Field applied to all wall and roof surfaces exposed to soil.

E. Fabrication:
1. Embeds:
    a. Install embedded items with provisions for drainage to remove dripping or standing water, and to minimize corrosion:
        1) Pulling irons may not be placed on the floor or in pockets that will collect water.
        2) Detail bottom of cable rack channels to provide a downward sloping “sill” at the bottom of each vertical channel, so that the channel slot drains toward the floor.

b. Concrete cover:
   1) Provide minimum 0.75-inch clear concrete cover between embeds and surrounding reinforcement.
   2) Provide minimum 1.25-inch clear concrete cover between embed and exterior face of wall.

F. Tests and inspections:
   1. Test and inspect structures in accordance with ASTM C 858 and ASTM C 1037.

PART 3 EXECUTION

3.01 GENERAL

A. Furnish and install precast electrical handholes and manholes as indicated on the Drawings and specified.

B. Install additional handholes and manholes required so installation procedures will conform to cable manufacturer's pulling tension requirements:
   1. Include proposed locations and details of such additional handholes and manholes with the submittals under Part 1.

3.02 PREPARATION

A. Design:
   1. Prepare detailed and scalable layouts for each manhole structure showing locations of conduit or duct bank penetrations, clearances, locations, and sizes of access openings and major accessories.

B. Protection:
   1. Where handhole and manhole structures are installed adjacent to existing site structures or utilities, provide excavation support or other protection as required to maintain those facilities in service and to prevent damage to both existing and new facilities.

C. Site preparation:
   1. Excavate and prepare exposed subgrade as indicated on the Drawings and as specified.
   2. Install and compact foundation layer as indicated on the Drawings and specified.
   3. Level foundation materials so that structures will be set plumb, and duct banks will be at proper grade and alignment:
      a. Install with uniform bearing on foundation materials.
      b. Wedging or blocking of base sections for leveling over the foundation materials will not be permitted.

3.03 INSTALLATION

A. General:
   1. Protect handholes and manholes from displacement, flooding, or flotation.

B. Polymer concrete handholes:
   1. Install structures in accordance with the manufacturer's recommendations.
   2. Clean joints between adjacent sections for tight fit.
   3. Set covers at elevations indicated on the Drawings:
      a. Securely attach cover to below-grade box.
   4. Backfill polymer concrete handholes as indicated on the Drawings and as specified.

C. Portland cement concrete handholes and manholes:
   1. Install structures in accordance with ASTM C 891 and the provisions of this Section:
      a. In the event of conflicts, the more restrictive provisions shall apply.
   2. Clean and prime joints between adjacent precast sections:
      a. Install sealing compound between sections and provide watertight joints.
   3. Set covers and hatches at elevations indicated on the Drawings:
      a. Securely attach frames to top of precast structures and grade adjustment rings.
   4. Penetrations:
      a. Holes for duct banks and other penetrations may not be cut into precast handholes and manholes unless they are located at designated locations shown on the shop drawings or at knockout panels cast into the structure during manufacturing.
      b. Carefully remove concrete from knockout panel areas with saws:
         1) Ensure that break-back does not extend beyond the designated limits of the knockout panel.
      c. Coat any reinforcement cut or exposed during removal of knockout panel sections with minimum 2 coats of high solids epoxy as specified in Section 09960:
         1) Apply epoxy coating applied over and at least 1-inch past the perimeter of the reinforcement.
   5. Install duct banks and conduit penetrations in accordance with the penetration details indicated on the Drawings:
      a. Place all joint fillers, caulks, and sealants before coating exterior concrete surface with bituminous dampproofing.
   6. Fill holes that were provided for handling or other temporary purposes with non-shrink cement grout using procedures as specified in Section 03300 unless otherwise detailed by the manufacturer.
   7. After structures are set and before backfilling, coat exterior below-grade surfaces (around the sidewalls, over the top slab, and around any vertical risers to grade) with 2 heavy coats of bituminous dampproofing as specified in Section 07110:
      a. Apply dampproofing in accordance with the coating manufacturer's instructions and at a rate of 40 to 60 square feet per gallon per coat.
      b. Mask over at least 1 inch back from joint caulks or sealants, and prevent dampproofing from coming in contact with those materials.
   8. Backfill handholes and manholes as indicated on the Drawings and as specified in Section 02300.

D. Site tolerances:
   1. Set electrical handholes and manholes plumb and true at locations indicated on the Drawings.

2. Tolerances on placing:
    a. Horizontal location: Plus or minus 1 inch.
    b. Vertical elevation: Plus or minus 1/2 inch.
    c. Plumb: Plus or minus 1/8 inch over 10 feet.

3.04 REPAIR/RESTORATION

A. Repair cracks or blemishes in concrete as described in Section 03300.

3.05 ADJUSTING

A. After final grading is complete, adjust access covers to grade.

3.06 CLEANING

A. Before installation of cables in any duct banks and handholes or manholes, remove all concrete spoil, forms, debris, silt, dust, and other foreign material.

B. Pressure wash interior of structures if required to provide clean interior surfaces:
    1. Block drains and provide pumps to remove washwater from structures.
    2. Do not permit washwater to drain into subgrade soils.

3.07 SCHEDULES

A. See Drawings for Electrical Handhole and Electrical Manhole Schedule.

END OF SECTION

SECTION 02621

STABILIZATION FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Woven stabilization fabric used for subgrade enhancement.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   2. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   6. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.03 DEFINITIONS

A. Stabilization fabric: Woven geotextile fabric manufactured from polypropylene yarns.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Installation Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish stabilization fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Field measurements:
   1. Take field measurements to determine the exact lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Ten Cate Geosynthetics, Mirafi 600X.
   2. Propex, Geotex 315ST.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

Property [(1)]	Test Method	Unit	Requirements[(1)]
Grab Tensile Strength	ASTM D 4632	lbs	315
Grab Elongation	ASTM D 4632	%	15
Trapezoid Tear Strength	ASTM D 4533	lbs	120
CBR Puncture Resistance	ASTM D 6241	lbs	900
UV Resistance (strength retained at 500 hrs)	ASTM D 4355	%	70
Apparent Opening Size (AOS)	ASTM D 4751	US sieve	40
Permittivity	ASTM D 4491	sec^{-1}	0.05
Flow Rate	ASTM D 4491	gpm/ft^2	4
Notes: (1) Minimum average roll values.			

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of stabilization fabric.

3.02 PREPARATION

A. Surface preparation: During grading operations, take care not to disturb the subgrade. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented herein.

B. Place the stabilization fabric smoothly without folds or wrinkles.

C. Use special care when placing the stabilization fabric in contact with the soil so that no void spaces occur between the stabilization fabric and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than recommended by manufacturer.

E. Do not drag stabilization fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers, if necessary. Do not allow equipment directly on stabilization fabric.

3.04 FIELD QUALITY CONTROL

A. Inspection: Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric. Repair all holes or rips by placing a new layer of fabric extending beyond the defect in all directions, a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 02742A

ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Asphalt pavement on prepared subgrade or aggregate base course to lines, grades, and compacted thickness as indicated on the Drawings.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 02050 - Soils and Aggregates for Earthwork.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft. lbf/f_4^3)(2,700 kN-m/m^3).
   2. D 1561 - Standard Practice for Preparation of Bituminous Mixture Test Specimens by Means of California Kneading Compactor.

B. Caltrans Standard Test Methods:
   1. Calif Test 202 - Sieve Analysis of Fine and Coarse Aggregates.
   2. Calif Test 304 - Preparation of Bituminous Mixtures for Testing.
   3. Calif Test 362 - Determining Asphalt Content in Bituminous Mixtures by Vacuum Extraction.
   4. Calif Test 375 - Determining the In-Place Density and Relative Compaction of AC Pavement.
   5. Calif Test 379 - Determining Asphalt Content in Bituminous Mixtures (Troxler Nuclear Gauge Model 3241).

C. State of California Department of Transportation Standard Specifications, latest edition (Caltrans Standard Specifications):
   1. Section 37 - Bituminous Seals.
   2. Section 39 - Hot Mix Asphalt.
   3. Section 88 - Geosynthetics.
   4. Section 92 - Asphalts.
   5. Section 93 - Liquid Asphalts.
   6. Section 94 - Asphaltic Emulsions.

1.03 SYSTEM DESCRIPTION

A. This Work shall consist of furnishing and mixing aggregate and asphalt binder at a central mixing plant, spreading and compaction of the mixture as specified and as indicated on the Drawings.

B. In general, asphalt concrete and asphalt concrete base shall conform to Section 39 "Hot Mix Asphalt," and all applicable referenced sections of the Caltrans Standard Specifications:
   1. Where conflicts exist, this specification shall govern.

1.04 DEFINITIONS

A. "Asphalt Concrete" as used by Caltrans shall be considered the "Surface Course," or the final lift of the pavement section.

B. "Asphalt Concrete Base" as used by Caltrans shall be the remaining portion of the asphalt pavement section excluding the final lift.

C. "Asphalt Pavement" shall be the total pavement section of asphalt including Asphalt Concrete and Asphalt Concrete Base.

1.05 SUBMITTALS

A. Mix design.

B. Shop drawings.

C. Product Data:
   1. Asphalt.
   2. Asphalt aggregate.
   3. Pavement reinforcing fabric.

D. Quality control submittals:
   1. Test results.
   2. Certificate of Compliance.
   3. Certificate of Competence.

E. Equipment list.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Asphalt pavement delivery:
   1. Transport the mixture from the mixing plant to the point of use in vehicles having tight bodies previously cleaned of all foreign materials.
   2. Treat bodies as necessary to prevent material from sticking to the bodies.
   3. Cover each load with canvas or other suitable material of sufficient size and thickness to protect the asphalt mixture from the weather.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Asphalt concrete:
      a. Place asphalt concrete only when surface is dry, and when atmospheric temperature in the shade is 40 degrees Fahrenheit and rising, or above 50 degrees Fahrenheit if falling.
      b. Do not place asphalt concrete when weather is foggy or rainy, when base on which material is to be placed is in wet or frozen conditions, or when, in the opinion of the Engineer, weather conditions will prevent proper handling, finishing, or compaction of the mixtures.

PART 2 PRODUCTS

2.01 ASPHALT PAVEMENT MATERIALS

A. Asphalts:
   1. Asphalt binder: Steam-refined paving asphalt, PG 64-10, conforming to Section 92-1.02C “Grades” of the Caltrans Standard Specifications.
   2. Tack coat: Grade SC-70, conforming to Section 93 of the Caltrans Standard Specifications.

B. Asphalt aggregate:
   1. Aggregate for asphalt concrete shall conform to Section 39-1.02E of the Caltrans Standard Specifications for Type B grading, 1/2-inch maximum, medium.
   2. Aggregate for asphalt concrete base shall conform to Section 39-1.02E of the Caltrans Standard Specifications for Type B grading.

C. Asphalt pavement shall be produced in a batch mixing plant, a continuous pugmill mixing plant, or dryer-drum mixing plant:
   1. Proportioning shall conform to Section 39-3.03 of the Caltrans Standard Specifications.
   2. Mixing shall conform to Section 39-3.04 of the Caltrans Standard Specifications.

2.02 SLURRY SEAL

A. Slurry seal, Type II, shall be applied in conformance with the provisions in Section 37-2, and all applicable referenced sections of the Caltrans Standard Specifications, at the following locations:
   1. All asphalt pavement.

2.03 AGGREGATE BASE COURSE

A. Aggregate base course: As specified in Section 02050.

B. Aggregate base course shall be placed at the following locations:
   1. At all locations indicated on the Drawings.
   2. All asphalt pavement.

C. Compacted thickness of aggregate base course shall be as indicated on the Drawings.

2.04 EQUIPMENT

A. Spreading and compacting equipment:
   1. Spreading equipment shall conform to Section 39-1.10 and all applicable referenced sections of the Caltrans Standard Specifications:
      a. Only in areas inaccessible to the machine, by approval of the Engineer, will hand spreading be permitted.
   2. Compaction equipment shall conform to Section 39-1.10 and all applicable referenced sections of the Caltrans Standard Specifications.

2.05 SOURCE QUALITY CONTROL

A. The Engineer will perform sampling and tests of materials in accordance with California Test Method Number 304 and California Test Method Number 362 or 379, as applicable. Samples will be taken from materials as delivered to the site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify surfaces and site conditions are ready to receive work. If unsatisfactory conditions exist, do not commence installation until such conditions have been corrected. Beginning application means acceptance of existing conditions.

3.02 PREPARATION

A. Protection:
   1. Protect concrete pavements and walks, curbs and bases, and other improvements adjacent to the operations with suitable materials.
   2. Building and other surfaces shall be covered with paper or other protection, when required.
   3. Contractor shall be responsible for any damage caused by Contractor's employees. All damage caused by the Contractor's operations shall be repaired to the satisfaction of the Engineer at no additional cost to Owner.

B. Subgrade preparation:
   1. Immediately prior to applying tack coat, or immediately prior to placing the asphalt pavement when tack coat is not required, the subgrade to receive asphalt pavement shall conform to the compaction requirement and elevation tolerances specified for the material involved and shall be cleaned to remove any loose or extraneous material.
   2. If the asphalt pavement is to be placed on an existing base or pavement that was not constructed as part of the contract, the Contractor shall clean the surface by sweeping, flushing, or other means to remove all loose particles of paving, all dirt, and all other extraneous material immediately before applying the tack coat.

3.03 TACK COAT

A. Tack coat:
   1. A tack coat of asphaltic emulsion shall be applied to all vertical surfaces of existing pavement, curbs, gutters, and construction joints in the surfacing against which additional material is to be placed, or as otherwise specified in this Section.
   2. Tack coat shall be applied in one application at a rate of 0.1 gallons per square yard of surface covered.

3.04 ASPHALT PAVEMENT

A. Placing materials in a windrow, then picking it up and placing it in the asphalt paver with loading equipment, will be permitted provided that:
   1. The asphalt paver is of such design that the material will fall into a hopper that has a movable bottom conveyor to feed and screed.
   2. The loader is constructed and operated so that substantially all of the material deposited into windrows is picked up and deposited into the paving machine.
   3. The windrow is deposited only so far in advance of the paver to provide for continuous operation of the paver and not so far as to allow the temperature of the asphalt pavement in the windrow to fall below 260 degrees Fahrenheit.

B. Unless lower temperatures are directed by the Engineer, asphalt concrete shall be spread, and the first coverage of initial or breakdown compaction shall be performed when the temperature of the mixture is not less than 250 degrees Fahrenheit, and all breakdown compaction shall be completed before the temperature of the mixture drops below 205 degrees Fahrenheit.

C. Asphalt pavement shall be spread and compacted in the number of layers and of the thicknesses indicated in the following table:
   1. A thickness tolerance of within 0.1 inches is allowed for asphalt concrete.
   2. A total thickness tolerance of within 0.2 inches is allowed for asphalt concrete base:

Total Thickness Indicated on Drawings(1)	**Number of Lifts**	**Top Layer Thickness**		**Next Lower Layer Thickness**		**All Other Lower Layer Thicknesses**	
		Min	**Max**	**Min**	**Max**	**Min**	**Max**
<2-3/4”	1	-----	-----	-----	-----	-----	-----
3”(2)	2	1-1/4”	1-1/2”	1-1/4”	1-1/2”	-----	-----
3-1/4” - 4-3/4”	2	1-3/4”	2-1/4”	1-3/4”	3”	-----	-----
>5”	(3)	1-3/4”	2-1/4”	1-3/4”	3”	1-3/4”	4-3/4”

Notes:
(1) When pavement-reinforcing fabric is shown to be placed between layers of asphalt pavement, the thickness of asphalt pavement above the pavement-reinforcing fabric shall be considered to be the “Total Thickness Indicated on the Drawings” for the purpose of spreading and compacting the asphalt pavement above the pavement-reinforcing fabric.
(2) If approved by the Engineer, one lift of 3 inches may be placed.
(3) At least 2 layers shall be placed if the total thickness is less than 5 inches. At least 3 layers shall be placed if the total thickness is more than 5 inches, and less than 10-1/2 inches. At least 4 layers shall be placed if the total thickness is greater than 10-1/2 inches.

D. A layer shall not be placed over another layer which exceeds 3 inches in compacted thickness until the temperature of the layer which exceeds 3 inches in compacted thickness is less than 160 degrees Fahrenheit at mid depth:
   1. If the temperature of any layer drops below 140 degrees Fahrenheit, or if directed by the Engineer, apply tack coat before placing next layer.

E. Unless otherwise indicated on the Drawings, asphalt mixtures shall not be handled, spread, or windrowed in a manner that will stain the finished surface of any pavement or other improvements.

F. The completed mixture shall be deposited on the prepared subgrade at a uniform quantity per linear foot, as necessary to provide the required compacted thickness without resorting to spotting, picking up, or otherwise shifting the mixture.

G. Spreading:
   1. All layers of asphalt pavement shall be spread with an asphalt paver and shall conform to Section 39-1.11 and all applicable referenced sections of the Caltrans Standard Specifications.
   2. At locations where the asphalt pavement is to be placed over areas inaccessible to spreading and rolling equipment, all layers of asphalt pavement shall be distributed directly out of the back of the dump truck and spread by hand:
      a. Asphalt pavement spread by hand shall be compacted thoroughly to the required lines, grades, and cross-sections by means of pneumatic tampers, or by other methods that will produce the same degree of compaction as pneumatic tampers.

H. Compaction:
   1. Compaction of asphalt pavement shall conform to Sections 39-1.11, 39-3.03, 39-3.04, and all applicable referenced sections of the Caltrans Standard Specifications.
   2. Minimum required density for each layer of asphalt pavement shall be 95 percent of that obtained in the laboratory in accordance with ASTM Test Method D 1561.

I. Segregation shall be avoided, and the surfacing shall be free of pockets of coarse or fine material. Asphalt pavement containing hardened lumps shall not be used:
   1. In areas inaccessible to paving and compacting equipment where spreading is done by hand, minimize the amount of segregation.

J. Location of longitudinal joints in the top layer will be determined by the Engineer and shall not adversely affect the quality of the finished product.

K. At all locations, or as directed by the Engineer, the asphalt concrete shall be square and at least 1-inch thick when conforming to existing surfacing. Tapering or feathering is not allowed.

3.05 FIELD QUALITY CONTROL

A. The Contractor shall control the quality of Work and shall provide adequate testing to ensure compliance with these Specifications:
   1. The type and size of the samples shall be suitable to determine conformance with stability, density, thickness, and other specified requirements. Use an

approved power saw or core drill for cutting samples. Furnish all tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed. Take a minimum of 1 sample for every 4,000 square feet of asphalt pavement placed.

B. All asphalt pavement shall match the grades indicated on the Drawings and shall be completely free from unintended hollows and high spots:
   1. After completion of paving work, all paving shall be flooded with water. Any ponding that results in standing water greater than 3/4 inch in depth shall be ringed with chalk. Such hollows shall be corrected by removing and replacing the asphalt concrete. The asphalt concrete patch shall be square and at least 1-inch thick when conforming to existing surfacing. Tapering or feathering is not allowed.

C. Contractor shall perform in-place density and compaction tests of the completed pavement in accordance with California Test Method Number 375, to determine compliance with the specified requirements. Submit test results to Engineer for approval.

D. Cracks, settling of surface, improper drainage, improper compaction, and sloppy connection to previously laid surfaces will be construed as improper workmanship and will not be accepted.

3.06 MAINTENANCE OF PAVEMENT

A. Upon completion of final rolling, traffic shall not be permitted on the finished pavement for at least 6 hours, or until the asphalt pavement has cooled sufficiently to withstand traffic without being deformed.

3.07 WORKMANSHIP AND WARRANTY

A. Contractor shall provide written warranty against defects in materials or workmanship for a period of not less than 1 year upon completion of Work.

END OF SECTION

SECTION 02772

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete curbs, gutters, sidewalks, driveways, access ramps, and alley intersections.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 02050 - Soils and Aggregates for Earthwork.
      b. Section 03150 - Concrete Accessories.
      c. Section 03300 - Cast-In-Place Concrete.
      d. Section 03366 - Tooled Concrete Finishing.

1.02 SYSTEM DESCRIPTION

A. Performance requirements: Construct various types of concrete curb, gutter, sidewalk, driveways and alley intersections to dimensions and details indicated on the Drawings.

1.03 SUBMITTALS

A. Product data: Submit data completely describing products.

B. Samples: Submit samples when requested.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Class A, as specified in Section 03300.

B. Curb finishing mortar: 1 part portland cement to 2 parts sand.

C. Form release material: Light oil or other releasing agent of type which does not discolor concrete or interfere with the application of finishing mortar to curb tops and faces.

D. Joint materials:
   1. Expansion: As specified in Section 03150.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Verify field conditions, including subgrade condition and interferences, before beginning construction.

3.02 PREPARATION

A. Surface preparation:
   1. Subgrade:
      a. Construct and compact true to grades and lines indicated on the Drawings and requirements as specified Section 02050.
      b. Remove soft or unsuitable material to depth of not less than 6 inches below subgrade elevation and replace with satisfactory material.
   2. Forms and subgrade: Water immediately in advance of placing concrete.

3.03 INSTALLATION

A. Special techniques:
   1. Contractor's option:
      a. Construct concrete curbs and gutters by conventional use of forms, or by means of curb and gutter machine when acceptable to the Engineer.
      b. When use of machines designed specifically for work of this Section are accepted by the Engineer, results must be equal to or better than those produced by use of forms.
      c. Applicable requirements of construction that apply to use of forms also apply to use of machines.
      d. Discontinue use of machines when results are not satisfactory to the Engineer.

B. Forms:
   1. Carefully set to line and grade and securely stake in position forms conforming to dimensions of items to be constructed.
   2. Thoroughly clean prior to each use and coat with form releasing material.

C. Expansion and weakened-plane joints:
   1. Expansion joints:
      a. Construct vertically, and at right angles to centerline of street and match joints in adjacent pavement or sidewalks.
      b. Constructed at radius points, driveways, alley entrances, and at adjoining structures.
      c. Fill joints with expansion joint filler material.
   2. Weakened-plane joints:
      a. Construct as indicated on the Drawings.
      b. .Match joint locations and details in adjacent curbs, gutters, and sidewalks.

D. Concrete:
   1. Placing:
      a. Thoroughly spade concrete away from forms so that no rock pockets exist next to forms and so that no coarse aggregate will show when forms are removed.
   2. Compacting:
      a. Compact by mechanical vibrators accepted by the Engineer.
      b. Continue tamping or vibrating until mortar flushes to surface and coarse aggregate is below concrete surface.
   3. Form removal:
      a. Front form faces: Do not remove before concrete has taken initial set and has sufficient strength to carry its own weight.
      b. Gutter and rear forms: Do not remove until concrete has hardened sufficiently to prevent damage to edges. Take special care to prevent damage.
   4. Finishing and curing: Comply with requirements as specified in Section 03366 except as modified here:
      a. As soon as curb face forms are stripped, apply finishing mortar to the top and face of curb and trowel to a smooth, even finish. Finish with fine haired broom in direction of work.
      b. Where curb is installed without integral gutter, extend finish 2 inches below grade.
      c. Edge concrete at expansion joints to 1/4 inch radius.
      d. Flow lines of gutters shall be troweled smooth 4 inches out from curb face for integral curb and gutter and 4 inches on both sides of flowline for gutters without curbs.
      e. Sidewalks and ramps: Broom finish.

E. Backfilling:
   1. Unless otherwise specified, backfill behind curbs, gutters, or sidewalks with soil native to area and to lines and grades indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Tests:
   1. Curbs and gutters:
      a. Test face, top, back, and flow line with 10 foot straightedge or curve template longitudinally along surface.
      b. Correct deviations in excess of 1/4 inch.
   2. Gutters:
      a. Frequency of testing: When required by the Engineer, where gutters have slope of 0.8 foot per 100 feet or less, or where unusual or special conditions cast doubt on capability of gutters to drain.
      b. Test method: Establish flow in length of gutter to be tested by supplying water from hydrant, tank truck, or other source.
      c. Required results:
         1) 1 hour after supply of water is shut off, inspect gutter for evidence of ponding or improper shape.
         2) In event water is found ponded in gutter to depth greater than 1/2 inch, or on adjacent asphalt pavement, correct defect or defects in manner acceptable to the Engineer without additional cost to the Contract.

3.05 ADJUSTING

A. Repair portions of concrete damaged while stripping forms or, when damage is severe, replace such work at no additional cost to the Contract. Evidence of repairs shall not be noticeable in the finished product.

B. Remove and replace sections of work deficient in depth or not conforming to requirements indicated on the Drawings and specified in the Specifications at no additional cost to the Contract. Removal and replacement shall be the complete section between 2 joints.

END OF SECTION

SECTION 02952

PAVEMENT RESTORATION AND REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Resurfacing roads and paved surfaces in which surface is removed or damaged by installation of new work.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 02722 - Aggregate Base Courses.
      b. Section 02742 - Asphaltic Concrete Paving.
      c. Section 03300 - Cast-in-Place Concrete.

1.02 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Limiting dimensions:
      a. Determine the exact lengths and dimensions of such roads, pavements, parking areas, and walks that will require removal and replacement for new work.
      b. Join existing surfaces to terminals of new surfacing in smooth juncture.

1.03 SUBMITTALS

A. Mix designs:
   1. Prior to placement of asphalt concrete, submit full details, including design and calculations for the asphalt concrete mix proposed.
   2. Submit gradation of aggregate base.
   3. Submit proposed mix design of portland cement concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate base course: As specified in Section 02722.

B. Asphalt pavement: As specified in Section 02742.

C. Portland cement concrete replacement material: Class A concrete as specified in Section 03300.

2.02 EQUIPMENT

A. Roads, pavements, parking areas, and walks:
   1. Equipment requirements: Good condition, capable of performing work intended in satisfactory manner.

2.03 ACCESSORIES

A. Material for painting asphalt concrete pavement: Tack coat as specified in Section 02742.

PART 3 EXECUTION

3.01 INSTALLATION

A. Aggregate surface removal replacement:
   1. When trench cut is in aggregate surfaced areas, replace aggregate base course material with material matching existing material compacted to 95 percent of its maximum density.

B. Pavement removal and temporary asphalt replacement:
   1. Install temporary asphalt pavement or first course of permanent pavement replacement immediately following backfilling and compaction of trenches that have been cut through existing pavement.
   2. Except as otherwise provided, maintain this temporary pavement in safe and reasonably smooth condition until required permanent pavement is installed.
   3. Remove and dispose of temporary paving from project site.
   4. Where longitudinal trench is partly in pavement, replace pavement to original pavement edge, on a straight line, parallel to centerline of roadway.
   5. Where no part of longitudinal trench is in pavement, surfacing replacement shall only be required where existing surfacing materials have been removed.

C. Asphalt pavement replacement:
   1. Replace asphalt pavement to same thickness as adjacent pavement and match as nearly as possible adjacent pavement in texture, unless otherwise indicated on the Drawings.
   2. Cut existing asphalt pavements to be removed for trenches or other underground construction by wheel cutter, clay spade, or other device capable of making neat, reasonably straight and smooth cut without damaging adjacent pavement. Cutting device operation shall be subject to acceptance of Engineer.
   3. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement replacement, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt pavements. No extra payment will be made for these items, and all costs

incurred in performing this work shall be incidental to pipe laying or pavement replacement.

4. Conform replacement of asphalt pavement to contour of original pavement.

D. Portland cement concrete pavement replacement:
   1. Where trenches lie within portland cement concrete section of streets, alleys, sidewalks, and similar concrete construction, saw cut such concrete (to a depth of not less than 1-1/2 inches) to neat, vertical, true lines in such manner adjoining surfaces are not damaged.
   2. Place portland cement concrete replacement material to dimension as indicated on the Drawings.
   3. Provide expansion joints that match existing.
   4. Before placing replacement concrete, thoroughly clean edges of existing pavement and wash with neat cement and water.
   5. Surface finish: Wood float finish.

E. Curb, gutter, and sidewalk replacement:
   1. Where any concrete curb, gutter, or sidewalk has been removed or displaced, replace to nearest construction joints with new Class A curb, gutter, or sidewalk to same dimensions and finish as original construction that was removed:
      a. Provide expansion joints of same spacing and thickness as original construction.

F. Asphalt pavements:
   1. Trim existing asphalt pavements which are to be matched by pavement widening or pavement extension to neat true line with straight vertical edges free from irregularities with saw specifically designed for this purpose. Minimum allowable depth of cut shall be 1-1/2 inches.
   2. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement widening or extension, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt concrete pavements.
   3. No extra payment will be made for these items and all costs incurred in performing this work shall be incidental to widening or pavement extension.

3.02 FIELD QUALITY CONTROL

A. Tests:
   1. Asphalt concrete as specified in Section 02742.
   2. Concrete as specified in Section 03300.

B. Inspection:
   1. Asphalt concrete:
      a. Lay 10-foot straightedge parallel to centerline of trench when the trenches run parallel to street, and across pavement replacement when trench crosses street at angle.
      b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.

2. Portland cement concrete replacement pavement:
    a. Lay 10-foot straightedge either across pavement replacement or longitudinal with centerline of gutter or ditch.
    b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.

END OF SECTION

SECTION 03055

ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bonding reinforcing bars and all thread rods in concrete using adhesives as specified.

B. Related sections:
   1. Section 01410 - Regulatory Requirements.
   2. Section 03200 - Concrete Reinforcing.
   3. Section 05120 - Structural Steel.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

B. ASTM international (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

C. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

D. Society for Protective Coatings (SSPC):
   1. Surface Preparation Standards (SP):
      a. SP-1 - Solvent Cleaning.

1.03 SUBMITTALS

A. Product Data: Furnish technical data for adhesives, including:
   1. Manufacturer’s printed installation instructions (MPII).
   2. Independent laboratory test results.
   3. Handling and storage instructions.

B. Quality control submittals:
   1. Adhesive manufacturer's past project experience data on at least 3 similar projects supplied with proposed products within the last 3 years.
   2. Special inspection: Provide detailed step-by-step instructions for the special inspection procedure in accordance with the building code as specified in Section 01410.

3. ICC Evaluation Service, Inc., Evaluation Services Report in compliance with the AC308-Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
4. Installer qualifications: Submit evidence of successful completion of certification program for each installer of work described in this Section.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Installer qualifications:
      a. All individuals performing the work described in this Section shall be certified by a qualified organization to install adhesive anchors by following the MPII. Those organizations deemed to be qualified are:
         1) ACI-CRSI Adhesive Anchor Installer Certification Program.
         2) An adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Store adhesives and adhesive components on pallets or shelving in a covered-storage area.
   2. Control temperature above 60 degrees Fahrenheit and dispose of product if shelf life has expired.
   3. If stored at temperatures below 60 degrees Fahrenheit, test components prior to use to determine if they still meet specified requirements.

1.06 PROJECT CONDITIONS

A. Seismic design category: D.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.

2.02 ADHESIVE FOR SELF-CONTAINED CARTRIDGE SYSTEM

A. Adhesive shall have a current ICC Evaluation Service report documenting acceptance under AC308 for use with cracked concrete and for the seismic design categories specified.

B. Materials:
   1. In accordance with ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
   2. 2-component, 100 percent solids, insensitive to moisture.
   3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

C. Packaging:
   1. Furnished in side-by-side cartridges with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle. Nozzle designed to thoroughly blend the components for injection from the nozzle directly into prepared hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

D. Manufacturers: One of the following or equal:
   1. Hilti, Inc., Tulsa, OK: RE 500-SD.
   2. Simpson Strong-Tie Company, Inc., Pleasanton, CA: SET-XP.

2.03 ALL THREAD RODS

A. Materials: As specified in Section 05120.

2.04 REINFORCING BARS

A. As specified in Section 03200.

PART 3 EXECUTION

3.01 GENERAL

A. Execution of this work is restricted to those installers certified through a qualified certification program described under Quality Assurance and accepted by the Engineer.

B. The work shall be performed in strict accordance with the accepted MPII and the following instructions. Where the accepted MPII and the following instructions conflict, the MPII shall prevail.

C. Provide adhesive packaged as follows:
   1. Disposable, self-contained cartridge system capable of dispensing multiple adhesive components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
   2. Dispense components through a mixing nozzle that thoroughly mixes components.

3.02 HOLE SIZING AND INSTALLATION

A. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device, and mark locations with construction crayon on the surface of the concrete.
   2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by Engineer.

B. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type with medium or light impact.
   2. Drill bits: Carbide-tipped in accordance with ANSI B212-15.

3. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.
4. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

C. Hole diameter: Reinforcing bar diameter or all thread rod diameter plus 1/8 inch.

D. Obstructions in drill path:
1. If an existing reinforcing bar or other obstruction is hit while drilling hole, stop drilling hole and fill the hole with drypack mortar. Relocate the hole to miss the obstruction and drill another hole. Repeat the above until the hole has been drilled to the required depth.
2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the structural member and endanger the stability of the structure. Drypack holes which hit obstructions and allow drypack to reach strength equal to the existing concrete before drilling adjacent holes. Epoxy grout may be substituted for drypack when acceptable to Engineer.
3. When existing reinforcing steel is encountered during drilling and when acceptable to Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter.
4. Bent bar reinforcing bars: Where edge distances are critical, and striking reinforcing steel is likely, and if acceptable to Engineer, drill hole at 10 degree angle or less from axis of reinforcing bar or all thread rod being installed.

E. Install reinforcing bars and all thread rods to depth, spacings, and locations as indicated on the Drawings:
1. Do not install adhesive-bonded all-thread rods or reinforcing bars in overhead applications.

F. Cleaning holes:
1. Insert long air nozzle into hole and blow out loose dust. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
2. Use a stiff bristle brush to vigorously brush hole to dislodge compacted drilling dust.
3. Repeat step 1.
4. Repeat above steps as required to remove drilling dust or other material that will reduce bond. The hole shall be clean and dry.

G. Cleaning reinforcing bars and all thread rods:
1. Clean reinforcing bars and all thread rods over embedment length to bare metal, free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
2. Solvent clean reinforcing bar and all thread rods over the embedment length in accordance with SSPC SP-1 Solvent Cleaning. Provide an oil and grease free surface to promote bonding of adhesive to steel.

H. Filling hole with adhesive:
   1. Fill hole with adhesive before inserting the reinforcing bar or all thread rod. Fill hole with adhesive starting from bottom of hole. Fill hole without creating air voids.
   2. Fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted into the hole.

3.03 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts reinforcing bars and all thread rods:
   1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
   2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC SP-1. Provide an oil and grease free surface for bonding of adhesive to steel.

B. Fill holes with adhesive:
   1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
   2. Fill hole as nozzle is withdrawn without creating air voids.
   3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
   4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.

C. Installing reinforcing bars and all thread rods:
   1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
   2. Insert reinforcing bars and all thread rods into adhesive in accordance with manufacturer's recommended procedures.
   3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
   4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
   5. Clean excess adhesive from the mouth of the hole.

D. Curing and loading.
   1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
   2. Do not disturb or load bonded embeds until manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

3.04 POST-INSTALLATION ACTIVITIES

A. Do not bend bars or all-thread rods after bonding to the concrete, unless accepted in advance by the Engineer.

B. Attachments to all thread rods:
   1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.

3.05 FIELD QUALITY CONTROL

A. Provide field quality control over the Work of this Section as specified in Section 01450.

B. Do not allow work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.

C. Manufacturer's services:
   1. Before beginning installation, furnish adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods:
      a. Provide notice of scheduled training to Engineer and to Special Inspector(s) not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
   2. Submit record, signed by the manufacturer's technical representative, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.

D. Field inspections and testing:
   1. Hole drilling and preparation.
   2. Results: Submit records of inspections and testing to Engineer by electronic copies within 24 hours after completion.

3.06 FIELD QUALITY ASSURANCE

A. Provide field quality assurance over the Work of this Section as specified in Section 01450.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01455.
   2. Frequency of inspections:
      a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
      b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
   3. Preparation:
      a. Review Drawings and Specifications for the Work to be observed.
      b. Review adhesive manufacturer's MPII and recommended installation procedures.
      c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.

4. Inspection - Periodic:
    a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements:
        1) Concrete: Class (minimum specified compressive strength) and thickness.
        2) Environment: Temperature conditions at work area, and moisture conditions of concrete and drilled hole.
        3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPII, and the "conditions of use" listed in the Evaluation Report.
        4) Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedure. Note initial set times observed during installation.
        5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.
    b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
        1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.
        2) For ongoing installations, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.
5. Inspection - Continuous:
    a. Make observations as described under "Inspection - Periodic, Initial Inspection" during all drilling, cleaning, and bonding activities for all bars and rods installed.
6. Records of inspections:
    a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
    b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspection.

END OF SECTION

SECTION 03071

EPOXIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Epoxy.
   2. Epoxy gel.
   3. Epoxy bonding agent.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 03072 - Epoxy Resin/Portland Cement Bonding Agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C 881 – Standard Specification for Epoxy-Resin-Base Systems for Concrete.
   2. C 882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. D 638 - Standard Test Method for Tensile Properties of Plastics.
   4. D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.

1.03 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Provide epoxy materials that are new.
   2. Store and use products within shelf life limitations set forth by manufacturer.
   3. Perform and conduct work of this Section in neat orderly manner.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data completely describing epoxy materials:
   1. Submit evidence of conformance to ASTM C 881. Include manufacturer's designations of Type Grade, Class, and Color.
   2. Submit evidence that materials meet or exceed the specified physical characteristics.

B. Quality control submittals:
   1. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Moisture tolerant, water-insensitive, two-component epoxy resin adhesive material containing 100 percent solids, and meeting or exceeding the performance properties specified when tested in accordance with the standards specified.

B. Epoxy: Low viscosity product in accordance with ASTM C 881; Types I, II and V; Grade 1; Class C:
   1. Manufacturers: One of the following or equal:
      a. BASF, Concresive Standard LVI.
      b. Sika Corporation, Sikadur 35 Hi-Mod LV.
   2. Required properties:

Table 1: Material Properties – Epoxy.

Property	Test Method	Required Results ("neat")
Tensile Strength (7-day)	ASTM D 638	7,500 pounds per square inch, minimum.
Compressive Strength, (7-day)	ASTM D 695	11,000 pounds per square inch, minimum.
Bond Strength (2-day)	ASTM C 882	Concrete shall fail before failure of epoxy.

Notes:
(1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.

C. Epoxy gel: Non-sagging product in accordance with ASTM C 881, Types I and IV, Grade 3, Class C:
   1. Manufacturers: One of the following or equal:
      a. BASF, Concresive Paste LPL.
      b. Sika Corporation, Sikadur 31, Hi-Mod Gel.

2. Required properties:

Table 2 – Material Properties – Epoxy Gel.		
Property	**Test Method**	**Required Results ("neat")**
Tensile Strength (7-day)	ASTM D 638	2,000 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D 695	8,000 pounds per square inch, minimum.
Bond Strength (14-day)	ASTM C 882	1,500 pounds per square inch, minimum.
Notes: (1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

D. Epoxy bonding agent: Non-sagging product in accordance with ASTM C 881, Type II, Grade 1, Class C:
   1. Manufacturers: One of the following or equal:
      a. BASF, Concresive Liquid LPL.
      b. Sika Chemical Corp., Sikadur 32 Hi-Mod LPL.
   2. Required properties:

Table 3 – Material Properties – Epoxy Bonding Agent		
Property	**Test Method**	**Required Results**
Tensile Strength (7-day)	ASTM D 638	4,400 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D 695	8,300 pounds per square inch, minimum.
Bond Strength (14-days)	ASTM C 882	1,800 pounds per square inch, minimum. Concrete shall fail before failure of epoxy bonding agent.
Pot Life	-	Minimum 70 minutes at 77 degrees Fahrenheit or Minimum 90 minutes at 73 degrees Fahrenheit
Notes: (1) Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

   3. If increased contact time is required for concrete placement, epoxy resin/portland cement bonding agent as specified in Section 03072 may be used instead of epoxy bonding agent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Epoxy:
   1. Apply in accordance with manufacturer's installation instructions.

C. Epoxy gel:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Use for vertical or overhead work, or where high viscosity epoxy is required.
   3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy bonding agent:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Bonding agent will not be required for filling form tie holes or for normal finishing and patching of similar sized small defects.

END OF SECTION

SECTION 03072

EPOXY RESIN/PORTLAND CEMENT BONDING AGENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy resin/portland cement bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   2. C 348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   3. C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   4. C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

B. Federal Highway Administration (FHWA):
   1. FHWA-RD-86-193 - Highway Concrete Pavement Technology Development and Testing Volume V: Field Evaluation of SHRP C9206 Test Sites (Bridge Deck Overlays).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sika Corporation, Lyndhurst, New Jersey, Sika Armatec 110.

B. Substitutions: The use of other than the specified product will be considered, providing the Contractor requests its use in writing to the Engineer. This request shall be accompanied by:
   1. A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds specified performance criteria, tested in accordance with the specified test standards.
   2. Documented proof that the proposed substitute product has a 1-year proven record of performance of bonding portland cement mortar/concrete to hardened portland cement mortar/concrete, confirmed by actual field tests and 5 successful installations that the Engineer can investigate.

2.02 MATERIALS

A. Epoxy resin/portland cement adhesive:
   1. Component "A" shall be an epoxy resin/water emulsion containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
   2. Component "B" shall be primarily a water solution of a polyamine.

3. Component "C" shall be a blend of selected portland cements and sands.
4. The material shall not contain asbestos.

2.03 PERFORMANCE CRITERIA

A. Properties of the mixed epoxy resin/portland cement adhesive:
   1. Pot life: 75 to 105 minutes.
   2. Contact time: 24 hours.
   3. Color: Dark gray.

B. Properties of the cured epoxy resin/portland cement adhesive:
   1. Compressive strength in accordance with ASTM C 109:
      a. 3 day: 4,500 pounds per square-inch minimum.
      b. 7 days: 6,500 pounds per square-inch minimum.
      c. 28 days: 8,500 pounds per square-inch minimum.
   2. Splitting tensile strength in accordance with ASTM C 496:
      a. 28 days: 600 pounds per square-inch minimum.
   3. Flexural strength:
      a. 1,100 pounds per square-inch minimum in accordance with ASTM C 348.
   4. Bond strength in accordance with ASTM C 882 modified at 14 days:
      a. 0 hours open time: 2,800 pounds per square-inch minimum.
      b. 24 hours open time: 2,600 pounds per square-inch minimum.
   5. The epoxy resin/portland cement adhesive shall not produce a vapor barrier.
   6. Material must be proven to prevent corrosion of reinforcing steel when tested under the procedures as set forth by the FHWA Program Report Number FHWA-RD-86-193. Proof shall be in the form of an independent testing laboratory corrosion report showing prevention of corrosion of the reinforcing steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mixing the epoxy resin: Shake contents of Component "A" and Component "B." Empty all of both components into a clean, dry mixing pail. Mix thoroughly for 30 seconds with a jiffy paddle on a low-speed with 400 to 600 revolutions per minute drill. Slowly add the entire contents of Component "C" while continuing to mix for a minimum of 3 minutes and until uniform with no lumps. Mix only the quantity that can be applied within its pot life.

B. Placement procedure:
   1. Apply to prepared surface with stiff-bristle brush, broom, or "hopper-type" spray equipment:
      a. For hand applications: Place fresh plastic concrete/mortar while the bonding bridge adhesive is wet or dry, up to 24 hours.
      b. For machine applications: Allow the bonding bridge adhesive to dry for 12 hours minimum.

C. Adhere to all limitations and cautions for the epoxy resin/portland cement adhesive in the manufacturer's current printed literature.

3.02 CLEANING

A. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION

SECTION 03102

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete formwork.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 03300 - Cast-in-Place Concrete.
      b. Section 03600 - Grouting.
      c. Section 07900 - Joint Sealants.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

C. Underwriters Laboratories (UL).

1.03 DEFINITIONS

A. Green concrete: Concrete with less than 100 percent of the minimum specified compressive strength ($f'_{c)}$.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Design of concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
   2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance requirements:
   1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
   2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
   3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
   4. Use forms that are clean and free from dirt, concrete, and other debris:
      a. Coat with form release agent if required, prior to use or reuse.

1.05 SUBMITTALS

A. Information on proposed forming system:
   1. Submit in such detail as the Engineer may require to assure himself that intent of the Specifications can be complied with by use of proposed system.
   2. Alternate combinations of plywood thickness and stud spacing may be submitted.

B. Form release agent. NSF 61 certification prepared by NSF, Underwriters Laboratories (UL) or other, similar, nationally recognized testing laboratory acceptable to the Engineer.

1.06 QUALITY ASSURANCE

A. Qualifications of formwork manufacturers: Use only forming systems by manufacturers having a minimum of 5 years experience, except as otherwise specified, or accepted in writing by the Engineer.

B. Regulatory requirements: Install work of this Section in accordance with local, state, and federal regulations.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Forms: Built-up plywood:
   1. Built-up plywood forms may be substituted for prefabricated forming system subject to following minimum requirements:
      a. Size and material:
         1) Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.
         2) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
      b. Wales: Minimum 2-inch by 4-inch lumber.
      c. Studding and wales: Contain no loose knots and be free of warps, cups, and bows.

B. Forms: Steel or steel framed:
   1. Steel forms:
      a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
      b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
   2. Steel framed plywood forms:
      a. Provide forms that are rigidly constructed and capable of being braced.
      b. Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

C. Form release agent:
   1. Effective, non-staining, bond-breaking coating compatible with form surfaces and concrete mixes used.
   2. Certified for conformance to NSF 61 and leaving no taste or odor on the concrete surface.

D. Form ties:
   1. General:
      a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
      b. Do not use wire ties or wood spreaders of any form.
      c. Provide ties of type that accurately tie, lock, and spread forms.
      d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
      e. Do not allow holes in forms for ties to allow leakage during placement of concrete.
   2. Cone-snap ties:
      a. Cone-snap ties shall form a cone shaped depression in the concrete with minimum diameter of 1 inch at the surface of the concrete and minimum depth of 1-1/2 inches.
      b. Provide neoprene waterseal washer that is located near the center of the concrete.
   3. Taper ties:
      a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickness.

E. Incidentals:
   1. External angles:
      a. Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
      b. Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, contraction, and construction joints.
   2. Keyways: Steel, plastic, or lumber treated with form release agent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Site verification of conditions:
   1. Do not place concrete until forms have been checked for alignment, level, and strength, and mechanical and electrical inserts or other embedded items for correct location.

3.02 INSTALLATION

A. Forms: Built-up plywood:
   1. Studding:
      a. Spaced at 16 inches or 24 inches on center.
      b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
      c. Install studs perpendicular to grain of exterior plys of plywood sheets.
   2. Wales: Form wales of double lumber material with minimum size as specified in this Section.
   3. Number of form reuses: Depends upon durability of surface coating or overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

B. Forms: Steel or steel framed:
   1. Steel forms:
      a. Adequately brace forms for minimum deflection of finish surface.
   2. Steel framed plywood forms:
      a. Rigidly construct and brace with joints fitting closely and smoothly.
      b. Number of form reuses: Depends upon durability of surface coating or overlay used.
   3. Built-up plywood forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

C. Forms: Incidental construction.

D. Form bracing and alignment:
   1. Line and grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
   2. Formwork:
      a. Securely brace, support, tie down, or otherwise hold in place to prevent movement.
      b. Make adequate provisions for uplift pressure, lateral pressure on forms, and deflection of forms.
   3. When second lift is placed on hardened concrete: Take special precautions in form work at top of old lift and bottom of new lift to prevent:
      a. Spreading and vertical or horizontal displacement of forms.
      b. Grout "bleeding" on finish concrete surfaces.

4. Pipe stubs, anchor bolts, and other embedded items: Set in forms where required.
5. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.

E. Forms: Incidentals:
1. Keyways: Construct as indicated on the Drawings.
2. Reentrant angles: May be left square.
3. Level strips: Install at top of wall concrete placements to maintain true line at horizontal construction joints.
4. Inserts:
   a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.
5. Pipe and conduit penetrations:
   a. Install pipe and conduit in structures as indicated on the Drawings, and seal with materials as specified in Section 07900.

F. Form release agent:
1. Apply in accordance with manufacturer's instructions.

G. Form ties:
1. Cone-snap ties: Tie forms together at not more than 2-foot centers vertically and horizontally.

3.03 FORM REMOVAL

A. Keep forms in place for at least the periods indicated in the following paragraphs:
1. Vertical forms:
   a. Keep vertical forms in place for a minimum of 24 hours after concrete is placed.
   b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.
2. Other forms and shoring: Keep in place:
   a. Sides of footings: 24 hours minimum.
   b. Vertical sides of beams, girders, and similar members: 48 hours minimum.
   c. Bottom of slabs, beams, and girders: Until concrete strength reaches specified strength f'_c or until shoring is installed.
   d. Shoring for slabs, beams, and girders: Shore until concrete strength reaches specified strength.
   e. Wall bracing: Brace walls until concrete strength of beams and slabs laterally supporting wall reaches specified strength.

B. Green concrete:
1. No heavy loading on green concrete will be permitted.

3.04 SURFACE REPAIRS AND FINISHING

A. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified in Section 03300.

B. Form ties: Remove form ties from surfaces. Fill tie holes as follows:
1. Remove form ties from surfaces.

2. Roughen cone shaped tie holes by heavy sandblasting before repair.
3. Dry pack cone shaped tie holes with dry-pack mortar as specified in Section 03600.
4. Taper ties:
    a. After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
        1) Heavy sandblast and then clean tie holes.
        2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
        3) Locate steel rod in cylindrical recess and against middle of plug during driving:
            a) At no time are plugs to be driven on flat area outside cylindrical recess.
    b. Dry-pack of taper tie holes:
        1) After installing plugs in tie holes, coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03600:
            a) Place dry-pack mortar in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.
            b) Dry-pack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.
            c) Wall surfaces in area of dry-packed tie holes: On the water side of water containing structures and the outside of below grade walls:
                (1) Cover with minimum of 10 mils of epoxy gel.
                (2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past dry-pack mortar filled tie holes.
                (3) Provide finish surfaces that are free from sand streaks or other voids.

3.05 TOLERANCES

A. Finished concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.

B. Construct work within the tolerances in accordance with ACI 117, except as modified in the following paragraphs or as indicated on the Drawings:
    1. General:
        a. At certain locations in the Work, tolerances required for equipment placement and operation may be more restrictive than the general tolerance requirements of this Section.
        b. Confirm equipment manufacturers' required tolerances for location and operation of equipment that will be installed, and construct concrete to satisfy those requirements.
    2. Slabs:
        a. Slope: Uniformly sloped to drain when slope is indicated on the Drawings.
        b. Slabs indicated to be level: Have maximum vertical deviation of 1/8-inch in 10-foot horizontal length without any apparent changes in grade.
    3. Circular tank walls:
        a. The Contractor may deviate from finish line indicated on the Drawings by use of forms with chord lengths not to exceed 2 feet.

4. Inserts and embedments:
   a. Set inserts and embedments to tolerances required for proper installation and operation of equipment or systems to which insert pertains.
   b. Maximum tolerances: As follows:

Item	Tolerance
Sleeves and inserts	Plus 1/8 Minus 1/8 inches.
Anchor bolts:	
Projected ends	Plus 1/4 Minus 0.0 inches.
Axial alignment	Not more than 2 degrees off the axis indicated on the Drawings.
Setting location	Plus 1/16 Minus 1/16 inches.

C. Remove and replace work that does not conform to required tolerances. Procedures and products employed in and resulting from such re-work shall be acceptable to the Engineer.

END OF SECTION

SECTION 03150

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Waterstops.
   2. Joint fillers.

B. Related sections:
   1. The Contract Drawings are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of the Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 03154 - Hydrophilic Rubber Waterstop.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 570 - Standard Test Method for Water Absorption of Plastics.
   2. D 624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   3. D 638 - Standard Test Method for Tensile Properties of Plastics.
   4. D 746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   5. D 747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
   6. D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   7. D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   8. D 1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   9. D 2240 - Standard Test Method for Rubber Property – Durometer Hardness.

B. American National Standards Institute (ANSI):
   1. A135.4 - Basic Hardboard.

C. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.03 SUBMITTALS

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of Compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.04 QUALITY ASSURANCE

A. Mock-ups:
   1. Welding demonstration:
      a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
   1. Polyvinyl chloride waterstops field joints: Free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of material to water pressure at any point. Replace defective joints. Remove faulty material from site and disposed of by Contractor at its own expense.

C. Inspections:
   1. Quality of welded joints will be subject to acceptance of Engineer.
   2. Polyvinyl chloride waterstop: Following defects represent partial list that will be grounds for rejection:
      a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      b. Exterior crack at joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      c. Any combination of offset or crack that will result in net reduction in cross section of waterstop in excess of 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      d. Misalignment of joint that will result in misalignment of waterstop in excess of 1/2 inch in 10 feet.
      e. Porosity in welded joint as evidenced by visual inspection.
      f. Bubbles or inadequate bonding.

PART 2 PRODUCTS

2.01 JOINT FILLERS

A. General:
   1. Use specific type in applications as indicated on the Drawings.
   2. Do not use scrap or recycled materials to manufacture joint fillers.

B. Preformed expansion joint materials:
   1. Bituminous fiber expansion joint material:
      a. Properties:
         1) Thickness: To match joint width indicated on the Drawings.
         2) Asphalt-impregnated fiber in accordance with ASTM D 1751.
      b. Manufacturers: One of the following or equal:
         1) Durajoint.
         2) W.R. Meadows, SealTight Fibre Expansion Joint.
   2. Synthetic sponge rubber expansion joint material:
      a. Properties:
         1) Thickness: As recommended for width indicated on the Drawings.
         2) Material in accordance with ASTM D 1752, Type I.
      b. Manufacturers: One of the following or equal:
         1) Durajoint.
         2) W.R. Meadows, SealTight Sponge Rubber.

2.02 WATERSTOPS

A. Waterstops - polyvinyl chloride (PVC):
   1. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements as specified in this Section.
   2. Manufacturers: One of the following or equal:
      a. Vinylex Corporation.
      b. Greenstreak Plastic Products Company, Inc.
   3. Type: Ribbed waterstop:
      a. Construction joints: 6-inch wide ribbed type.
      b. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb.
      c. Expansion joints: 9-inch wide ribbed type with hollow center bulb.
      d. Dumbbell-type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
      e. No scrap or reclaimed material shall be used.
   4. Properties as indicated in the following table:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D 792	Not less than 1.3.
Hardness	ASTM D 2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D 638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D 638	Not less than 300 percent.

Physical Characteristics	Test Method	Required Results
Alkali Extraction	CRD-C-572	Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.
Low Temperature Brittle Point	ASTM D 746	No sign of cracking or chipping at -35 degrees Fahrenheit.
Water Absorption	ASTM D 570	Not more than 0.15 percent after 24 hours.
Accelerated Extraction Test	CRD-C-572	Tensile strength: Not less than 1,600 pounds per square inch. Elongation: Not less than 280 percent.
Stiffness in Flexure	ASTM D 747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D 624	Not less than 225 pounds per inch.
Thickness	–	3/8 inch.
Center Bulb		
6-inch Waterstops	–	7/8 inch or 1-inch nominal outside diameter.
9-inch Waterstops	–	For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.
Allowable Tolerances		
Width	–	Plus or minus 3/16 inch.
Thickness	–	Plus or minus 1/32 inch.

B. Waterstops – hydrophilic rubber:
   1. As specified in Section 03154.

2.03 JOINT DOWELS

A. Expansion joint dowels:
   1. Smooth, undeformed steel bars conforming to ASTM A615, Grade 60.
   2. Provide dowels straight and clean, free of loose flaky rust and loose scale.
   3. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04 inches on the diameter of the dowel and extends no more than 0.04 from the end.
   4. Expansion end of the dowel:
      a. Coat bars with a bond breaker.
      b. Provide expansion dowel caps.

B. Slip dowel plastic sleeves:
   1. Manufactured using polypropylene.
   2. Manufacturers: One of the following or equal:
      a. Greenstreak, speed dowel system.

C. Slip dowel end caps:
1. Manufacturers: One of the following or equal:
a. Heckmann Building Products, Inc.: No. 87 Dowel Caps.
b. Dayton Superior Corporation: Style K-11 Dowel Caps.
c. Meadow Steel Products, Inc.:
1) Style 3070 , DT-8, Metal Dowel Tube.
2) Style 3075, PD-13, Plastic Dowel Tube.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops:
1. General:
a. Store waterstops so as to permit free circulation of air around waterstop material and prevent direct exposure to sunlight.
b. Install waterstops in concrete joints where indicated on the Drawings.
c. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
d. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
e. Provide waterstops that are continuous.
f. Set waterstops accurately to position and line as indicated on the Drawings.
g. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
h. Position the waterstop so that symmetrical halves of waterstop are equally divided between concrete pours. Center axis of waterstop shall be coincident with centerline of the joint.
i. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
j. Use wires at not more than 24 inches on centers near outer edge of waterstop to tie waterstops into position.
k. Special clips may be used in lieu of wires, at Contractor's option.
l. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.
m. When any waterstop is installed in concrete on one side of joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, take suitable precautions to shade and protect exposed waterstop from direct rays of sunlight during entire exposure and until exposed portion is embedded in concrete.
n. When placing concrete at waterstops in slabs, lift edge of waterstop while placing concrete below the waterstop. Manually force waterstop against and into concrete, and then cover waterstop with fresh concrete.
2. Polyvinyl chloride waterstop:
a. Install waterstops so that joints are watertight.
b. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
1) Do not damage material by heat sealing.
2) Make joints by overlapping, then simultaneously cut ends of sections to be spliced so they will form smooth even joint. Heat cut ends with

splicing tool until the plastic melts. Press 2 ends together until plastic cools.

3) Maintain continuity of waterstop ribs and tubular center axis.
4) The splices shall have tensile strength of not less than 60 percent of unspliced materials tensile strength.

c. Butt joints of ends of 2 identical waterstop sections may be made while material is in forms.
d. Manufacturer shall factory prefabricate joints for crosses and tees.
e. Split-type waterstops will not be permitted except where specifically indicated on the Drawings.

B. Joints:
1. Construct construction and expansion joints as indicated on the Drawings.
2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

END OF SECTION

SECTION 03154

HYDROPHILIC RUBBER WATERSTOP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydrophilic rubber waterstop.

1.02 SUBMITTALS

A. General:
   1. Submit the following items for each type, style and size of hydrophilic waterstop to be installed.
   2. Product data:
      a. Manufacturer’s product data sheets:
         1) Include complete physical dimensions, expansion characteristics, and laboratory test reports indicating that average material properties conform to the requirements specified.
         2) Provide data sheets for all materials to be included in the waterstop system.
   3. Samples:
      a. Minimum 6-inch long samples of each type of waterstop to be used if requested by the Engineer.
   4. Manufacturer's installation instructions:
      a. Installation instructions and recommended installation details for the complete waterstop system, and for each component used in that system.

PART 2 PRODUCTS

2.01 HYDROPHILIC RUBBER WATERSTOP

A. General:
   1. System composed of flexible hydrophilic urethane polymer with preformed strips, adhesives, paste, fasteners, and other accessories required for a complete and watertight installation:
      a. To ensure compatibility of materials, a single manufacturer shall provide all products and accessories for the hydrophilic waterstop system.
      b. Products incorporating bentonite are not acceptable under this Section.
      c. Provide waterstop and accessories resistant to degradation under cyclic wetting and drying.

B. Hydrophilic strip waterstop:
   1. Pre-formed strips of flexible hydrophilic rubber designed to undergo controlled expansion when exposed to moisture:
      a. Strips manufactured to limit expansion in directions parallel to the plane of the joint, and to direct expansion against confining material perpendicular to that plane.

2. Provide normal or low-expansion pressure as scheduled and as indicated on the Drawings.
3. Manufacturers. One of the following, or equal:
    a. Hydrophilic strip:
        1) Adeka Ultra Seal USA: MC-2010MN.
        2) Greenstreak: Hydrotite CJ1020-2K.
    b. Low expansion hydrophilic strip:
        1) Adeka Ultra Seal USA: KBA-1510FP.
        2) Greenstreak: Hydrotite CJ0725-3K.

C. Hydrophilic paste waterstop:
1. Single-component gun grade paste of hydrophilic rubber designed to undergo controlled expansion when exposed to moisture after initial curing.
2. Manufacturers: One of the following, or equal:
    a. Adeka Ultra Seal USA: P-201.
    b. Greenstreak: Leakmaster LV-1.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and recommended details.

B. Prepare concrete joint surfaces:
1. Use wire brushing or scraping to expose an uncontaminated, solid surface.
2. Clean prepared surface with high-pressure air or water to remove residue and debris.
3. Confirm that prepared surfaces conform to manufacturer’s recommendations for surface profile and moisture conditions before installing materials.

C. Provide manufacturer’s recommended lap, splice, and corner details for hydrophilic waterstops:
1. Use hydrophilic paste at all corner joints and overlap splices of hydrophilic strips.

D. Hydrophilic strip waterstop:
1. Install primers and adhesives when recommended by the manufacturer before setting hydrophilic strips.
2. Keep hydrophilic strip taut during the fastening process.
3. Secure hydrophilic strip in place with concrete nails, screws, or adhesive.
4. Provide installation with no gap between the hydrophilic strip and the concrete to which it is attached. At rough or irregular surfaces, set hydrophilic strip waterstop strip in a bead of hydrophilic paste:
    a. Fill all voids and rough areas under the hydrophilic strip with hydrophilic paste.
    b. Allow hydrophilic paste to cure in accordance with manufacturer’s recommendations before encapsulating paste in fresh concrete.

3.02 SCHEDULE

A. At the following joint locations/conditions, use the hydrophilic strip waterstop configuration noted.

B. Concrete construction joints:
   1. Under all of the following conditions, use hydrophilic strip waterstop set in a bed of hydrophilic paste waterstop, and screw strip waterstop to concrete surface:
      a. Slab or wall thickness is greater than 10 inches.
      b. Waterstop is placed between 2 rows of steel reinforcement.
      c. Concrete cover from waterstop to nearest concrete face is at least 4 inches.
   2. Under any one of the following conditions, use low-expansion hydrophilic strip waterstop set in bed of hydrophilic paste waterstop and screw strip to concrete surface:
      a. Waterstop is placed on 1 side of a single row of steel reinforcement.
      b. Concrete cover from waterstop to nearest concrete face is less than 4 inches.

C. Pipe penetrations through concrete:
   1. Pipe diameter less than 4 inches: Not allowed.
   2. Pipe diameter of 4 to 24 inches: Continuous bead of hydrophilic paste waterstop, minimum 1/4 inch high by 1/2 inch wide, encircling pipe.
   3. Pipe diameter greater than 24 inches: Continuous hydrophilic strip waterstop around perimeter of pipe, with hydrophilic paste seal at lapped ends of strip.

END OF SECTION

SECTION 03200

CONCRETE REINFORCING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Bar supports.
   2. Reinforcing bars.
   3. Thread bars.
   4. Tie wires.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.
   2. 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   3. SP-66 - ACI Detailing Manual.

B. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

C. ASTM International (ASTM):
   1. A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   2. A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   3. A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

1.03 DEFINITIONS

A. Give away bars:
   1. Reinforcing bars that are not required by Contract Documents, but are installed by Contractor to support required reinforcing bars.

1.04 SYSTEM DESCRIPTION

A. Drawings contain general notes concerning amount of reinforcement and placing, details of reinforcing bars at wall corners and intersections, and details of extra reinforcing bars around openings in concrete.

1.05 SUBMITTALS

A. Shop drawings:
   1. Changes to reinforcement in contract drawing:
      a. Indicate in separate letter submitted with shop drawings any changes to requirements in Contract Document for reinforcement.

b. Such changes will not be acceptable unless Engineer has accepted such changes in writing.

2. Reinforcement shop drawings:
   a. Submit reinforcement shop drawings for each specific structure in complete package. Partial submittals will be rejected.
   b. Reinforcement mill certificates.

B. Samples:
   1. Submit samples of bar support chairs proposed for use along with letter stating where each type of chair will be used.

C. Welding of reinforcing bars:
   1. Welding procedures specificator.
   2. Procedures qualification record.
   3. Welder qualification Test record.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance at site:
   1. Reinforcing bars:
      a. Deliver reinforcing bars lacking grade identification marks accompanied by manufacturer's guarantee of grade.

1.07 SEQUENCING AND SCHEDULING

A. Bar supports:
   1. Do not place concrete until samples and product data for bar supports have been accepted by Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bar supports:
   1. Wire bar supports located between reinforcing bars and face of concrete:
      a. Stainless steel. Type 304 stainless steel bar supports:
         1) Support reinforcing bars for concrete placed on ground using wire bar support chairs with Type 304 stainless steel plates for resting on ground that are welded to chairs.
   2. Wire bar supports located between mats of reinforcing bars:
      a. Steel bar supports.

B. Reinforcing bars:
   1. Reinforcing bars embedded in concrete:
      a. In accordance with ASTM A615 or A706 Grade 60, deformed reinforcing bars.

2. Reinforcing bars that are required to be welded shall meet the following requirements:
    a. Low-alloy, Grade 60, deformed reinforcing bars in accordance with ASTM A706.
3. Reinforcing bars that are required to resist earthquake-induced flexural and axial forces in concrete frame members and in concrete shear wall boundary members that meet following requirements:
    a. Low-alloy, Grade 60, deformed reinforcing bars in accordance with ASTM A706.

C. Tie wires:
1. Annealed steel.

D. Welded wire reinforcement:
1. In accordance with ASTM A185.
2. Provide welded wire reinforcement in flat sheet form.
3. Welded wire reinforcement oil may be used in place of reinforcing bars if accepted by Engineer:
    a. Provide welded wire reinforcement having cross-sectional area per linear foot of not less than cross-sectional area per linear foot of reinforcing bars indicated on the Drawings.

2.02 FABRICATION

A. Shop assembly:
1. Cut and bend reinforcing bars in accordance with ACI 318, ACI 350, and ACI SP-66.
2. Bend reinforcing bars cold.
3. Provide reinforcing bars free from defects and kinks and from bends not indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
1. Reinforcing bars and welded wire reinforcement: Verify that reinforcement is new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings that will adversely affect bonding capacity when placed in work.

3.02 PREPARATION

A. Surface preparation:
1. Reinforcing bars:
    a. Thin coating of red rust resulting from short exposure will not be considered objectionable.
    b. Thoroughly clean any reinforcing bars having rust scale, loose mill scale, or thick rust coat.
2. Cleaning of reinforcement materials:
    a. Remove concrete or other deleterious coatings from dowels and other projecting reinforcing bars by wire brushing or sandblasting before reinforcing bars are embedded in subsequent concrete placement.

3.03 INSTALLATION

A. Reinforcing bars: General:
   1. Do not field blend reinforcing bars.
   2. Roll hoop bars to radius of structure.

B. Placing reinforcing bars:
   1. Accurately place reinforcing bars in accordance with tolerances in ACI 318 and ACI 350 adequately secure them in position.
   2. Lap length bars at lap splices as indicated on the Drawings or specified:
      a. Unless specifically otherwise indicated on the Drawings, install bars at lap splices in contact with each other and fasten together with tie wire.
      b. Where reinforcing bars are to be lap spliced at concrete joints, ensure that bars project from first concrete placement, length equal to or greater than minimum lap splice length indicated on the Drawings.
      c. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318 and ACI 350.
   3. Reinforcing bar supports:
      a. Do not use give away bars that have less cover than required by Contract Documents. Do not adjust location of reinforcement required by Contract Documents to provide cover to give away bars.
      b. Do not use brick, concrete masonry units, spalls, rocks, wood, or similar materials for supporting reinforcing bars.
      c. Provide sufficient number of bar supports to prevent sagging, and shifting, and to support loads during construction. In no case less bar support than quantities and at locations as indicated in ACI SP-66.
   4. If not indicated on the Drawings, provide protective concrete cover in accordance with ACI 350 and ACI SP-66.

C. Tying of reinforcing bars:
   1. Fasten reinforcing bars securely in place with wire ties.
   2. Tie reinforcing bars sufficiently often to prevent shifting.
   3. Provide at least 3 ties in each reinforcing bar length:
      a. Does not apply to dowel lap splices or to reinforcing bars shorter than 4 feet, unless necessary for rigidity.
   4. Tie slab reinforcing bars at every intersection around periphery of slab.
   5. Tie wall reinforcing bars and slab bar intersections other than around periphery at not less than every fourth intersection, but not greater than following maximum spacings:

Bar Size	Slab Bar Spacing Inches	Wall Bar Spacing Inches
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

   6. After tying wire ties, bend ends of wire ties in towards center of concrete section:
      a. Cover for wire ties shall be same as cover requirements for reinforcing bars.

D. Welded wire fabric:
   1. Install necessary tie wires, spacing chairs, or supports to keep welded wire reinforcement in place while concrete is being placed.
   2. Bend welded wire reinforcement as indicated on the Drawings or required to fit Work.
   3. Unroll or otherwise straighten welded wire reinforcement to make flat sheet before placing in Work.
   4. Lap splice welded wire fabric as indicated on the Drawings.
   5. If lap splice length is not indicated on the Drawings, splice welded wire fabric in accordance with ACI 318 and ACI 350.

E. Welding reinforcing bars:
   1. Weld reinforcing bars where indicated on the Drawings and where acceptable to Engineer.
   2. Perform welding in accordance with AWS D1.4 and welding procedures accepted by Engineer:
      a. Conform to requirements for minimum preheat and interpass temperatures.
   3. Submit:
      a. Welding procedures specification.
      b. Procedures qualification record.
      c. Welder qualification test record.
   4. Do not tack weld reinforcing bars except where indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Inspection of welding of reinforcing bars:
   1. Reinforcing bar welding will be continuously inspected by inspection laboratory hired by Owner.
   2. In addition to visual inspection, Owner may inspect reinforcing bar welds by other methods including radiographic inspection.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-in-place concrete.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 03071 - Epoxies.
      b. Section 03150 - Concrete Accessories.
      c. Section 03366 - Tooled Concrete Finishing.
      d. Section 03600 - Grouting.
      e. Section 03931 - Epoxy Injection System.
      f. Section 07900 - Joint Sealants.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 305 - Hot Weather Concreting Standard.
   2. 306 - Cold Weather Concreting Standard.
   3. 318 - Building Code Requirements for Structural Concrete and Commentary.
   4. 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   5. Manual of Concrete Practice.

B. ASTM International (ASTM):
   1. C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   2. C 33 - Standard Specification for Concrete Aggregates.
   3. C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   5. C 42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. C 88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

7. C 94 - Standard Specification for Ready-Mixed Concrete.
8. C 114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.
9. C 117 - Standard Test Method for Materials Finer that 75-m (No. 200) Sieve in Mineral Aggregates by Washing.
10. C 123 - Standard Test Method for Lightweight Particles in Aggregate.
11. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
12. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
13. C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate.
14. C 143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
15. C 150 - Standard Specification for Portland Cement.
16. C 156 - Standard Test Method for Water Loss from a Mortar Specimen Through Liquid Membrane-Forming Curing Compounds for Concrete.
17. C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
18. C 171 - Standard Specifications for Sheet Materials for Curing Concrete.
19. C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
20. C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
21. C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
22. C 289 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
23. C 295 - Standard Guide to Petrographic Examination of Aggregates for Concrete.
24. C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. C 311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
26. C 494 - Standard Specification for Chemical Admixtures for Concrete.
27. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
28. C 856 – Standard Practice for Petrographic Examination of Hardened Concrete.
29. D 75 - Standard Practice for Sampling Aggregates.
30. D 2103 - Standard Specification for Polyethylene Film and Sheeting.

C. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Alkali: Sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Cementitious materials: Portland cement and fly ash.

C. Cold weather: A period when for more than 3 consecutive days, the average daily outdoor temperature drops below 40 degrees Fahrenheit. The average daily temperature is the average of the highest and lowest temperatures during the period from midnight to midnight. When temperatures above 50 degrees Fahrenheit

occur during more than half of any 24-hour duration, the period shall no longer be regarded as cold weather.

D. Cold weather concreting: Operations for placing, finishing, curing, and protection of concrete during cold weather.

E. Green concrete: Concrete with less than 100 percent of the specified strength.

F. Hairline crack: Crack with a crack width of less than 4 thousandths of an inch.

G. Hot weather: A period when project conditions such as low humidity, high temperature, solar radiation, and high winds, promote rapid drying of freshly placed concrete.

H. Hot weather concreting: Operations for placing, finishing, curing, and protection of concrete during hot weather.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fly ash, fine aggregate, coarse aggregate, admixtures and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
      b. Proportion materials in a manner that will secure lowest water-cementious materials ratio that is consistent with good workability, plastic and cohesive mixture, and a mixture that is within specified slump range.
      c. Proportion fine and coarse aggregates in manner such as not to produce harshness in placing or honeycombing.
   2. It is the intent of this Section to secure for every part of the Work concrete with homogeneous mixture, which when hardened will have required strength, watertightness, and durability:
      a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
      b. Construction and expansion joints have been specified and positioned in structures as indicated on the Drawings, and curing methods specified, for purpose of reducing number and size of cracks, due to normal expansion and contraction expected from specified concrete mixes.
      c. Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
      d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy as specified in Section 03931:
         1) Floors and walls of water bearing structures.
         2) Walls and overhead slabs of passageways or occupied spaces, outsides of which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
         3) Other items not specified to receive separate waterproof membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.

e. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
f. Pressure injection and sealing: Continue as specified above until structure is watertight and remains watertight for not less than 1 year after final acceptance or date of final repair, whichever occurs later in time.

3. Workmanship and methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318, ACI 350, Manual of Concrete Practices, and recommended practices.

1.05 SUBMITTALS

A. Cement mill tests: Include alkali content, representative of each shipment of cement for verification of compliance with specified requirements.

B. Cold weather concreting:
1. Procedures for the production, transportation, placement, protection, curing, and temperature monitoring for concrete during cold weather.
2. Procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

C. Concrete mixes: Full details, including mix design calculations for concrete mixes proposed for use for each class of concrete:
1. Include information on correction of batching for varying moisture contents of fine aggregate.
2. Source quality test records with mix design submittal:
a. Include calculations for required compressive strength (f'_{cr}) based on source quality test records.

D. Concrete aggregate tests: Certified copies in triplicate of commercial laboratory tests not more than 90 days old of all samples of concrete aggregates:
1. Coarse aggregate:
a. Abrasion loss.
b. Clay lumps and friable particles.
c. Coal and lignite.
d. Materials finer than 200 sieve.
e. Reactivity.
f. Shale and chert.
g. Soundness.
2. Fine aggregate:
a. Clay lumps.
b. Color.
c. Decantation.
d. Reactivity.
e. Shale and chert.
f. Soundness.

E. Drying shrinkage test data.

F. Fine or coarse aggregate batched from more than 1 bin: Analyses for each bin, and composite analysis made up from these, using proportions of materials to be used in mix.

G. Fly ash Certificate of Compliance: Identify source of fly ash and certify compliance in accordance with ASTM C 618.

H. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Corrective measures for use prior to placing concrete.

I. Hot weather concreting: Procedures for production, placement, finishing, curing, protection, and temperature monitoring for concrete during hot weather and appropriate corrective measures.

J. Heating equipment for cold weather concreting: Information on type of equipment used for heating materials and new concrete in process of curing during excessively cold weather.

K. Information on mixing equipment.

L. Product data: Submit data completely describing products.

M. Sequence of concrete placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.

N. Sieve analysis: Submit sieve analyses of fine and coarse aggregates being used in triplicate at least every 3 weeks and at any time there is significant change in grading of materials.

O. Trial batch test data:
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

P. Weather monitoring: Records of:
   1. Relative humidity.
   2. Site ambient temperature.
   3. Wind speed.

Q. Temperature of freshly placed concrete.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver, store, and handle concrete materials in manner that prevents damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Monitoring weather conditions:
      a. Install an outdoor weather station capable of measuring and recording ambient temperature, wind speed, and humidity. Furnish instruments accurate to within 2 degrees Fahrenheit, 5 percent relative humidity, and 1 mile per hour wind speed.
      b. Measure and record temperature of fresh concrete. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature of concrete.
      c. Monitor and keep records of the weather forecast starting at least 48 hours prior to placing concrete in order to allow enough time for taking appropriate measures pertaining to Hot or Cold weather concreting.
   2. Hot weather concreting:
      a. Initiate evaporation control measures when concrete and air temperatures, relative humidity of the air, and the wind velocity have the capacity to evaporate water from a free surface at a rate that is equal to or greater than 0.2 pounds per square feet per hour. Determine evaporation rate using the Menzel Formula and monograph in ACI 305 3.1.3.
      b. When ambient air temperature is above 85 degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel by water cooling to below 90 degrees Fahrenheit.
      c. Monitor weather conditions at the site including air temperature, humidity, and wind speed, to assess the need for evaporation control measures begin monitoring site conditions no later than 1 hour before the start of concrete placement. Continue to monitor site conditions at intervals of 30 minutes until concrete curing has begun.
      d. Temperature of concrete mix at time of placement: Keep temperature below 90 degrees Fahrenheit by methods which do not impair quality of concrete.
      e. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Take corrective measures to minimize rapid water loss from concrete.
      f. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.
   3. Cold weather concreting:
      a. Concrete placed below ambient air temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit:
         1) Make provision for heating water.
      b. Follow recommendations of ACI 306 for preparation, placement, and protection of concrete during cold weather.
      c. If materials have been exposed to freezing temperatures to degree that any material is below 35 degrees Fahrenheit: Heat such materials.
      d. Heating water, cement, or aggregate materials:
         1) Do not heat in excess of 160 degrees Fahrenheit.
      e. Protection of concrete in forms:
         1) Do not remove forms from concrete when outside ambient air temperature is below 50 degrees Fahrenheit until concrete has attained its minimum specified compressive strength. Evidence of

strength shall be based on by testing of cylinders stored in the field under equivalent conditions to those at the concrete structure.

2) Protect by means of covering with tarpaulins, or other acceptable covering acceptable to Engineer.
3) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Admixtures:
   1. General:
      a. Do not use admixtures of any type, except as specified, unless written acceptance has been obtained from the Engineer.
      b. Admixtures shall be compatible with concrete and other admixtures. Admixtures other than pozzolans shall be the products of a single manufacture to ensure compatibility.
      c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight of cement.
      d. Use in accordance with manufacturer's recommendations. Add each admixture to concrete mix separately.
   2. Air entraining admixture:
      a. Provide concrete with 5 percent, within 1 percent, entrained air of evenly dispersed air bubbles at time of placement.
      b. In accordance with ASTM C 260.
   3. Water reducing admixture:
      a. May be used at the Contractor's option.
      b. In accordance with ASTM C 494, Type A or Type D.
      c. Not contain air-entraining agents.
      d. Liquid form before adding to the concrete mix.
      e. No decrease in cement is permitted as result of use of water reducing admixture.
   4. Super-plasticizers: Are not to be used without acceptance by Engineer.

B. Aggregate:
   1. General:
      a. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts specified.
      b. Grade aggregate in accordance with ASTM C 136 and D 75.
      c. Provide unit weight of fine and coarse aggregate that produces in place concrete with weight of not less than 140 pounds per cubic foot.
      d. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.

2. Fine aggregate:
   a. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
   b. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances:
      1) In no case shall total exceed percent listed:

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C 117	3
Shale or Chert	ASTM C 123 ASTM C 295*	1 1
Clay Lumps	ASTM C 142	1
* Test Method C 123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C 295 is used to identify which of the lightweight particles are shale or chert. If the results of Test Method C 123 are less than 1 percent, Test Method C 295 is not required.		

   c. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with ASTM C 33.
3. Coarse aggregate:
   a. Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
   b. Not exceeding 15 percent by weight, of thin or elongated pieces having length greater than 5 times average thickness.
   c. Deleterious substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent:

Item	Test Method	Percent
Shale or chert	ASTM C 123 ASTM C 295**	1.25 1
Coal and lignite	ASTM C 123	1/4
Clay lumps and friable particles	ASTM C 142	1/4
Materials finer than Number 200 sieve	ASTM C 117	1/2*
* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent. ** Test Method C 123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C 295 is used to identify which of the lightweight particles are shale, chert, coal, or lignite. If the results of Test Method C 123 are less than 1.25 percent (the minimum combined percentage of shale, chert, coal and lignite), Test Method C 295 is not required.		

   d. Grading:
      1) Aggregate for Class A, B, C, and D concrete: In accordance with ASTM C 33, Size Number 57, except as otherwise specified or authorized in writing by the Engineer.
      2) Aggregate for Class CE concrete for encasement of electrical conduits:
         a) Graded in accordance with ASTM C 33, Size Number 8.

C. Concrete sealer:
   1. Manufacturers: One of the following or equal:
      a. Euclid Chemical Company: Diamond Hard.
      b. L&M Construction Chemicals: SealHard.

D. Conduit encasement coloring agent:
   1. Color: Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
   2. Manufacturers: One of the following or equal:
      a. Davis Company, #100 Utility Red.
      b. I. Reiss Company, Inc., equivalent product.
      c. Euclid Chemical Company, Increte Division, “Colorcrete Brick Red.”
   3. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

E. Evaporation retardant:
   1. Manufacturers: One of the following or equal:
      a. BASF, Cleveland, Ohio, Confilm.
      b. Euclid Chemical Company, Cleveland, Ohio, Eucobar.

F. Fly ash:
   1. Fly ash in accordance with ASTM C 618, Class F**,** may be used in concrete made with Type II portland cement.
   2. Maximum of 15 percent by weight of fly ash to total weight of cementitious materials:
      a. The total weight of cementitious materials shall not be less than minimum cementitious materials listed in Table A.
   3. Do not use in concrete made with portland-pozzolan cement.
   4. Loss on ignition: Not exceed 4 percent.

G. Keyway material: Steel, plastic, or lumber.

H. Nonslip abrasive:
   1. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Exolon Company, Tonawanda, New York.
      b. Abrasive Materials, Incorporated, Hillsdale, Michigan.
      c. “Non-Slip Aggregate”, Euclid Chemical Company, Cleveland, Ohio.

I. Portland cement:
   1. Conform to specifications and tests in accordance with ASTM C 150, Types II or III, low alkali, except as specified otherwise.
   2. Have total alkali containing not more than 0.60 percent.
   3. Exposed concrete in any individual structure: Use only one brand of portland cement.
   4. Cement for finishes or repairs: Provide cement from same source and of same type as concrete to be finished or repaired.

J. Sheet membrane for curing:
   1. Polyethylene film:
      a. In accordance with ASTM C 171.
      b. Color: White.
      c. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D 2103. Thickness of polyethylene film at any point shall not be less than 0.0030 inches.
      d. Loss of moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C 156.

K. Sprayed membrane curing compound: Clear type with fugitive dye in accordance with ASTM C 309, Type 1D.

L. Surface sealant system: Manufacturers: One of the following or equal:
   1. Radcon Laboratories, Inc., Las Vegas, Nevada, Formula Number 7.
   2. IPA Systems, Philadelphia, Pennsylvania, Duripal.

M. Water:
   1. Water for concrete, washing aggregate, and curing concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
   2. Chlorides and sulfate ions:
      a. Water for conventional reinforced concrete: Use water containing not more than 1,000 milligrams per liter of chlorides calculated as chloride ion, nor more than 1,000 milligrams per liter of sulfates calculated as sulfate ion.
      b. Water for prestressed or post-tensioned concrete: Use water containing not more than 650 milligrams per liter of chlorides calculated as chloride ion, or more than 800 milligrams per liter of sulfates calculated as sulfate ion.

2.02 EQUIPMENT

A. Mixing concrete:
   1. Mixers may be of stationary plant, paver, or truck mixer type.
   2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
   3. Mixing equipment:
      a. Capable of combining aggregates, cementitious materials, and water within specified time into thoroughly mixed and uniform mass and discharging mixture without segregation.
      b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
      c. Proportion cementitious materials and aggregate by weight.

B. Machine mixing:
   1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.

2. If bulk cementitious materials are used, weigh them on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
3. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
4. Procedure of mixing cementitious materials with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
5. Retempering of concrete will not be permitted.
6. Discharge entire batch before recharging.
7. Volume of mixed material per batch: Not exceed manufacturer's rated capacity of mixer.
8. Mixers:
    a. Perform mixing in batch mixers of acceptable type.
    b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
    c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing:
        1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-mixed concrete:
1. Mix and deliver in accordance with ASTM C 94.
2. Total elapsed time between addition of water at batch plant and discharging completed mix:
    a. Not to exceed 90 minutes.
    b. Elapsed time at project site shall not exceed 30 minutes.
3. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the Engineer.
4. Equip each truck mixer with device interlocked to prevent discharge of concrete from drum before required number of turns and furnish device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch:
    a. Do not add water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The Contractor will not be entitled to additional compensation because of such increase or decrease.

D. Other types of mixers: In case of other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than 1 cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of materials:
   1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
   2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
   3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
   4. Measuring or weighing devices: Subject to review by the Engineer. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
   5. Weighing cementitious materials:
      a. Weigh cementitious materials separately.
      b. Cement in unbroken standard packages (sacks): Need not be weighed.
      c. Weigh bulk cementitious materials and fractional packages.
   6. Measure mixing water by volume or by weight.

B. Concrete proportions and consistency:
   1. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
   2. Prevent unnecessary or haphazard changes in consistency of concrete.
   3. Ratio of coarse aggregate to fine aggregate: Not less than 1.0 or more than 2.0 for all concrete Classes, with exception of Class CE.
   4. Aggregate:
      a. Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operation.
   5. Maximum concrete mix water to cementitious materials ratio, minimum cementitious materials content, and slump range: Conform to values specified in Table A in this Section.
   6. Concrete batch weights: Control and adjust to secure maximum yield. At all times, maintain proportions of concrete mix within specified limits.
   7. Mix modification: If required, by the Engineer, modify mixture within limits set forth in this Section.

C. Concrete mixes:
   1. Proportioning of concrete mix: Proportion mixes based on required compressive strength f'_{cr}.
   2. Mixes:
      a. Adjusting of water: After acceptance, do not change mixes without acceptance by Engineer, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
      b. Total water content of each concrete class: Not exceed those specified in Table A in this Section.
      c. Checking moisture content of fine aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
   3. Change in mixes: Submit new mix design and perform new trial batch and test program as specified in this Section.

D. Classes of concrete:
   1. Provide concrete consisting of 5 classes: Classes A, B, C, D, and CE. Use where specified or indicated on the Drawings.
   2. Weight of concrete classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
   3. Class B concrete: Class B concrete may be substituted for Class A concrete, when high-early strength concrete is needed in areas specifically accepted by the Engineer and that do not require sulfate resistant concrete.
   4. Class C concrete: Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
   5. Class D concrete: Use Class D for precast concrete items.
   6. Class CE concrete: Use Class CE for electrical conduit encasements.
   7. All other concrete, unless specified or otherwise indicated on the Drawings: Use Class A concrete:

TABLE A
CONCRETE
WITH AIR ENTRAINMENT

Class	Specified Compressive Strength f'_c at 28 Days (Pounds per Square Inch)	Water-to-Cementitious Materials Ratio	Cementitious Materials per Cubic Yard of Concrete by Weight (Pounds)	Slump Range (Inches)
A	4,000	0.40 to 0.45	564 to 658	2 to 4
B (Type III cement)	4,000	0.40 to 0.45	564 to 658	2 to 4
C	2,500	Maximum 0.62	Minimum 423	3 to 6
D	4,500	0.40 to 0.45	564 to 658	2 to 4
CE	2,500	Maximum 0.62	Minimum 423	3 to 6

   8. Pumped concrete: Provide pumped concrete that complies with all requirements of this Section.
   9. Do not place concrete with slump outside limits indicated in Table A.
   10. Classes:
      a. Classes A, C, D, and CE concrete: Make with Type II low alkali portland cement.
      b. Class B concrete: Make with Type III low alkali portland cement.
      c. Admixtures: Provide admixtures as specified in this Section.

E. Air entraining admixture:
   1. Add agent to batch in portion of mixing water.
   2. Batch solution by means of mechanical batcher capable of accurate measurement.

2.04 SOURCE QUALITY CONTROL

A. Tests:
   1. Trial batches:
      a. After concrete mix designs have been accepted by Engineer, have trial batches of the accepted Class A, Class B, and Class D concrete mix designs prepared by testing laboratory acceptable to the Engineer.

b. Prepare trial batches using cementitious materials and aggregates proposed to be used for the Work.
c. Prepare trial batches with sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient test cylinders.
d. Test cylinders: Provide cylinders having 6-inch diameter by 12-inch length and that are prepared in accordance with ASTM C 31 for tests specified in this Section.
e. Determine slump in accordance with ASTM C 143.
f. Test cylinders from trial batch:
    1) Test 8 cylinders for compressive strength in accordance with ASTM C 39:
        a) Test 4 cylinders at 7 days and 4 at 28 days.
        b) Establish ratio between 7 day and 28 day strength for mix. 7-day strength may be taken as satisfactory indication of 28-day strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.
    2) Average compressive strength of 4 test cylinders tested at 28 days: Equal to or greater than required average compressive strength (f'_{cr}) on which concrete mix design is based.
g. Drying shrinkage:
    1) Prepare 5 drying shrinkage specimens in accordance with ASTM C 157, except as modified in this Section.
    2) Remove drying shrinkage specimens from molds at age of 23 hours within 1 hour after trial batching, then immediately place them in water at 73 degrees Fahrenheit within 3 degrees for at least 30 minutes and then measure specimens within 30 minutes thereafter to determine original length:
        a) Then submerge specimens in saturated limewater at 73 degrees Fahrenheit within 3 degrees for moist curing.
    3) Make measurement to determine expansion expressed as percentage of original length at age 7 days:
        a) Use length at age 7 days as base length for drying shrinkage calculations.
    4) Immediately store specimens in humidity controlled room maintained at 73 degrees Fahrenheit within 3 degrees and 50 percent within 4 percent relative humidity for remainder of test.
    5) Make and report measurements to determine shrinkage expressed as percentage of base length separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
    6) Drying shrinkage deformation:
        a) Measure drying shrinkage deformation of each specimen as difference between base length and length after drying at each test age.
        b) Measure average drying shrinkage deformation of specimens to nearest 0.0001 inch at each test age.
        c) If drying shrinkage of any specimen departs from average of test age by more than 0.0004 inch, disregard results obtained from that specimen and test another specimen.
        d) Shrinkage of trial batch concrete at 28 days drying age shall not exceed 0.045 percent maximum.

h. If trial batch tests do not meet specified requirements for slump, strength, workability, consistency, drying shrinkage, and finishing, change concrete mix design proportions and, if necessary, source of aggregate:
   1) Perform additional trial batches and tests until an acceptable trial batch is produced that meets requirements of this Section.
i. Perform test batches and tests required to establish trial batches and acceptability of materials without change in Contract Price.
j. Do not place concrete until the concrete mix design and trial batch have been accepted by Engineer.

2. Required average compressive strength:
   a. Determine required average compressive strength (f'_{cr}) for selection of concrete proportions for mix design, for each class of concrete, using calculated standard deviation for its corresponding specified compressive strength (f'_c,) in accordance with ACI 318 and ACI 350.
   b. When test records of at least 30 consecutive tests that span period of not less than 45 calendar days are available, establish standard deviation as in accordance with ACI 318 and ACI 350 and as modified in this Section.
   c. Provide test records from which to calculate standard deviation that represent materials, quality control procedures, and conditions similar to materials, quality control procedures, and conditions expected to apply in preparation of concrete for the Work.
   d. Provide test records with materials and proportions that are more restricted than those for the Work.
   e. Specified compressive strength (f'_c) of concrete used in test records: Within 1,000 pounds per square inch of that specified for the Work.
   f. When lacking adequate test records for calculation of standard deviation meeting requirements, determine required average compressive strength f'_{cr} from following Table B:

TABLE B
REQUIRED AVERAGE COMPRESSION STRENGTH

Specified Compressive Strength f'_c (pounds per square inch)	**Required Average Compressive Strength f'_{cr} (pounds per square inch)**
Less than 3,000	$f'_c + 1,000$
3,000 to 5,000	$f'_c + 1,200$
Over 5,000	$1.10f'_c + 700$

3. Aggregate:
   a. Testing of concrete aggregate is at Contractor's expense.
   b. If there is change in aggregate source or if there is a significant change in aggregate quality or sieve analysis from same source, submit new set of design mixes covering each class of concrete and prepare new trial batches before further placing of concrete.
   c. Sieves: Use sieves with square openings for testing grading of aggregates.
   d. Sample aggregate in accordance with ASTM C 136 and D 75.
   e. Fine aggregate:
      1) Provide fine aggregate that does not contain strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C 40.

2) Provide aggregate having soundness in accordance with ASTM C 33 when tested in accordance with ASTM C 88.
3) Provide aggregate complying with reactivity requirements in accordance with ASTM C 33 when tested in accordance with ASTM C 289.

f. Coarse aggregate:
1) Soundness when tested in accordance with ASTM C 88: Have loss not greater than 10 percent when tested with sodium sulfate.
2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C 131.
3) Reactivity: Not exceed limits specified in Appendix of ASTM C 33 when tested in accordance with ASTM C 289.
4) Fly ash:
a) Sampling and testing: Sample and test fly ash in accordance with ASTM C 311.
5) Portland cement:
a) Determination of alkali content: In accordance with ASTM C 114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Liquid evaporation retardant:
1. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, immediately after the concrete has been screeded, coat the surface of the concrete with a liquid evaporation retardant.
2. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks.
3. Conditions which result in rapid evaporation of moisture may include one or more of the following:
a. Low humidity.
b. Windy conditions.
c. High temperature.

B. Surface sealant system:
1. Apply as recommended by manufacturer published instructions.
2. Where concrete continues to sweat or leak, apply additional coats of surface sealant until the sweating or leaks stop.

C. Joints and bonding:
1. As far as practicable construct concrete work as monolith.
2. Locations of construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
3. Time between placement of adjacent concrete separated by joints:
a. Provide not less than 3 days (72 hours) between placement of adjacent sections for the following:
1) Slabs.
2) Walls.

b. Provide not less than 7 days (168 hours) between placement of upper and lower pours for the following:
    1) Walls over slabs.
    2) Slabs over walls.
    3) Slabs keyed into the sides of walls.

4. Construction joints:
    a. Where construction joints are not indicated on the Drawings, provide construction joints in slabs and walls at intervals not greater than 35 feet.
    b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized the Engineer.
    c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of heavy sandblasting.
    d. Cleaning of construction joints:
        1) Wash construction joints free of sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
        2) Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
        3) Provide cleanout hole at base of each wall and column for inspection and cleaning.
    e. At horizontal joints: As initial placement over cold joints, thoroughly spread bed of cement grout as specified in Section 03600 (with a thickness of not less than 1/2 inch nor more than 1 inch.
5. Take special care to ensure that concrete is well consolidated around and against waterstops and waterstops are secured in proper position.
6. Construction and expansion Joints:
    a. Constructed where and as indicated on the Drawings.
    b. Waterstops, expansion joint material, synthetic rubber sealing compound, and other similar materials: As specified in Sections 03150 and 07900.
7. Repair of concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent as specified in Section 03071.

D. Conveying and placing concrete:
1. Convey concrete from mixer to place of final deposit by methods that prevent separation or loss of materials.
2. Use equipment for chuting, pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without segregation of materials.
3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of day's placement.

E. Placing concrete:
1. Place no concrete without prior authorization of the Engineer.

2. Do not place concrete until:
    a. Reinforcement is secure and properly fastened in its correct position and loose form ties at construction joints have been retightened.
    b. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
    c. Forms have been cleaned and oiled as specified.
3. Do not place concrete in which initial set has occurred, or that has been retempered.
4. Do not place concrete during rainstorms or high velocity winds.
5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
6. Keep sufficient protective covering on hand at all times for protection of concrete.
7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the Engineer.
8. Notify the Engineer in writing of readiness, not just intention, to place concrete in any portion of the work:
    a. Provide this notification in such time in advance of operations, as the Engineer deems necessary to make final inspection of preparations at location of proposed concrete placing.
    b. Place forms, reinforcement, screeds, anchors, ties, and inserts in place before notification of readiness is given to the Engineer.
    c. Depositing concrete:
        1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
        2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
        3) Do not drop concrete freely into place from height greater than 5 feet.
        4) Use tremies for placing concrete where drop is over 5 feet.
        5) Commence placement of concrete on slopes, starting at bottom of slope.
9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
11. After concrete placement begins, continue concrete placement without significant interruption. Plan and implement precautions to prevent any delay, between layers being placed, from exceeding 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.
13. Placement of concrete for slabs, beams, or walkways:
    a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
    b. Allow set time of not less than 1 hour for shrinkage.

F. Consolidating concrete:
    1. Place concrete with aid of acceptable mechanical vibrators.
    2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.

3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
    a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
    b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
    c. Do not place concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms to leave no voids.
6. Take every precaution to make concrete solid, compact, and smooth. If for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the Engineer.

G. Footings and slabs on grade:
1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the Engineer.
2. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
3. If subgrade becomes dry prior to concrete placement, sprinkle again, without forming pools of water.
4. Do not place concrete if subgrade is muddy or soft.

H. Loading concrete:
1. Green concrete:
    a. No heavy loading of green concrete will be permitted.
2. No backfill shall be placed against concrete walls, connecting slabs, or beams until the concrete has reached the specified strength.
3. Use construction methods, sequencing, and allow time for concrete to reach adequate strength to prevent overstress of the concrete structure during construction.

I. Curing concrete:
1. General:
    a. Cure concrete by methods specified in this Section.
    b. Keep concrete continuously moist and at a temperature of at least 50 degrees Fahrenheit for minimum of 7 days after placement.
    c. Cure concrete to be painted with water or sheet membrane.
    d. Do not use sprayed membrane curing or sealing compounds on concrete surfaces that are to receive paint or upon which any material is to be bonded.
    e. Water cure or sheet membrane cure concrete slabs that are specified to be sealed by concrete sealer.
    f. Cure other concrete by water curing or sprayed membrane curing compound at the Contractor's option.
    g. Floor slabs may be cured using sheet membrane curing.
2. Water curing:
    a. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days.
    b. Each day forms remain in place count as 1 day of water curing.

c. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
d. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
e. Flood top of walls with water at least 3 times per day, and keep concrete surfaces moist at all times during 7 day curing period.

3. Sprayed membrane curing compound:
   a. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   b. If more than 1 hour elapses after removal of forms, do not use curing compound, but use water curing for full curing period.
   c. If surface requires repairing or painting, water cure such concrete surfaces.
   d. Do not remove curing compound from concrete in less than 7 days.
   e. Curing compound may be removed only upon written request by Contractor and acceptance by Engineer, stating what measures are to be performed to adequately cure concrete.
   f. Take care to apply curing compound to construction joints. Apply to all surfaces along full profile of joints.
   g. After curing period is complete, remove curing compound placed within construction joint profile by heavy sandblasting prior to placing any new concrete.
   h. Contractor's Option: Instead of using curing compound for curing of construction joints, such joints may be water cured.
   i. Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
   j. Apply curing compound in at least 2 coats.
   k. Apply each coat in direction 90 degrees to preceding coat.
   l. Apply curing compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
   m. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
   n. Thickness and coverage of curing compound: Provide curing compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
   o. The Contractor is cautioned that method of applying curing compound specified in this Section may require more curing compound than normally suggested by manufacturer of curing compound and also more than is customary in the trade.
   p. Apply amounts specified in this Section, regardless of manufacturer's recommendations or customary practice.
   q. If the Contractor desires to use curing compound other than specified curing compound, coat sample areas of concrete wall with proposed curing compound and also similar adjacent area with specified compound in specified manner for comparison:
      1) If proposed sample is not equal or better, in opinion of the Engineer, in all features, proposed substitution will not be allowed.
   r. Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

4. Sheet membrane curing:
    a. Install sheet membrane as soon as concrete is finished and can be walked on without damage.
    b. Seal joints and edges with small sand berm.
    c. Keep concrete moist under sheet membrane.

3.02 CONCRETE FINISHING

A. Provide concrete finishes as specified in Section 03366.

B. Edges of joints:
1. Provide joints having edges as indicated on the Drawings.
2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

C. Concrete sealer:
1. Floors and slabs to receive concrete sealer: As specified in the Contract Documents on finish schedule.
2. Apply concrete sealer:
    a. Apply concrete sealer at coverage rate not to exceed 300 square feet per gallon.
    b. Apply as soon as slab or floor will bear weight.
    c. Sealer:
        1) Before applying concrete sealer, sweep entire surface clean with very soft bristled brush that will not mark concrete finish and remove any standing water.
        2) Apply concrete sealer with sprayer.
        3) Use of paint rollers or mop is not acceptable.
        4) Workmen shall wear flat soled shoes which will not mark or scar concrete surface.
        5) Do not allow traffic on floors and slabs until concrete sealer has dried and hardened.

3.03 FIELD QUALITY CONTROL

A. Testing of concrete:
1. During progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with requirements specified.
2. Tests will be performed in accordance with ASTM C 31, ASTM C 39, and ASTM C 172.
3. The Engineer will make and deliver test cylinders to the laboratory and testing expense will be borne by the Owner.
4. Furnish test equipment.
5. Make provisions for and furnish concrete for test specimens, and provide manual assistance to the Engineer in preparing said specimens.
6. Assume responsibility for care of and providing of curing conditions for test specimens in accordance with ASTM C 31.
7. Sampling frequency:
    a. 1 set of test cylinders for each 150 cubic yards of each class of concrete.
    b. Minimum of 1 set of test cylinders for each class of concrete placed.

c. Not less than 1 set of test cylinders for each half-day's placement.
d. At least 2 sets of test cylinders for each structure.

B. Compressive strength tests:
1. Set of 3 cylinder specimens, 6-inch diameter by 12 inch long.
2. Information: Test 1 cylinder at 7 days.
3. Acceptance: Test 2 cylinders at 28 days.

C. Slump tests:
1. Test slump of concrete using slump cone in accordance with ASTM C 143.
2. Do not use concrete that does not meet specification requirements in regards to slump:
a. Remove such concrete from project site.
b. Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the Engineer.

D. Air entrainment tests:
1. Test percent of entrained air in concrete at beginning of each placement, as often as necessary to keep entrained air within specified range, and when requested to do so by the Engineer.
2. Do not use concrete that does not meet Specification requirements for air entrainment:
a. Remove such concrete from project site.
3. Test air entrainment in concrete in accordance with ASTM C 173.
4. The Engineer may at any time test percent of entrained air in concrete received on project site.

E. Enforcement of strength requirement:
1. Concrete is expected to reach a compressive strength (f'_c) than that specified in Table A.
2. Strength level of concrete will be considered acceptable if following conditions are satisfied:
a. Averages of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength(f'_c).
b. No individual strength test (average of 2 cylinders) falls below specified compressive strength (f'_c) by more than 500 pounds per square inch.
3. Non-compliant strength tests:
a. Mark non-compliant strength test reports to highlight that they contain non-complying results and immediately forward copies of test reports to all parties on the test report distribution list.
b. Provide treatment of non-compliant concrete at no additional cost to Owner and with no additional time added to project schedule.
c. Initial treatment may consist of additional curing and testing of the affected concrete:
1) Provide additional curing of concrete using means and duration acceptable to the Engineer.
2) Upon completion of the additional curing, provide additional testing designated by the Engineer:
a) Obtain and test core samples for compression strength in accordance with ASTM C 42, ACI 318, and ACI 350.

b) Provide not less than 3 cores for each affected area. Obtain Engineer's acceptance of proposed coring locations before proceeding with that work.
c) Submit report of compression strength testing for Engineer's review.
d) If required by the Engineer, provide additional cores and obtain petrographic examination in accordance with ASTM C 856. Submit report of petrographic analysis for Engineer's review.

3) If additional curing does not bring average of 3 cores taken in affected area to at least the minimum specified compressive strength (f'_c), designate such concrete in affected area as defective.

3.04 ADJUSTING

A. Provide repair of defective concrete at no additional cost to Owner and with no additional time added to the project schedule.

B. Make repairs using approach and means acceptable to the Engineer:
1. Provide repairs having strength equal to or greater than specified concrete for areas involved.
2. Do not patch, repair, or cover defective work without inspection by the Engineer.
3. Acceptable means may include, but are not limited to strengthening, repair, or removal and replacement.

C. Strengthening of defective concrete:
1. By addition of concrete.
2. By addition of reinforcing.
3. By addition of both concrete and reinforcing.

D. Repairs:
1. Methods of repair:
a. Dry pack method:
1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
2) Smooth holes: Clean and roughen by heavy sandblasting before repair.
b. Mortar replacement method:
1) Use for holes too wide to dry pack and too shallow for concrete replacement.
2) Comparatively shallow depressions, large or small, which extend no deeper than nearest surface reinforcement.
c. Concrete replacement method:
1) Use when holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.

2. Preparation of concrete for repair:
    a. Chip out and key imperfections in the work and make them ready for repair.
    b. Obtain Engineer's acceptance of surface preparation methods and of prepared surfaces prior to repair.
    c. Surfaces of set concrete to be repaired: First coat with epoxy bonding agent as specified in Section 03071.

E. Remove and replace defective concrete.

END OF SECTION

SECTION 03366

TOOLED CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Tooled concrete finishes.

1.02 QUALITY ASSURANCE

A. Mock-ups:
   1. Test panels for concrete finishes:
      a. Prepare test panels for F4 and F5 finishes and tie-hole repairs for review by Engineer.
      b. Accepted test panels serve as standard of quality and workmanship for project.
   2. Prepare test panel showing horizontal and vertical joints proposed for project for review by the Engineer. Refer to finishes specified in this Section.
   3. Test panels indicating methods for making concrete repairs: Prepare test panels for proposed repairs at beginning of project for review by Engineer:
      a. Accepted test panels serve as standard for repairs during the project.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MIXES

A. Mortar mix for F4 finish: Consist of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.

B. Mortar mix for F5 finish: Consist of 1 part cement to 1-1/2 parts of sand which passes Number 16 screen.

PART 3 EXECUTION

3.01 CONCRETE FINISHES

A. Cement for finishes:
   1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.

B. Finish vertical concrete surfaces with one of the following finishes as indicated in the Finish Schedule:
   1. F1 finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing compound.
   2. F2 finish: No special treatment other than repair defective work, remove fins, fill depressions 1/2 inch or deeper and tie holes with mortar after removal of curing compound.
   3. F3 finish: Repair defective work, remove fins, offsets, and grind projections smooth. Fill depressions 1/4 inch or larger in depth or width and tie holes with mortar after removal of curing compound.
   4. F4 finish: Receive same finish as specified for F3 finish, and, in addition fill depressions and holes 1/16 inch or larger in width with mortar:
      a. "Brush-Off" sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
      b. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
      c. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
      d. Do not let any material remain on surfaces, except that within pits and depressions.
      e. Wipe surfaces clean and moist cure.
   5. F5 finish: Receive same finish as specified for F3 finish, and, in addition, receive special stoned finish, in accordance with following requirements:
      a. Remove forms and perform required repairs, patching, and pointing as specified in this Section.
      b. Wet surfaces thoroughly with brush and rub with hard wood float dipped in water containing 2 pounds of portland cement per gallon.
      c. Rub surfaces until form marks and projections have been removed.
      d. Spread grindings from rubbing operations uniformly over surface with brush in such manner as to fill pits and small voids.
      e. Moist cure brushed surfaces and allow to harden for 3 days:
         1) After curing, obtain final finish by rubbing with carborundum stone of approximately Number 50 grit until entire surfaces have smooth texture and are uniform in color.
         2) Continue curing for remainder of specified time.
      f. If any concrete surface is allowed to become too hard to finish in above specified manner, sandblast and wash related surfaces exposed to view, whether finished or not:
         1) While still damp, rub over surface, plastic mortar, as specified for brushed surfaces and handstoned with Number 60 grit carborundum stone, using additional mortar for brushed surfaces until surface is evenly filled without an excess of mortar.
         2) Continue stoning until surface is hard.
         3) After moist curing for 3 days, make surface smooth in texture and uniform in color by use of Number 50 or Number 60 grit carborundum stone.
         4) After stoning, continue curing until 7 day curing period is completed.

C. Finish horizontal concrete surfaces with one of the following finishes as indicated in the Finish Schedule after proper and adequate vibration and tamping:
   1. S1 finish: Screeded to grade and leave without special finish.
   2. S2 finish: Smooth steel trowel finish.
   3. S3 finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
   4. S4 finish: Steel trowel finish, without local depressions or high points, followed by light hairbroom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish is subject to review and acceptance by the Engineer.
   5. S5 finish: Nonslip abrasive: After concrete has been screeded level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.
   6. S6 finish: Roughened finish: After concrete has been screeded to grade, apply a roughened finish by use of a jitterbug roller or similar device.

D. Finish concrete floor surfaces to which surfacing material is applied: Finish smooth with tolerance within 1/8 inch in 10 feet in any direction from lines indicated on the Drawings.

3.02 CONCRETE FINISH SCHEDULE

A. Finish concrete surfaces as follows:
   1. F4 finish for following vertical surfaces:
      a. Concrete surfaces specified or indicated to be painted.
      b. Concrete surfaces, interior or exterior, exposed to view.
   2. Surfaces in open channels, basins, and similar structures:
      a. F3 finish for vertical surfaces which are normally below water surface.
      b. F4 finish for vertical surfaces located above normal water surface and exposed to view.
      c. Remove fins and fill tie holes from concrete surfaces located in closed boxes or channels where there is normally no access or passageway.
   3. S1 finish for following surfaces:
      a. Projecting footings which are to be covered with dirt.
      b. Slab surfaces which are to be covered with concrete fill.
   4. S2 finish for following surfaces:
      a. Tops of corbels.
      b. Tops of walls and beams not covered above in this Section.
      c. Tops of slabs not covered above in this Section.
      d. All other surfaces not specified to be finished otherwise.
   5. S3 finish for following surfaces:
      a. Building and machine room floors which are not covered with surfacing material: Provide floors that are free from trowel marks.
   6. S4 finish for following surfaces:
      a. Exterior walkways.
      b. Tops of exterior walls or beams which are to serve as walkways.

c. Tops of exterior walls or beams which are to support gratings.
d. Top surface of slabs for basins, channels, digesters, and similar structures.

7. S6 finish for following surfaces:
   a. Basin bottoms, or other similar slab surfaces, over which layer of basin bottom grout will be applied.

END OF SECTION

SECTION 03565

BASIN BOTTOM GROUT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Grouting basin bottom slabs.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 03300 - Cast-in-Place Concrete.

1.02 REFERENCES

A. International Concrete Repair Institute (ICRI):
   1. 310.2 - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.

1.03 DEFINITIONS

A. Grout that has not bonded: Grout that, after placing and setting, has hollow sound when tapped with 4-foot long, nominal, 2-inch by 4-inch piece of lumber.

B. Jitterbug: An expanded metal or grate tamper designed for finishing concrete surfaces with a rough surface profile.

1.04 SUBMITTALS

A. Manufacturer's instructions:
   1. For equipment to be used in grouting basin bottom slabs:
      a. Submit grout placement instructions from manufacturer of equipment designated to operate in basin.
      b. Include in such instructions statements on limitations and precautions to be observed when using equipment for grout placement.

1.05 QUALITY ASSURANCE

A. Pre-installation conference for grouting basin bottom slabs: Schedule meeting with Engineer not less than 24 hours before planned grouting operations to discuss method of placement of grout.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for grout:
   1. Cement, sand, and water: As specified in Section 03300.

2.02 MIXES

A. Grout mixture:
   1. One part portland cement and 4-1/2 parts sand, by weight.
   2. Water content:
      a. Sufficient to allow workability for spreading grout with screeds attached to arms of equipment mechanism.
      b. Not excessive, to prevent formation of surface water, laitance, segregation, and to allow grout to stay in place after screeding.
   3. Do not use admixtures.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Basin bottom slab surface preparation:
      a. Concrete slab surfaces shall have rough texture, suitable for bonding grout.
      b. During concrete placement: finish concrete surface with jitterbug. Do not provide a smooth troweled surface.
      c. Roughen top of slab surface to a ICRI 310.2 surface profile of CSP-5 or rougher using one of the following methods:
         1) Abrasive blasting.
         2) Steel shotblasting.
         3) Ultra high-pressure water jetting.
      d. Clean entire slab surface as required to remove dirt, oil, curing compound, laitance, dust, and other matter that may prevent proper grout bonding.
      e. Saturate concrete slabs with water for minimum of 3 days just before placing grout. At time grout is placed, concrete shall be saturated and surface damp.

B. Equipment preparation:
   1. Preparation of equipment for grouting basin bottom slabs:
      a. Setting the screeds:
         1) Bolt nominal 2-inch by 4-inch section of lumber blades on arms of equipment mechanism.
         2) Locate leading edge of lumber approximately 2 inches in front of blade and cut it parallel to centerline of arm.
         3) Securely nail nominal 2-inch by 6-inch screed board to ends of 2 by 4 lumber, in manner such that screed runs parallel to centerline of arm.
         4) Nail bent sheet metal to lower edge of screed board.
         5) Ensure that bottom of screed board is 1-1/2 inches below steel blades on arms of equipment mechanism.

3.02 APPLICATION

A. Grouting basin bottom slabs:
   1. Placement, general:
      a. Place grout in accordance with equipment manufacturer's instructions and in accordance with limitations and precautions given in such instructions.
      b. Bring promptly to attention of the Engineer, conflicts between manufacturer's instructions and this Section.
   2. Placing grout:
      a. Use grouting equipment to apply grout for basin bottom slabs.
      b. Perform grouting continuously without interruptions until basin slab is covered.
      c. Place ring of grout approximately 3 feet wide on outer edge of slab and gradually widened towards center following spiral pattern until basin bottom slab is covered.
      d. Unacceptable placing procedure: Following procedures will not be accepted:
         1) Grouting by circular sectors or "pie" sections.
         2) Grouting from center outward.
      e. Use finishing workers to control area immediately in front of screed boards in manner so that:
         1) Grout is installed to specified thickness.
         2) No low areas occur.
         3) No excessive amount of grout accumulates.
         4) Grout surface has uniform wood trowel finish without ridges, gouges, or other defect.
      f. Coordinate grout placement rate and number of finishing workers with travel speed of arms of equipment mechanism.
      g. Last grout area to be grouted in center may be finished by worker operating from 1 of the arms.
      h. Use misters or means acceptable to Engineer to keep grout from drying out before start of curing.
   3. Following grout placement:
      a. After completion of slab grouting, allow mechanism to run continuously until there is no more danger that grout sloughing may occur.
      b. Prevent dry clumps of grout or rocks from being caught under screed board and gouging finish surface of grout.
   4. Corrections:
      a. Before grout has set:
         1) Where sloughing has occurred, remove grout from sloughed areas and place grout in low areas.
         2) Repair gouges in grouted surface.
   5. Curing:
      a. After grout has set, water cure grout for 7 days.
      b. Keep grout surface continuously wet for duration of curing period.

B. Tolerances:
   1. For grouting basin bottom slabs:
      a. Tolerance in elevation of finished grout surface: Plus or minus 1/8 inch:
         1) Specified tolerance is more exacting than customary industry standards for slab finish.
         2) Tolerance is required for proper operation of equipment.

b. Thickness of grout layer:
    1) Not less than 1 inch at any point.
    2) Provide average thickness of grout as indicated on the Drawings.

3.03 FIELD QUALITY CONTROL

A. Inspection:
    1. Verify grout elevation tolerance on basin bottom slabs as follows:
        a. After grout has set, operate grouting equipment with blades set to clear grout surface.
        b. Under these conditions, blades shall not clear grout surface by more than 1/4 inch at any point:
            1) Excess clearance: Correct as specified in article titled "Adjusting" in this Section.

3.04 ADJUSTING

A. Grouting basin bottom slabs:
    1. After grout has set:
        a. Where clearance between blades and grouted surface exceeds tolerance specified in this Section, grind high points in grout surface using terrazzo machine until specified tolerance is met.
        b. Grout that has not bonded to concrete slab is not acceptable. Remove and replace such grout.

END OF SECTION

SECTION 03600

GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cement grout.
   2. Cement mortar.
   3. Dry-pack mortar.
   4. Epoxy grout.
   5. Grout.
   6. Non-shrink epoxy grout.
   7. Non-shrink grout.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 03071 - Epoxies.
      b. Section 03300 - Cast-in-Place Concrete.
      c. Section 15050 - Basic Mechanical Materials and Methods.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch or [50-millimeter] cube specimens).
   2. C 230 - Standard Specification for Flow Table for Use In Tests of Hydraulic Cement.
   3. C 531 - Standard Test Method for Liner Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   4. C 579 - Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
   5. C 939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   6. C 942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.

7. C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
8. C 1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.

B. International Concrete Repair Institute (ICRI):
1. 310.2R – Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

A. Cement grout:
1. Mix design.
2. Material submittals.

B. Cement mortar:
1. Mix design.
2. Material submittals.

C. Non-shrink epoxy grout:
1. Manufacturer's literature.

D. Non-shrink grout:
1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.

B. Store materials in cool dry place and in accordance with manufacturer's recommendations.

C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Non-shrink epoxy grout:
1. Manufacturers: One of the following or equal:
a. Five Star Products, Inc., Five Star Epoxy Grout.
b. BASF Construction Chemicals, Masterflow 648 CP Plus.
c. L&M Construction Chemicals, Inc., EPOGROUT.
2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
3. Maintain flowable consistency for at least 45 minutes at 70 degrees Fahrenheit.
4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C 531.

5. Minimum compressive strength: 10,000 pounds per square inch at 24 hours and 14,000 pounds per square inch at 7 days when tested in accordance with ASTM C 579, Method B.
6. Compressive creep: Not exceed 0.0027 inches/per inch when tested under 400 pounds per square inch constant load at 140 degrees Fahrenheit in accordance with ASTM C 1181.
7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C 531, Method B.

B. Non-shrink grout:
1. Manufacturers: One of the following or equal:
   a. Five Star Products, Inc., Five Star Grout.
   b. BASF Construction Chemicals, Masterflow 928.
   c. L&M Construction Chemicals, Inc., CRYSTEX.
2. In accordance with ASTM C 1107.
3. Preportioned and prepackaged cement-based mixture.
4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
5. Require only addition of potable water.
6. Water for pre-soaking, mixing, and curing: Potable water.
7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C 230:
   a. If at fluid consistency, verify consistency in accordance with ASTM C 939.
9. Dimensional stability (height change):
   a. In accordance with ASTM C 1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
   b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C 1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C 109 as modified by ASTM C 1107.

2.02 MIXES

A. Cement grout:
1. Use same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
2. Use same materials for cement grout that are used for concrete.
3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
4. For spreading over surfaces of construction or cold joints.

B. Cement mortar:
1. Use same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
2. Use same materials for cement mortar that are used for concrete.
3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.

4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

C. Dry-pack mortar:
   1. Proportions by weight: 1 part portland cement to 2 parts concrete sand:
      a. Portland cement: As specified in Section 03300.
      b. Concrete sand: As specified in Section 03300.

D. Epoxy grout:
   1. Consist of mixture of epoxy or epoxy gel and sand:
      a. Epoxy: As specified in Section 03071.
      b. Epoxy gel: As specified in Section 03071.
      c. Sand: Clean, bagged, graded, and kiln-dried silica sand.
   2. Proportioning:
      a. For horizontal work: Consist of mixture of 1 part epoxy with not more than 2 parts sand.
      b. For vertical or overhead work: Consist of 1 part epoxy gel with not more than 2 parts sand.

E. Grout:
   1. Mix in proportions by weight: 1 part portland cement to 4 parts concrete sand:
      a. Portland cement: As specified in Section 03300.
      b. Concrete sand: As specified in Section 03300.

F. Non-shrink epoxy grout:
   1. Mix in accordance with manufacturer's installation instructions.

G. Non-shrink grout:
   1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and loose material or foreign matter likely to reduce bond or performance of grout or mortar.

3.02 PREPARATION

A. Surface preparation for grouting other baseplates:
   1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
   2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher:
      a. Remove loose or broken concrete.
   3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

A. Mixing:
   1. Cement grout:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Dry-patch mortar:
      a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.
   4. Non-shrink epoxy grout:
      a. Keep temperature of non-shrink epoxy grout from exceeding manufacturer's recommendations.
   5. Non-shrink grout:
      a. May be drypacked, flowed, or pumped into place. Do not overwork grout.
      b. Do not retemper by adding more water after grout stiffens.

B. Placement:
   1. Cement grout:
      a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
      b. Do not use cement grout that has not been placed within 30 minutes after mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Epoxy grouts:
      a. Wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.
   4. Non-shrink epoxy grout:
      a. Mix in complete units. Do not vary ratio of components or add solvent to change consistency of mix.
      b. Pour hardener into resin and mix for at least 1 minute and until mixture is uniform in color. Pour epoxy into mortar mixer wheelbarrow and add aggregate. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in mix.
   5. Non-shrink grout:
      a. Add non-shrink cement grout to premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
      b. Mix in accordance with manufacturer's instructions to uniform consistency.

C. Curing:
   1. Cement based grouts and mortars:
      a. Keep continuously wet for minimum of 7 days. Use wet burlap, soaker hose, sun shading, ponding, and in extreme conditions, combination of methods.
      b. Maintain above 40 degrees Fahrenheit until it has attained compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for minimum of 24 hours to avoid damage from subsequent freezing.

2. Epoxy based grouts:
    a. Cure grouts in accordance with manufacturers' recommendations:
        1) Do not water cure epoxy grouts.
    b. Do not allow any surface in contact with epoxy grout to fall below 50 degrees Fahrenheit for minimum of 48 hours after placement.

D. Grouting equipment bases, baseplates, soleplates, and skids: As specified in Section 15050.

E. Grouting other baseplates:
1. General:
    a. Use non-shrink grout as specified in this Section.
    b. Baseplate grouting shall take place from one side of baseplate to other in continuous flow of grout to avoid trapping air in grout.
    c. Maintain hydrostatic head pressure by keeping level of grout in headbox above bottom of baseplate. Fill headbox to maximum level and work grout down.
    d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove trapped air.
2. Forms and headboxes:
    a. Build forms using material with adequate strength to withstand placement of grouts.
    b. Use forms that are rigid and liquidtight. Caulk cracks and joints with elastomeric sealant.
    c. Line forms with polyethylene for easy grout release. Coating forms with 2 coats of heavy-duty paste wax is also acceptable.
    d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located on one side of baseplate.
    e. After grout sets, remove forms and trim back grout at 45 degree angle from bottom edges of baseplate.

3.04 FIELD QUALITY CONTROL

A. Non-shrink epoxy grout:
1. Test for 24-hour compressive strength in accordance with ASTM C 579, Method B.

B. Non-shrink grout:
1. Test for 24-hour compressive strength in accordance with ASTM C 942.

END OF SECTION

SECTION 03926

STRUCTURAL CONCRETE REPAIR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Repairing damaged structural concrete.

B. Related section:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 03071 - Epoxies.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens.
   2. C 293 – Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading).
   3. C 348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars).
   4. C 666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   5. C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

1.03 SYSTEM DESCRIPTION

A. General: Structural repair concrete composed of cementitious material capable of being placed in formed vertical and overhead applications, and on horizontal surfaces.

B. Design requirements:
   1. Provide material suitable for performing in environments subject to corrosive attack by chlorides and sulfates, freeze/thaw cycles, low permeability, and abrasion resistant.
   2. Provide concrete repair mortar cement that is placeable from 1 inch in depth and extendable in greater depths.
   3. Concrete repair mortar shall be capable of being poured in place or troweled in place to suit the conditions encountered.

1.04 SUBMITTALS

A. Product data: Submit manufacturer's data completely describing structural repair concrete materials.

B. Certificates of Compliance.

C. Manufacturer's Instructions.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: The manufacturer of the specified product shall have been in existence, for a minimum of 10 years.

B. Allowable tolerances: Deviation from plumb or level shall not exceed 1/8 inch within 10 feet in any direction, as determined with a 10-foot straight edge.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver the specified product in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers.

B. Store and condition the specified product as recommended by the manufacturer.

C. Deliver, store, and handle packaged materials in the manufacturer's original, sealed containers, each clearly identified with the manufacturer's name, and name and type of product.

D. Store materials subject to damage by dirt and moisture in a clean, dry location, off the ground, and suitably protected.

1.07 PROJECT CONDITIONS

A. Existing conditions:
   1. Hot weather: ACI 305.
   2. Cold weather: ACI 306.
   3. Do not place concrete repair mortar during precipitation, unless adequate protection is provided.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural repair concrete:
   1. Manufacturers: One of the following or equal:
      a. BASF, “EMACO S66-CI.”
      b. Sika Corporation, "SikaTop 123 Plus."
   2. Compressive strength: As follows in accordance with ASTM C 109:
      a. 1 day: 2,500 pounds per square inch, minimum.
      b. 7 day: 6,000 pounds per square inch, minimum.
      c. 28 day: 7,000 pounds per square inch, minimum.

3. Bond strength by slant shear: 2,200 pounds per square inch minimum at 28 days, in accordance with ASTM C 882 modified.
4. Flexural strength: 2,000 pounds per square inch minimum at 28 days, when tested in accordance with ASTM .C 293, or 770 pounds per square inch minimum at 28 days when tested in accordance with ASTM C 348.
5. Rapid freeze/thaw durability: in accordance with ASTM C 666; Procedure A:
   a. Relative durability factor at 300 cycles: 95 percent minimum.
6. Working time: 30 to 40 minutes.
7. Color: Concrete gray.

B. Water: Potable, clean, not detrimental to concrete.

C. Form materials:
1. Smooth finish.
2. Brace as required to maintain tolerances.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that concrete surfaces and exposed reinforcing are clean and free of contaminates.

3.02 PREPARATION

A. Prepare existing concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.

B. Thoroughly clean reinforcement and other embedded items to remove loose rust and other objectionable matter.

C. Thoroughly wet wood forms, except coated plywood, and adjacent concrete at least 1 hour in advance of placing concrete; securely close cleanout end inspection ports; repeat wetting as necessary to keep forms damp.

D. Damaged concrete:
1. Areas to be repaired shall be clean, sound, and free of contaminants:
   a. Remove all loose and deteriorated concrete by mechanical means acceptable to the Engineer.
   b. Saw cut perimeter 1/2-inch maximum.
2. Chip concrete substrate to obtain a surface profile of 1/16 inch to 1/8 inch in depth with a new fractured aggregate surface:
   a. The area to be repaired shall be not less than 1 inch in depth.
3. Concrete removal shall extend along the reinforcing steel to locations along the bar free of bond inhibiting corrosion, and where the bar is well bonded to surrounding concrete.

E. Use the following procedures where reinforcing steel with active corrosion is encountered:
1. Sandblast reinforcing steel to remove all contaminants and rust.

2. Determine section loss, splice new reinforcing steel where there is more than 15 percent loss as directed by the Engineer:
    a. If more than half the diameter of the reinforcing steel is exposed, chip out behind the reinforcing steel a minimum of 1/2 inch. The distance chipped behind the reinforcing steel must also equal or exceed the minimum placement depth of the accepted material.

F. Treat cracks in the substrate at the area of patching or overlay work as directed by the Engineer.

G. Extend existing control and expansion joints through any concrete repair.

H. Apply an epoxy-bonding agent to area to be repaired, as specified in Section 03071, prior to patching concrete with polymer-modified portland cement mortar.

3.03 MIXING

A. Mix in accordance with manufacturer's mixing instructions.

3.04 INSTALLATION

A. Formed surface finishes:
    1. Smooth finish:
        a. Obtain by the use of plywood, sheet metal, or lined wood forms; no fins, pockmarks, or other irregularities shall be present in the exposed surfaces of concrete.
        b. Place no structural repair concrete without prior authorization of Engineer.

B. Verify that form materials are in place and ready to receive installation of concrete repair material.

C. Install in accordance with manufacturer's installation instructions.

D. In accordance with ACI recommendations, apply concrete repair material only when ambient conditions of moisture, temperature, humidity, and wind are favorable for curing.

E. Scrub mortar into substrate, filling all cracks, voids, and pores.

F. For new construction, finish of repaired area shall match required finish for concrete being repaired.

G. For existing concrete, finish of repair area shall match finish of concrete being repaired.

H. During the curing process, protect concrete repair from rain, wind, or freezing as required:
    1. Keep sufficient covering on hand at all times for protection of repair concrete.

3.05 CLEANING

A. Remove debris and excess material. Leave work site in a neat, clean condition.

END OF SECTION

SECTION 03931

EPOXY INJECTION SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy injection system.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01450 - Quality Control.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Test Method for Epoxy-Resin-Base Bonding Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
   5. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.
   6. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 SUBMITTALS

A. General: Submit as specified in Section 01330.

B. Product data:
   1. Submit manufacturer's data completely describing epoxy injection system materials, and including test methods and results for strength in tension, flexure, compression and bond; flexural modulus of elasticity; coefficient of thermal expansion; and elongation.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.
   3. Protection plan for surrounding areas and non-cementitious surfaces.

1.04 QUALITY ASSURANCE

A. Products:
   1. Provide materials that are new and use them within shelf life limitations set forth by manufacturer.

B. Qualifications:
   1. Installer:
      a. Minimum 5 years' experience in concrete repair, with focus on application of similar systems and products to projects of similar size and scope.

C. Pre-installation meeting:
   1. At least 1 week prior to commencing work of this Section, convene a meeting at the project site to review and discuss the following:
      a. Surface preparation.
      b. Substrate conditioning and pre-treatment.
      c. Installation procedures.
      d. Environmental conditions (including weather forecast) and curing requirements.
      e. Testing and inspection procedures.
      f. Protection of surrounding surfaces and equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Labels shall include product identification, batch numbers, and shelf life information.

B. Store materials off the ground and away from moisture and direct sunlight, and at temperatures within manufacturer's recommended range.

C. Pre-condition materials to manufacturer's recommended temperatures before mixing and using.

1.06 PROJECT CONDITIONS

A. Take precautions to protect surfaces and equipment in the work area from damage and staining.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers: One of the following or equal:
   1. BASF Building Systems: MasterInject 1500 (formerly Concressive Standard LVI).
   2. Sika Chemical Corp., Sikadur 35 Hi-Mod LV.

B. Epoxy:
   1. In accordance with ASTM C881, Types I, II and IV, Grade 1, Class C.
   2. Water-insensitive 2-component low viscosity, epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified:

Table 1 - Epoxy, Physical Properties		
Characteristic	**Test Method**	**Required Results, minimum(1,2)**
Viscosity (mixed)	--	250 - 375 centipoise
Tensile Strength	ASTM D638	7,500 pounds per square inch
Tensile Elongation at Break	ASTM D638	1 percent
Compressive Strength	ASTM D695	11,000 pounds per square inch
Compressive Modulus	ASTM D695	2.5×10^5 pounds per square inch.
Bond Strength, slant shear, hardened concrete to hardened concrete	ASTM C882	1500 pounds per square inch at 2 days at minimum 73 degrees Fahrenheit. Concrete shall fail before failure of epoxy.
Heat Deflection Temperature	ASTM D648	124 degrees Fahrenheit
Notes: (1) Properties for mixes, neat epoxy. (2) Results after 7-day cure at temperature between 72 and 78 degrees Fahrenheit, unless otherwise noted.		

2.02 EQUIPMENT

A. Injection pump:
   1. Use positive displacement injection pump with interlock to provide in-line mixing and metering system for 2 component epoxy.
   2. Use pressure hoses and injection nozzle designed to properly mix of 2 components of epoxy.
   3. Standby injection unit may be required.

PART 3 EXECUTION

3.01 PREPARATION

A. Surface preparation:
   1. Confirm that surface temperature and moisture conditions are within manufacturer's recommended limits. Condition surfaces to within those limits before commencing epoxy injection.
   2. Sweep or clean area in vicinity of cracks that will be injected with epoxy. Leave area in generally clean condition after epoxy injection is complete.
   3. Clean cracks so they are free from dirt, laitance, and other loose matter.

3.02 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Mixing:
   1. Mix epoxy in accordance with manufacturer's installation instructions.
   2. Do not use solvents to thin epoxy system materials introduced into cracks or joints.

C. Injection:
   1. Apply adequate surface seal to crack to prevent leakage of epoxy.
   2. Establish injection points at distance along crack not less than thickness of cracked member.
   3. Crack injection sequence:
      a. Inject epoxy into crack or joint at first port with sufficient pressure to advance epoxy to adjacent port. Start at lowest port along the injection line and work upwards.
      b. Seal original port and shift injection to next adjacent port where epoxy appears.
      c. Continue port-to-port injection until crack has been injected for its entire length.
      d. For small amounts of epoxy, or where excessive pressure developed by injection pump might further damage structure, premixed epoxy and use hand caulking gun to inject epoxy if acceptable to the Engineer.
      e. Seal ports, including adjacent locations where epoxy seepage occurs, as necessary to prevent drips or run out.
      f. After epoxy injection is complete, remove surface seal material and refinish concrete in area where epoxy was injected to match existing concrete. Leave finished work and work area in a neat, clean condition.

3.03 FIELD QUALITY ASSURANCE

A. Provide Contractor quality control as specified in Section 01450.

B. Field inspections and testing:
   1. Submit records of inspections and tests to Engineer within 24 hours after completion.

C. Manufacturer's services.
   1. Pre-installation meeting: Provide manufacturer's technical representative to attend pre-installation meeting specified in this Section.

3.04 FIELD QUALITY CONTROL

A. Provide Owner's quality assurance for the Work of this Section as specified in Section 01450.

B. Special inspections special tests, and structural observation:
   1. Not required.

C. Field inspections:
   1. Preparation:
      a. Review manufacturer's product data and installation instructions.

2. Required inspections:
    a. Observe surfaces to be injected for temperature and moisture conditions and for surface preparation.
    b. Observe conditioning and mixing of epoxy resin components.
    c. Observe injection procedures for filling cracks.
3. Records of inspections:
    a. Provide record of each inspection.
    b. Submit to Engineer upon request.

3.05 NON-CONFORMING WORK

A. Rework surface finishes that do not match surrounding concrete to the satisfaction of Engineer at no additional cost to Owner.

END OF SECTION

SECTION 05140

STRUCTURAL ALUMINUM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Structural aluminum products, including sheet, pipe, extrusions, and associated accessories.

B. Related Sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      b. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. B 308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

B. American Welding Society (AWS):
   1. A5.10 - Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
   2. D1.2 - Structural Welding Code - Aluminum.

1.03 SUBMITTALS

A. Quality control submittals:
   1. Test Reports: Certified copies of mill tests or reports from a recognized commercial laboratory including chemical and tensile properties of each shipment of structural metal or part thereof having common properties. Tests and analyses shall be made in accordance with applicable ASTM Standards.
   2. Welder's certificates.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current AWS certificate for the type of welding to be performed.
   2. Notify Engineer 24 hours minimum before starting shop or field welding.
   3. Engineer may check materials, equipment, and qualifications of welders.
   4. Remove welders performing unsatisfactory work, or require to requalify.
   5. Engineer may use gamma ray, magnetic particle dye penetrant, or other aids to visual inspection to examine any part of welds or all welds.
   6. Contractor shall bear costs of retests on defective welds.
   7. Contractor shall bear costs in connection with qualifying welders.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural sheet aluminum: ASTM B 209, Alloy 6061-T6.

B. Structural aluminum: ASTM B 308, Alloy 6061-T6.

C. Extruded aluminum: ASTM B 221, Alloy 6063-T42.

D. Isolating sleeves and washers:
   1. As indicated on the Drawings and as specified in Section 05190.

E. Miscellaneous materials:
   1. Furnish supplementary parts necessary to complete each item even where such work is neither definitely indicated on the Drawings nor specified.
   2. Size, form, attachment, and location shall conform to the best of current practice.
   3. Conform to applicable ASTM Standards for materials not otherwise specified.

2.02 FABRICATION

A. Aluminum layout:
   1. Center punch hole centers, and punch or scribe cutoff lines, except where marks would remain on fabricated material.
   2. Apply temperature correction where necessary in layout of critical dimensions. Use a coefficient of expansion of 0.000013 per degree of Fahrenheit.

B. Cutting aluminum:
   1. Material 1/2-inch thick or less: Shear, saw, or cut with a router.
   2. Material more than 1/2-inch thick: Saw or rout.
   3. Make cut edges true and smooth, free from excessive burrs or ragged breaks.
   4. Avoid reentrant cuts wherever possible. Where used, fillet by drilling prior to cutting.
   5. Do not flame cut aluminum alloys.
   6. Punch or drill rivet or bolt holes to finished size before assembly:
      a. Make finished diameter of holes for bolts 1/16-inch maximum larger than nominal bolt diameter.

b. Make holes cylindrical and perpendicular to principal surface.
c. Do not permit holes to drift in a manner to distort metal.

C. Aluminum forming and assembly:
1. Do not heat structural aluminum, except as follows:
a. Heat aluminum to 400 degrees Fahrenheit for 30 minutes maximum, to facilitate bending or welding.
b. Heat only when proper temperature controls and supervision can ensure that limitations on temperature and time are observed.

D. Before assembly, remove chips lodged between contacting surfaces.

E. Welding aluminum:
1. Perform welding of aluminum in accordance with AWS D1.2.
2. Weld aluminum in accordance with the following:
a. Preparation:
1) Remove dirt, grease, forming or machining lubricants, and organic materials from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
2) Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
3) Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
4) Suitably prepare edges to assure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.
b. Filler metal: Aluminum alloys conforming to the requirements of AWS A5.10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
c. Perform welding of structures which are to be anodized using filler alloys which will not discolor when anodized, AWS ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
d. Perform welding by using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
e. Do not use welding process that requires use of a welding flux.
f. Neatly make welded closures.
g. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
h. Make welds full penetration welds unless otherwise indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION

A. Install structural aluminum products as indicated on the Drawings and specified.

B. Install structural aluminum products accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.

C. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.

D. Place anchor bolts or other anchoring devices accurately and make surfaces which bear against structural items smooth and true to level.

E. Rigidly support and brace structural products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

F. Interface with other products:
   1. Where aluminum comes in contact with dissimilar metals, use stainless steel bolts or anchors and separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190.
   2. Coat those parts of aluminum which will be cast into concrete or which will be in contact with concrete, grout, masonry, wood, or other materials that will cause the aluminum to corrode, as specified in Section 09960.

END OF SECTION

05190

MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cast-in anchors and fasteners:
      a. Anchor bolts.
   2. Post-installed steel anchors and fasteners:
      a. Concrete anchors.
   3. Appurtenances for anchoring and fastening:
      a. Anchor bolt sleeves.
      b. Isolating sleeves and washers.
      c. Thread coating for threaded stainless steel fasteners.

B. Related sections:
   1. Section 01330 - Submittals.
   2. Section 01410 - Regulatory Requirements.
   3. Section 01450 - Quality Control.
   4. Section 01455 - Special Tests and Inspections.
   5. Section 01610 - Project Design Criteria.
   6. Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods.
   7. Section 05120 - Structural Steel.
   8. Section 05500 - Metal Fabrications.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary.

B. American National Standards Institute (ANSI):
   1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
   4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

5. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
7. A308 - Standard Specification for Steel Sheet, Terne (Lead-Tin Alloy) Coated by the Hot-Dip Process.
8. A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
9. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
10. B633 - Standard Specification for *Electrodeposited* Coatings of Zinc on Iron and Steel.
11. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
12. E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
13. F436 - Standard Specification for Hardened Steel Washers.
14. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
15. F594 - Standard Specification for Stainless Steel Nuts.
16. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
17. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. International Code Council Evaluation Service, Inc. (ICC-ES):
   1. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 DEFINITIONS

A. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.

B. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.

C. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 60-degrees above a horizontal line so that the fastener resists sustained tension loads.

D. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.

E. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.

F. Terms relating to structures or building environments as used with reference to anchors and fasteners:
   1. Corrosive locations: Describes interior and exterior locations as follows:
      a. Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
   2. Wet and moist locations: Describes locations, other than “corrosive locations,” that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
      a. Exterior portions of buildings and structures.
      b. Liquid-containing structures:
         1) Locations at and below the maximum operating liquid surface elevation.
         2) Locations above the maximum operating liquid surface elevation and:
            a) Below the top of the walls containing the liquid.
            b) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams or walkways enclosing the open top of the structure).
      c. Liquid handling equipment:
         1) Bases of pumps and other equipment that handles liquids.
      d. Indoor locations exposed to moisture, splashing or routine wash down during normal operations, including floors with slopes toward drains or gutters.
      e. Other locations indicated on the Drawings.
   3. Other locations:
      a. Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 SUBMITTALS

A. General:
   1. Submit as specified in Section 01330.
   2. Submit information listed for each type of anchor or fastener to be used.

B. Action submittals:
   1. Product data:
      a. Cast-in anchors:
         1) Manufacturer’s data including catalog cuts showing anchor sizes and configuration, materials, and finishes.
      b. Post-installed anchors:
         1) For each anchor type, manufacturer’s data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.
   2. Samples:
      a. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.
   3. Certificates:
      a. Cast-in anchors:
         1) Mill certificates for steel anchors that will be supplied to the site.

b. Post-installed anchors:
1) Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the site comply with the materials properties specified.

4. Test reports:
a. Post-installed anchors: For each anchor type used for the Work:
1) Current ICC-ES Report (ESR**)** demonstrating:
a) Acceptance of that anchor for use under the building code specified in Section 01410.

5. Manufacturer's instructions:
a. Requirements for storage and handling.
b. Recommended installation procedures including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
c. Requirements for inspection or observation during installation.

6. Qualification statements:
a. Post-installed anchors: Installer qualifications:
1) Submit list of personnel performing installations and include date of manufacturer's training for each.

1.05 QUALITY ASSURANCE

A. Qualifications:
1. Post installed anchors shall be in accordance with building code specified in Section 01410.
2. Installers: Post-installed mechanical anchors:
a. Installations shall be performed by trained installers having at least 3 years' experience performing similar installations with similar types of anchors.

B. Special inspection:
1. Provide special inspection of post-installed anchors as specified in Section 01455 and this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.

B. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.

C. Protect anchors from weather and moisture until installation.

1.07 PROJECT CONDITIONS

A. As specified in Section 01610.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
   1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor:
      a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
      b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
   2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact Engineer for clarification.
   3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
   1. Provide and install anchors of materials as in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

A. Anchor bolts:
   1. Description:
      a. Straight steel rod having one end with integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
      b. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to Engineer:
         1) Rods or bars with angle bend for embedment in concrete (i.e.: “L” or “J” shaped anchor bolts) are not permitted in the Work.
   2. Materials:
      a. Type 316 stainless steel:
         1) Surfaces descaled, pickled, and passivated in accordance with ASTM A308.
         2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
         3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
         4) Washers: Type 316 stainless steel.
      b. Galvanized steel:
         1) Hot-dip galvanized coating in accordance with ASTM F2329.
         2) Bolt: ASTM F1554, Grade 36 heavy hex, coarse thread.
         3) Nuts: ASTM A563, Grade A heavy hex, threads to match bolt.
         4) Washers: ASTM F436, Type 1.

2.03 POST-INSTALLED ANCHORS AND FASTENERS – ADHESIVE

A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete: As specified in Section 03055.

2.04 POST-INSTALLED ANCHORS AND FASTENERS – MECHANICAL

A. General:
   1. Post-installed anchors used for the Work shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01410:
      a. Conditions of use: The acceptance report shall indicate acceptance of the product for use under the following conditions:
         1) In regions of concrete where cracking has occurred or may occur.
         2) To resist short-term loads due to wind forces.
         3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.
   2. Substitutions: When requesting product substitutions, submit calculations, indicating the diameter, effective embedment depth and spacing of the proposed anchors, and demonstrating that the substituted product will provide load resistance that is equal to or greater than that provided by the anchors listed in this Section:
      a. Calculations shall be prepared by and shall bear the signature and sealed of a Civil or Structural Engineer licensed in the State of California.
      b. Decisions regarding the acceptability of proposed substitutions shall be at the discretion of the Engineer.

B. Concrete anchors:
   1. Description. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torquing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. (Sometimes referred to as “expansion anchors” or “wedge anchors.”):
      a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.
   2. Concrete anchors for anchorage to concrete:
      a. Acceptance criteria:
         1) Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
         2) Concrete anchor performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
      b. Manufacturers: One of the following or equal:
         1) Hilti: Kwik Bolt TZ Expansion Anchor.
         2) Powers fasteners: PowerStud+ SD2.
         3) Simpson Strong-Tie®: Strong Bolt 2 Wedge Anchor.

c. Materials. Integrally threaded stud, wedge, washer and nut:
1) Stainless steel: Type 316.
2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

C. Flush shells:
1. Description: Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
2. Flush shell anchors are not permitted in the Work.

2.05 APPURTENANCES FOR ANCHORING AND FASTENING

A. Anchor bolt sleeves:
1. Having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long.
2. Plastic sleeves:
a. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.
3. Fabricated steel sleeves:
a. Fabricate to the following dimensions unless otherwise indicated on the Drawings:
1) Inside diameter: At least 2 inches greater than bolt diameter.
2) Inside length: Not less than 10 bolt diameters.
3) Bottom plate:
a) Square plate with dimensions equal to the outside diameter of the sleeve plus 1/2 inch each side.
b) Thickness equal to or greater than one-half of the anchor bolt diameter.
b. Carbon steel anchor bolts:
1) Fabricated from ASTM A36 plate and ASTM A53, Grade B pipe.
2) Welded connections: Conform to requirements of AWS D1.1.
3) Hot dip galvanized in accordance with ASTM A153.
c. Stainless steel anchor bolts:
1) Fabricated from ASTM A240 plate and pipe. Type 304L or Type 316L to match Type of the anchor bolt.
2) Welded connections: In accordance with AWS D1.6.

B. Isolating sleeves and washers:
1. Manufacturers: One of the following or equal:
a. Central Plastics Company, Shawnee, Oklahoma.
b. Corrosion Control Products, PSI Inc., Gardena, CA.
2. Sleeves: Mylar, 1/32 inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending half way into both steel washers.
3. One sleeve required for each bolt.
4. Washers: The inside diameter of all washer shall fit over the isolating sleeve and both the steel and isolating washers shall have the same inside diameter and outside diameter:
a. Proper size to fit bolts. 2 insulating washers are required for each bolt.
b. Two 1/8-inch thick steel washers for each bolt.

c. G3 Phenolic:
1) Thickness: 1/8 inch.
2) Base material: Glass.
3) Resin: Phenolic.
4) Water absorption: 2 percent.
5) Hardness (Rockwell): 100.
6) Dielectric strength: 450 volts per mil.
7) Compression strength: 50,000 pounds per square inch.
8) Tensile strength: 20,000 pounds per square inch.
9) Maximum operating temperature: 350 degrees Fahrenheit.

C. Coating for repair of galvanized surfaces:
1. Manufacturers: One of the following or approved equal:
a. Galvinox.
b. Galvo-Weld.

D. Thread coating: For use with threaded stainless steel fasteners:
1. Manufacturers: One of the following or equal:
a. Never Seez Compound Corporation, Never-Seez.
b. Oil Research, Inc., WLR No. 111.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION: GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
1. Post-installed anchors may not be used as an alternative to cast-in / built-in anchors at locations where the latter are indicated on the Drawings.
2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.

C. Protect products from damage during installation. Take special care to protect threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.
2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.

E. Interface with other products:
   1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

3.03 INSTALLATION: CAST-IN ANCHORS

A. General:
   1. Accurately locate cast-in and built-in anchors:
      a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
      b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
      c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not “stab” anchors into plastic concrete, mortar, or grout.
      d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.
   2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
   3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

B. Anchor bolts:
   1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.

3.04 INSTALLATION: POST-INSTALLED ADHESIVE ANCHORS

A. Where indicated on the Drawings, set anchor bolts in plastic, galvanized steel or stainless steel sleeves to allow for adjustment.

B. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03055.

3.05 INSTALLATION: POST-INSTALLED MECHANICAL ANCHORS

A. General:
   1. Install anchors in accordance with the manufacturer’s instructions, ACI 355.2, the anchor’s ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements in this Section, the requirements of the ICC-ES Report shall control.
   2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.

3. After anchors have been positioned and inserted into concrete or masonry, do not:
    a. Remove and reuse/reinstall anchors.
    b. Loosen or remove bolts or studs.

B. Holes drilled into concrete and masonry:
1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f'c or f'm).
2. Accurately locate holes:
    a. Before drilling holes, use a reinforcing bar locator to identify the position of all reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
    b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.
3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry:
    a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await Engineer's instructions before proceeding.
4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
5. Drill using anchor manufacturer's recommended equipment and procedures:
    a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
        1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.
        2) Drill bits: Carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred.
6. Drill holes at manufacture's recommended diameter and to depth required to provide the effective embedment indicated.
7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor:
    a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
    b. Repeat cleaning process as required by the manufacturer's installation instructions.
    c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in full compliance with the manufacturer's installation instructions:
1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Concrete Anchors			
Nominal Diameter	**Minimum Effective Embedment Length**		**Minimum required member thickness**
	In concrete	In grouted masonry	
3/8 inch	2 1/2 inch	2 5/8 inch	8 inch
1/2 inch	3 1/2 inch	3 1/2 inch	8 inch
5/8 inch	4 1/2 inch	4 1/2 inch	10 inch
3/4 inch	5 inch	5 1/4 inch	12 inch

E. Flush shell anchors:
   1. Flush shell anchors are not permitted in the Work.
   2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact Engineer for instructions before proceeding.

3.06 FIELD QUALITY CONTROL

A. Contractor shall provide quality control over the Work of this Section as specified in Section 01450:
   1. Expenses associated with work described by the following paragraphs shall be paid by the Contractor.

B. Post-installed anchors:
   1. Review anchor manufacturer's installation instructions and requirements of the Evaluation Service Report (hereafter referred to as "installation documents") for each anchor type and material.
   2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
   3. Certify in writing to the Engineer that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.07 FIELD QUALITY ASSURANCE

A. Owner will provide on-site observation and field quality assurance for the Work of this Section:
   1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted submittals, and manufacturer's installation instructions for the products used.
   2. Record of inspections:
      a. Maintain record of each inspection.
      b. Submit copies to Engineer upon request.
   3. Statement of special inspections: At the end of the project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.

C. Special inspections: Anchors cast into concrete and built into masonry:
   1. Provide special inspection during positioning of anchors and placement of concrete or masonry (including mortar and grout) around the following anchors:
      a. Anchor bolts.
   2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents:
      a. Anchor:
         1) Type and dimensions.
         2) Material: Galvanized steel, Type 304 stainless steel, or Type 316 stainless steel as specified in this Section or indicated on the Drawings.
         3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
         4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.
   3. Following hardening and curing of the concrete or masonry surrounding the anchors, provide periodic special inspection to observe and confirm the following:
      a. Base material (concrete or grouted masonry):
         1) Solid and dense concrete or grouted masonry material within required distances surrounding anchor.
         2) Material encapsulating embedment is dense and well-consolidated.

D. Special Inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry:
   1. Provide special inspection during installation of the following anchors:
      a. Concrete anchors.
   2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torquing of anchors:
      a. Provide continuous special inspection for post-installed anchors in “overhead installations” as defined in this Section.
   3. Requirements for periodic special inspection:
      a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours:
         1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor, shall require a new “initial inspection.”
      b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor’s rated strength.
      c. Anchor:
         1) Manufacturer, type, and dimensions (diameter and length).
         2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).
      d. Hole:
         1) Positioning: Spacing and edge distances.
         2) Drill bit type and diameter.
         3) Diameter, and depth.

4) Hole cleaned in accordance with manufacturer's required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
5) Anchor's minimum effective embedment.
6) Anchor tightening/installation torque.

4. Requirements for continuous special inspection:
   a. The special inspector shall observe all aspects of anchor installation, except that holes may be drilled in his/her absence provided that he/she confirms the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
1. Owner may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications:
   a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
   b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.

3.08 NON-CONFORMING WORK

A. Remove misaligned or non-performing anchors.

B. Fill empty anchor holes and repair failed anchor locations using high-strength, non-shrink, non-metallic grout.

C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque or proof load, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

3.09 SCHEDULES

A. Stainless steel. Provide and install stainless steel anchors at the following locations:
1. "Corrosive locations" as defined in this Section: Type 316 stainless steel.
2. "Wet and moist locations" as defined in this Section: Type 316 stainless steel.
3. At locations indicated on the Drawings.

B. Galvanized: Provide and install galvanized carbon steel anchors at the following locations:
1. Locations not requiring stainless steel.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Cast iron stop plank grooves.
   4. Concrete inserts.
   5. Handrails and guardrails.
   6. Ladders.
   7. Manhole frames and covers.
   8. Metal gratings.
   9. Metal tread plate.
   10. Preformed channel pipe supports.
   11. Stairs.
   12. Miscellaneous metals.
   13. Associated accessories to the above items.

B. Related sections:
   1. Section 05190 - Mechanical anchoring and Fastening to Concrete and Masonry.
   2. Section 09960 - High Performance Coatings.
   3. Section 15061 - Pipe Supports.
   4. Section 15062 - Preformed Channel Pipe Support System.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45: Designations from Start to Finish:
      a. M12-C22-A41.

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

C. ASTM International (ASTM):
   1. A 36 - Standard Specification for Carbon Structural Steel.
   2. A 48 - Standard Specification for Gray Iron Castings.
   3. A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
   4. A 123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. A 240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications.
   6. A 276 - Standard Specification for Stainless Steel Bars and Shapes.

7. A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
8. A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
9. A 380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
10. A 489 - Standard Specification for Carbon Steel Lifting Eyes.
11. A 490 - Standard Specification for Structural Bolts, Alloy Steel, Heat-Treated, 150 ksi Minimum Tensile Strength.
12. A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
13. A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
14. A 635 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
15. A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
16. A 992 - Standard Specification for Structural Steel Shapes.
17. B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
18. B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
19. B 308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
20. B 429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
21. F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.

D. American Welding Society (AWS):
   1. A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

E. National Association of Architectural Metal Manufacturers (NAAMM):
   1. Metal Finishes Manual.

F. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. Passivation: Removal of exogenous iron or iron compounds from the surface of a stainless steel by means of chemical dissolution resulting from treatment with an acid solution that removes the surface contamination but does not significantly affect the stainless steel itself.

1.04 SUBMITTALS

A. Product Data:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Cast iron stop plank grooves.

4. Handrail and guardrail.
5. Manhole frames and covers.
6. Metal grating.

B. Shop drawings:
   1. Handrails and guardrails:
      a. Including details on connection attachments, gates, kick plates, ladders, and angles.
      b. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
      c. Include erection drawings, elevations, and details where applicable.
      d. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Ladders.
   3. Metal grating.
   4. Metal tread plate.
   5. Stairs.
   6. Miscellaneous metals.

C. Samples:
   1. Guardrails with specified finishes.

D. Quality control submittals:
   1. Design data.
   2. Test reports:
      a. Guardrails: 3 copies of certified tests performed by an independent testing laboratory certifying that guardrails meet current State and OSHA strength requirements.
      b. Gratings:
         1) Grating manufacturers' calculations showing that gratings will meet specified design load, stress, and deflection requirements for each size grating for each span.
         2) Reports of tests performed.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals in accordance with the standards of the ASTM, including the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron		
Cast Iron	A 48	Class 40B
Steel		
Galvanized sheet iron or steel	A 653	Coating G90
Coil (plate)	A 635	--

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Structural plate, bars, rolled shapes, and miscellaneous items (except W shapes).	A 36	--
Rolled W shapes	A 992	Grade 50
Standard bolts, nuts, and washers	A 307	--
High strength bolts, nuts, and hardened flat washers	A 325 A 490	--
Eyebolts	A 489	Type 1
Tubing, cold-formed	A 500	--
Tubing, hot-formed	A 501	--
Steel pipe	A 53	Grade B
Stainless Steel		
Plate, sheet, and strip	A 240	Type 304* or 316**
Bars and shapes	A 276	Type 304* or 316**
Bolts (Type 304)	F593	Group 1 Condition CW
Bolts (Type 316)	F593	Group 2 Condition CW
Aluminum		
Flashing sheet aluminum	B 209	Alloy 5005-H14, 0.032 inches minimum thickness
Structural sheet aluminum-	B 209	Alloy 6061-T6
Structural aluminum	B 209 B 308	Alloy 6061-T6
Extruded aluminum	B 221	Alloy 6063-T42
* Use Type 304L if material will be welded. ** Use Type 316L if material will be welded.		

1. Stainless steels are designated by type or series defined by ASTM.
2. Where stainless steel is welded, use low-carbon stainless steel.

2.02 MANUFACTURED UNITS

A. Aluminum grating stair tread:
   1. Manufacturers: One of the following or equal:
      a. IKG Borden Industries, Aluminum Grating Stair Tread with Mebac nosing.
      b. McNichols Co., Type A-Standard with Corrugated Angle Nosing.
   2. Material: Welded aluminum grating tread with non-slip nosing and integral end plates for bolt on attachment to stair stringers.
   3. Size:
      a. Tread width: To equal tread spacing plus 1 inch minimum.
      b. Tread length: Length to suit stringer-to-stringer dimension indicated on the Drawings.
      c. Depth: 1-3/4 inches.
   4. Bolts: Type 316 stainless steel.

B. Aluminum stair nosing:
   1. Manufacturers: One of the following or equal:
      a. Wooster Products, Inc., Type 101 Nosing.
      b. American Safety Tread Co., Inc., Style 801 Nosing.
   2. Material: Cast aluminum abrasive nosings with aluminum oxide granules integrally cast into metal, forming permanent, nonslip, long-wearing surface.
   3. For installation in cast-in-place stairs.
   4. Configuration: 4 inches wide, fabricated with integrally cast stainless steel anchors at approximately 12-inch centers. Length to extend within 3 inches of stair edge on each side.

C. Cast iron stop plank grooves:
   1. Manufacturers: One of the following or equal:
      a. Neenah Foundry Company, R-7500 Series, Type A.
      b. McKinley Iron Works, Type L.
   2. Size: 2-inch wide groove opening by 1-1/2 inch deep, unless otherwise indicated on the Drawings.
   3. Recess groove with the cast iron surface of the groove set flush with the concrete surface.

D. Concrete inserts:
   1. Concrete inserts for supporting pipe and other applications are specified in Section 15061.

E. Handrails and guardrails:
   1. General:
      a. Design and fabricate assemblies to conform to current local, State, and OSHA standards and requirements.
      b. Coordinate layout of assemblies and post spacings to avoid conflicts with equipment and equipment operators:
         1) Indicate on the shop drawings locations of such equipment.
         2) Highlight locations where railings cannot be made continuous, and obtain Engineer's directions on how to proceed before fabricating or installing railings.
   2. Aluminum handrails and guardrails (nonwelded pipe):
      a. Rails, posts, and fitting-assembly spacers:
         1) In accordance with ASTM B 429, 6005, 6063 or 6105, minimum Schedule 40, extruded aluminum pipe of minimum 1.89-inch outside diameter and 0.14-inch wall thickness.
      b. Kick plates: 6061 or 6105 aluminum alloy.
      c. Fastenings and fasteners: As recommended or furnished by the manufacturer.
      d. Other parts: 6063 extruded aluminum, or F214 or F514.0 aluminum castings:
         1) Fabrications: In accordance with ASTM B 209 or ASTM B 221 extruded bars:
            a) Bases: 6061 or 6063 extruded aluminum alloy.
         2) Plug screws or blind rivets: Type 305 stainless steel:
            a) Other parts: Type 300 series stainless steel.
      e. Finish of aluminum components:
         1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41,

mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
2) Pretreat aluminum for cleaning and removing markings before anodizing.

f. Fabrication and assembly:
1) Fabricate posts in single, unspliced pipe length.
2) Perform without welding.
3) Do not epoxy bond the parts.
4) Maximum clear opening between assembled railing components as indicated on the Drawings.

g. Manufacturers: One of the following or equal:
1) Moultrie Manufacturing Company, Wesrail.
2) Golden Railings, Golden, CO, Riveted System.
3) Craneveyor Corporation Enerco Metals, C-V Rail.

3. Fastenings and fasteners: As recommended or furnished by guardrail manufacturer for use with this system.

F. Ladders:

1. General:
a. Type: Safety type conforming to local, State, and OSHA standards as minimum. Furnish guards for ladder wells.
b. Size: 18 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.

2. Aluminum ladders:
a. Materials: 6063-T5 aluminum alloy.
b. Rungs:
1) 1-inch minimum solid square bar with 1/8-inch grooves in top and deeply serrated on all sides.
2) Capable of withstanding 1,000 pound load without failure.
c. Side rails: Minimum 4-inch by 1/2-inch flat bars.
d. Finish of aluminum components:
1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
2) Pretreat aluminum for cleaning and removing markings before anodizing.
e. Fabrication:
1) Welded construction, of size, shape, location, and details indicated on the Drawings.
2) For ladders over 20 feet high, furnish standard ladder cages or fall prevention system designed in accordance with State and OSHA requirements.
f. Fall prevention system: Include but not limit to railing, brackets, clamps, 2 sleeves, and 2 belts, satisfying OSHA safe climbing requirements:
1) Manufacturers: One of the following or equal:
a) North Consumer Products, Saf-T-Climb.
b) Swager Communications, Climbers Buddy System.

G. Manhole frames and covers:
   1. Material: Gray iron castings, in accordance with ASTM A 48, Class 30-B.
   2. Type: Heavy-duty traffic type, with combined minimum set weight of 265 pounds.
   3. Machine horizontal and vertical bearing surfaces to fit neatly, with easily removable cover bearing firmly in frame without rocking.
   4. Frame:
      a. Bottom flange type.
      b. Approximately 4-1/2 inches frame height.
      c. Dimensions as indicated on the Drawings:
         1) Minimum inside clear dimension may not be smaller than nominal diameter minus 2 inches.
   5. Cover:
      a. Skid-resistant grid pattern design stamped with name of utility service provided by manhole, such as "ELECTRICAL," "SEWER," "TELEPHONE," or "WATER."
      b. Solid type without ventilation holes.
   6. Finish: Unpainted.

H. Metal gratings:
   1. General:
      a. Fabricate grating to cover areas indicated on the Drawings.
      b. Unless otherwise indicated on the Drawings, grating over an opening shall cover entire opening.
      c. Make cutouts in grating where required for equipment access or protrusion, including valve operators or stems, and gate frames.
      d. Band ends of grating and edges of cutouts in grating:
         1) End banding: 1/4 inch less than height of grating, with top of grating and top edge of banding flush.
         2) Cutout banding: Full-height of grating.
         3) Use banding of same material as grating.
         4) Panel layout: Enable installation and subsequent removal of grating around protrusions or piping.
         5) Openings 6 inches and larger: Lay out grating panels with edges of 2 adjacent panels located on centerline of opening.
         6) Openings smaller than 6 inches: Locate opening at edge of single panel.
         7) Where an area requires more than 1 grating section to cover area, clamp adjacent grating sections together at 1/4-points with fasteners acceptable to Engineer.
         8) Fabricate steel grating sections in units weighing not more than 50 pounds each.
         9) Fabricate aluminum grating sections in units of weighing not more than 50 pounds each.
         10) Gaps between adjacent grating sections shall not be more than the clear spacing between bearing bars.
      e. When requested by Engineer, test 1 section of each size grating for each span length involved on the job under full load:
         1) Furnish a suitable dial gauge for measuring deflections.
      f. Grating shall be aluminum, unless otherwise specified or indicated on the Drawings.

2. Aluminum grating:
    a. Material for gratings, shelf angles, and rebates: 6061-T6 or 6063-T6 aluminum alloy, except crossbars may be 6063-T5 aluminum alloy.
    b. Shelf angle concrete anchors: Type 304 or Type 316 stainless steel.
    c. Grating rebate rod anchors: 6061-T6 or 6063-T6 aluminum alloy.
    d. Bar size and spacing: As determined by manufacturer to enable grating to support design load.
    e. Design live load: A minimum of 100 pounds per square foot uniform live load on entire grating area, but not less than the live load indicated on the Drawings for the area where grating is located.
    f. Maximum fiber stress for design load: 12,000 pounds per square inch.
    g. Maximum deflection due to design load: 1/240 of grating clear span.
    h. Maximum spacing of main grating bars: 1-1/8 inches clear between bars.
    i. Minimum grating height: 1-1/2 inches.
    j. Manufacturers: One of the following or equal:
        1) IKG Borden Industries, grooved aluminum I-bar.
        2) Brodhead Steel Products, Inc., grooved aluminum I-bar.
3. Heavy-duty steel grating:
    a. Heavy-duty type, fabricated from structural steel and designed in accordance with AASHTO Standard Specifications for Highway Bridges, using H-20 loading.
    b. Hot-dip galvanized after fabrication in accordance with ASTM A 123.
    c. Manufacturers: One of the following or equal:
        1) Reliance Steel Products Company, Heavy-Duty Steel Grating.
        2) Seidelhuber Metal Products, Inc., equivalent product.

I. Metal tread plate:
1. Plate having a raised figured pattern on 1 surface to provide improved traction.

J. Preformed channel pipe supports:
1. Preformed channel pipe supports for pipe supports and other applications are specified in Section 15062.

K. Stairs:
1. Aluminum stairs:
    a. Stringers: 6061-T6 aluminum alloy.
    b. Stair treads:
        1) Aluminum of same type specified under Aluminum Grating.
        2) Of sizes indicated on the Drawings, and 1-3/4 inch minimum depth with cast abrasive type safety nosings.
    c. Handrails and guardrails: Aluminum pipe specified under Aluminum Handrails and Guardrails (Nonwelded Pipe).
    d. Fasteners: Type 304 or Type 316 stainless steel.

L. Miscellaneous aluminum:
1. Fabricate aluminum products, not covered separately in this Section, in accordance with the best practices of the trade and field assemble by riveting or bolting.
2. Do not weld or flame cut.

M. Miscellaneous cast iron:
    1. General:
        a. Tough, gray iron, free from cracks, holes, swells, and cold shuts.
        b. Quality such that hammer blow will produce indentation on rectangular edge of casting without flaking metal.
        c. Before leaving the foundry, clean castings and apply 16-mil dry film thickness coating of coal-tar epoxy, unless otherwise specified or indicated on the Drawings.

N. Miscellaneous stainless steel:
    1. Provide miscellaneous stainless steel items not specified in this Section as indicated on the Drawings or specified elsewhere:
        a. Fabricate and install in accordance with the best practices of the trade.
    2. Cleaning and passivation:
        a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
        b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
        c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated:
            1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
        d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A 380 to remove deposited contaminants before shipping:
            1) Passivation by citric acid treatment is not allowed:
                a) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
            2) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A 380.
            3) After pickling, final cleaning of stainless steel shall conform to Part II of Table A2.1 of Annex A2 of ASTM A 380.
        e. After cleaning, inspect using methods specified for “gross inspection” in ASTM A 380.
        f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

O. Miscellaneous structural steel:
    1. Provide miscellaneous steel items not specified in this Section as indicated on the Drawings or specified elsewhere:
        a. Fabricate and install in accordance with the best practices of the trade.

P. Isolating sleeves and washers:
    1. As indicated on the Drawings and as specified in Section 05190.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Examine work in place to verify that it is satisfactory to receive the work of this Section.
   2. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.
   2. Interface between materials:
      a. Dissimilar metals: Where steel comes in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals:
         1) Make application so that the isolating or protective barrier is not visible in the completed construction.
         2) Isolating sleeves and washers: As specified in Section 05190.
      b. Aluminum in contact with concrete or masonry: Coat aluminum surfaces as specified in Section 09960.
      c. Aluminum in contact with concrete.

B. Aluminum stair nosing:
   1. Install stair nosings on treads of concrete stairs, including top tread on upper concrete slab.
   2. Omit stair nosings where concrete is submerged.
   3. Cast stair nosings in fresh concrete, flush with tread and riser faces. Install nosing in center of step approximately 3 inches from each stair edge.

C. Cast iron stop plank grooves:
   1. Recess stop plank grooves with cast iron surfaces of groove set flush with concrete surface.

D. Handrails and guardrails:
   1. General:
      a. Fasten pipe rails to fittings with Series 300 stainless steel pop rivets or flush set screws.
      b. Make pipe cuts clean and straight, free of burrs and nicks, and square and accurate for minimum joint-gap.
      c. Drill and countersink holes to proper size, as required for a tight flush fit of screws and other component parts.
      d. Space attachment brackets as indicated in the manufacturer's instructions.
   2. Aluminum pipe handrails and guardrails:
      a. During construction, keep exterior surfaces of handrails and guardrails covered with 0.4 millimeters, minimum, heat shrink polyethylene film.
      b. Do not remove protective film before handrails and guardrails have been accepted by Engineer nor before other work in proximity of handrails and guardrails has been completed.

c. Discontinue handrails and guardrails at lighting fixtures.
d. Provide 1/8-inch diameter weep hole at base of each post.
e. Space posts as indicated on the Drawings.
f. Anchor posts into concrete by grouting posts into formed holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces as specified and indicated on the Drawings.
g. Space rails as indicated on the Drawings.
h. Make adequate provision for expansion and contraction of kick plates and rails:
    1) Make provisions for removable sections where indicated on the Drawings.
i. Make lower rails a single, unspliced length between posts, or continuous.
j. Make top rails continuous whenever possible, and attach single, unspliced lengths to 3 posts minimum.
k. Draw up fasteners tight with hand wrench or screw driver.
l. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.
m. Completed installation shall have handrails and railings rigid and free of play at joints and attachments.
n. Protect handrail and guardrail finish from scratches, gouges, dents, stains, and other damage.
o. Replace damaged or disfigured handrails and guardrails with new.
p. Shortly before final acceptance of the work, and after removal of protective polyethylene film, clean handrails and guardrails with mild detergent or with soap and water:
    1) After cleaning, thoroughly rinse handrails and guardrails and wipe with soft cloth.
q. Erect guardrail straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade, which are visible to the eye.

E. Ladders:
1. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.
2. Where exit from ladder is forward over top rung, extend side rails 3 feet 3 inches minimum above landing, and return the rails with a radius bend to the landing.
3. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.
4. Erect rail straight, level, plumb, and true to position indicated on the Drawings:
    a. Correct deviations from true line or grade which are visible to the eye.

F. Manhole frames and covers:
1. Installation: As specified in Section 02084.

G. Metal gratings:
1. General:
    a. Allow 1/8-inch maximum clearance between ends of grating and inside face of vertical leg of shelf angles.
    b. Horizontal bearing leg of shelf angles shall be 2 inches minimum.
    c. Install aluminum plate or angles where necessary to fill openings at changes in elevation and at openings between equipment and grating.

d. Install angle stops at ends of grating.
e. Installed grating shall not slide out of rebate or off support.
f. Weld stops in place, unless otherwise specified or indicated on the Drawings.
g. Top surfaces of grating sections adjacent to each other shall lie in same plane.

2. Aluminum grating:
   a. Aluminum grating: Support on aluminum shelf angles or rebates.
3. Heavy-duty steel grating:
   a. Support on hot-dip galvanized structural steel rebates embedded and anchored in concrete.
   b. Use for roadways, traffic areas, and where indicated on the Drawings.

H. Stairs:
1. General:
   a. Install guard railings around stair wells as indicated on the Drawings or specified.

I. Stainless Steel:
1. Welding:
   a. Passivate field-welded surfaces:
      1) Provide cleaning, pickling and passivating as specified in this Section.
      2) Clean using Derustit Stainless Steel Cleaner, or equal.

END OF SECTION

SECTION 06608

FIBERGLASS REINFORCED PLASTIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: General fabrication and design requirements for fiberglass reinforced plastic fabrications.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01410 - Regulatory Requirements.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. ASTM International (ASTM):
   1. C 582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   2. D 883 - Standard Terminology Relating to Plastics.
   3. D 2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
   4. D 2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   5. D 2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.
   6. D 3299 - Standard Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks.
   7. D 4097 - Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

1.03 DEFINITIONS

A. The terminology of this specification is in accordance with ASTM D 883. Fabricators using this specification are responsible for correct interpretation.

B. Fiberglass reinforced plastic: Fiberglass Reinforced Plastic or glass fiber and resin fabrication consisting of approximately 35 to 55 percent glass fiber reinforcement by weight for hand lay-up structural laminates and 55 to 70 percent glass for filament wound structural laminates, unless otherwise specified.

C. Equipment: The fiberglass reinforced plastic equipment, including ancillary equipment, work, and materials as described in this specification.

D. Fabrication drawings: Those drawings produced by the Fabricator or Contractor, with the intention of providing the necessary information to construct or install the equipment.

E. Mat: Fibrous material consisting of randomly oriented chopped or swirled filaments loosely held together with a binder.

F. Chopped glass: Fibrous material consisting of randomly oriented chopped filaments applied directly to a mold surface or laminated under construction by a chopper gun.

G. Fiber prominence (jackstraw): The distinct visibility of individual glass strands causing a loss of translucency of the laminate.

1.04 DESIGN REQUIREMENTS

A. Design fiberglass reinforced plastic tanks, scrubbers, and other vessels following the procedures and methods, utilizing the equations and formulas, and incorporating safety factors and allowable design stresses and strains set forth in ASME RTP-1. Base the design of duct and other fiberglass reinforced plastic equipment not covered by ASME RTP-1 on the engineering rationale, applicable formulas, and safety factors set forth in ASME RTP-1.

B. Perform calculations necessary to ensure long-term, low risk service of the fiberglass reinforced plastic equipment with minimum reasonable maintenance requirements:
   1. Long-term, low risk service is defined as a service life of 20 years without major structural failure or leakage.
   2. The design shall ensure proper functioning of the equipment at the stated operating conditions.
   3. The design shall include as a minimum, engineering calculations, materials selection and documented physical and mechanical properties, and detailed drawings required for fabrication and assembly of the equipment.

C. Design in accordance with applicable national, regional, and local design and building codes:
   1. Wind and seismic forces shall be determined in accordance with the building code as specified in Section 01410.

D. Resistance to overturning shall not include the weight of the liquid contained in the equipment.

E. Consider the interaction of the installed system including but not limited to thermal expansion of duct, tanks, and vessels and the effects of external loading from piping, fans, pumps, platforms, and other attached items.

F. Allow for the most severe combination of conditions which may include, but not be limited to, the following:
   1. Internal or external pressure.
   2. Static head of contents (working and test conditions).

3. Mass of structure and contents.
4. Design temperature including upset conditions.
5. Superimposed loads, such as seismic and wind forces.
6. Bending moments due to eccentric loads.
7. Localized loads acting at supports, lugs, and other attachments.
8. Shock loads.
9. Loads due to heating or cooling and thermal gradients.
10. Loads applied during transport or erection.
11. Loads imposed by personnel during erection and operations.
12. Fatigue.

G. Use safety factors and allowable strains specified in ASME RTP-1 unless otherwise specified. Do not use safety factors and allowable strains less than the following:
   1. Allowable hoop and axial strain shall be 0.001 inch per inch for filament wound tanks.
   2. A safety factor of 10 for hand lay-up components in tension, flexure, or other loading conditions where elastic stability is not in question.
   3. A safety factor of 5 for external loading (vacuum) or local buckling due to seismic or wind loading.

H. Safety factors for upset conditions or infrequent loading situations may be less than the above values for the specific condition if acceptable to the Engineer.

I. There will typically be other aspects which should be considered. Identify and consider their effects, identify design limitations, and submit this information.

J. Provide test reports or other documentation for laminate properties used in the design. Laminates shall be similar in construction, layer sequence, resin type, and cure to those used to determine tested properties. Properties shall be adjusted to reflect reductions at operating temperatures. Test reports shall be provided for:
   1. Grating: Indicate grating strength and deflection.
   2. Physical properties of test cover panels.
   3. Tanks showing conformance with specified strength requirements.

K. The corrosion liner shall be a minimum of 100 mils in thickness, unless otherwise specified, and documentation shall be provided verifying veil type, liner thickness, and resin cure:
   1. Consider 50 mils of the corrosion liner as sacrificial and do not include it in determining structural wall thickness.
   2. Use structural wall thickness not less than 0.375 inches for tanks and vessels and 0.1875 inches for ductwork.
   3. Submit minimum structural thicknesses of other types of fiberglass reinforced plastic fabrications.

L. Laminate types may include hand layup, helical winding, and hoop/chop construction methods:
   1. In laminates with helix angles greater than 80 degrees and in hoop/chop laminates, orientate approximately 10 percent of the structural wall thickness at 0 degrees (longitudinal direction).
   2. Apply this reinforcement in at least 2 layers of weft unidirectional fabric and equally spaced within the structural wall.

M. For tanks and scrubbers; nozzles, determine manways and shell reinforcements according to the tables and formulas in ASME RTP-1.

N. Anchor tanks and vessels using lugs and a continuous filament wound band or an integral filament wound load ledge with external stainless steel anchor clips:
   1. The anchor clips shall be bolted to the concrete foundation; use non-shrink grout to level anchor clips.
   2. The design shall resolve the sum of the moments and the sum of the force equal to 0.

O. Design internal beams and support attachments using a maximum of 200 pounds per square inch shear stress for secondary bonds. Also apply this to design of external lugs required for ladders, platforms, and other attached items.

1.05 SUBMITTALS

A. Shop drawings and calculations:
   1. Submit general arrangement and fabrication drawings, calculations, and elements of the design.
   2. Include submittal information which describes specifically how the equipment is to be built and details necessary to ascertain that products meet specified requirements. Provide in the form of drawings, standards, specifications, or other shop instructions, but may also be partially contained in quality control records. The submittal shall include, but not be limited to:
      a. Fabrication drawings.
      b. General arrangement drawings signed by an Engineer registered in the state where the project is located, showing complete structural, fasteners, and erection procedures for a complete assembly.
      c. Quality control programs.
      d. Verification that the manufacturer has been engaged in fabrication of similar fiberglass reinforced plastic equipment for a minimum of 5 years.
      e. Statement of compliance with contract design requirements, codes, and standards.
      f. Recommendation for each resin selection from resin manufacturer.
      g. Type and amounts of fillers.
      h. Nominal corrosion liner description.
      i. Reinforcement types and glass content range for hand lay-up laminates.
      j. For filament wound laminates:
         1) Helix angle.
         2) Glass content range.
         3) Strand yield.
         4) Strand per inch in the winding band.
         5) Ply thickness.
         6) Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.
      k. For other components:
         1) Construction type.
         2) Laminate thicknesses.
         3) Ply sequences.
         4) Glass content range.

l. For secondary overlays (both interior and exterior):
    1) Laminate thicknesses.
    2) Ply sequences and widths.
m. Construction details: Construction details for assembly and other special configurations, including:
    1) Tank bottom/top attachments with knuckle configuration and overlays and thicknesses.
    2) Tank support and anchor lugs, including attachment details.
    3) Tank nozzles and installation, including cutout reinforcement, gusseting, and similar items.
    4) Tank lateral or other support fabrication details, including platform attachment clips and/or shoulders.
    5) Scrubber configuration and fabrication details of internal support system and other specialty items.
    6) Cover panel joints, anchorage detail, and details of doors and inspection ports and their attachment or incorporation within the cover.
n. Miscellaneous equipment required.
o. Test reports and certification of compliance with physical property requirements.
p. Color samples.
q. Manufacturer's installation instructions.
r. ASME RTP-1 certification.

B. Operation and Maintenance Data.

C. Warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer qualifications: Fiberglass reinforced plastic manufacturer with experienced personnel, physical facilities, and management capacity sufficient to produce custom-made glass fiber and resin products of quality and size specified for minimum 5 years with satisfactory performance record.

B. Quality assurance plan: Fabricator shall be responsible for implementation of a comprehensive quality assurance plan. The quality assurance plan describes procedures with the following minimum requirements:
    1. Fabricator shall designate personnel to inspect equipment while in process and after completion to assure compliance to every aspect of the section and fabrication drawings:
        a. Inspection shall include, as a minimum, checks for visual defects, laminate thickness and sequence, glass content, Barcol hardness, dimensional tolerances, adherence to construction details, surface preparation, and environmental conditions.
        b. Fabricator's inspector shall complete a report of the findings including method of measurement for each separate assembly.
    2. Prior to use of resins in fabrication, fabricator shall extract samples of resins and retain them for use by the Engineer. Sample size shall be 100 cubic centimeters minimum:
        a. Take 1 sample for each manufacturer's batch number if resin is received in the form it will be used.

b. If the fabricator alters the resin after receipt, such as through the addition of styrene, promoters, or other additives, take samples from each drum or portion thereof mixed with additives.
c. Fabricator shall provide documentation for each sample including resin type, manufacturer, batch and lot number, drum number, complete listing of additives with amounts added, and description and manufacturer of each additive.

3. Fabricator shall inspect glass reinforcement prior to use in fabrication:
   a. Do not use glass that does not meet the manufacturer's acceptance standards.
   b. Do not use glass material that is wet or has been wet.
   c. For each type of glass and lot number used, fabricator shall record the manufacturer, product description, binder type, product code, production date, and lot number.
   d. For mat, woven roving, unidirectional roving, and cloth, also include in records actual measured weight per square yard of material.
4. Fabricator shall retain nozzle cutouts and other excess laminate, clearly marking each piece to identify its original location. These laminate samples become the property of the Owner.
5. For areas where valid laminate samples are not available, take sample plugs at the Engineer's request:
   a. Repair subsequent holes in a manner acceptable to the Engineer.
6. Fabricator shall verify glass content on available samples in accordance with ASTM D 2584. Complete this test and submit the results complete for each major component where samples are available.
7. Prior to final shipment of the equipment, fabricator shall submit to the Engineer a complete quality control report, consisting of copies of records maintained for compliance with this section.

PART 2 PRODUCTS

2.01 RESIN AND REINFORCEMENT MATERIALS

A. General physical properties: In accordance with applicable specifications PS15-69, ASTM C 582, ASTM D 3299, ASTM D 4097, and ASME RTP-1 with verification of properties. Physical properties may include tensile, flexural, and compression modulus of elasticity and ultimate strengths, limiting strains, Poisson ratios, coefficients of expansion, and other directional properties as required for the design of the equipment.

B. Resin:
   1. Fabricate equipment using the corrosion-resistant resin(s) specified in the fiberglass reinforced plastic equipment specifications. The fabricator is required to obtain independent endorsement of each resin selection from the resin manufacturer. Unless otherwise specified, use the resin throughout laminates.
   2. The type of catalyst recommended varies between resin manufacturers. Submit resin/catalyst before fabrication begins to verify compliance to the resin manufacturer's recommended procedures.

3. Employ no fillers, additives, or pigments in the resin:
    a. A thixotropic agent for viscosity control may be used in the proportion and type recommended by the resin manufacturer.
    b. Use no thixotropic agent in the corrosion liner or on surfaces to be in contact with the corrosive environment.
4. Make resin putty using the same resin as was used in the original fabrication and shall contain milled glass fibers:
    a. The use of silica flour, grinding dust, or other fillers is not allowed.
5. When specified, add antimony trioxide or antimony pentoxide to the resin in the amount necessary to achieve the required fire retardancy rating in the structural wall only. Follow resin manufacturer's recommendations:
    a. Unless otherwise specified, the corrosion liner shall not contain this additive.

C. Reinforcement:
1. Show the type and sequence of reinforcements to be used on the fabrication drawings.
2. Use as commercial grade corrosion-resistant borosilicate glass fiber reinforcement, unless otherwise specified.
3. Use glass fiber reinforcing having a surface finish and binder that is specifically recommended by the glass manufacturer for the particular resin system to be used.
4. Use Type C (chemical grade) glass, 10 mils (0.01 inches) thickness, or polyester surfacing veil, such as Nexus surfacing veils.
5. Use Type E (electrical grade) glass, 1-1/2 ounces or 3/4-ounce per square foot, with nominal fiber length of 1.25, within 0.75 inches mat.
6. Continuous glass roving used in chopper guns for spray up shall be Type E chopper roving.
7. Woven roving shall be 24 ounces per square yard Type E glass and have a 5-by-4 plain weave.
8. Continuous roving used in filament wound structures shall be Type E glass winder roving with a yield of 200 yards or more per pound.
9. Use Type E glass unidirectional fabric. Weft unidirectional fabric shall be 15.7 ounces per square yard.
10. When specified, use Type ECR glass reinforcements supplied in similar fabric styles to those specified above.

2.02 FABRICATION

A. Molds:
1. Construct molds of a suitable material to produce a smooth and glossy corrosion liner surface on the fiberglass reinforced plastic equipment.
2. Covering of mandrels with cardboard must be accepted by the Engineer prior to start of fabrication.

B. Laminates:
1. Determine specified glass content in accordance with ASTM D 2584.
2. Consider laminate thicknesses shown on the fabrication drawings as construction minimums. Verify that minimum thicknesses are obtained using the laminate sequences specified. When only total laminate thicknesses are specified or indicated on the Drawings, the minimum allowable structural

laminate thickness shall be the total laminate thickness less the specified corrosion liner thickness.

3. Interruptions in laminating sequence shall follow the application of a ply of mat and be succeeded by a ply of mat.
4. The interruption shall not exceed 24 hours, and the in-process surface must retain acetone sensitivity until laminating is resumed. Lack of compliance with these aspects or indication that contamination of the surface has occurred shall require that surface preparation be accomplished before resuming.
5. Chopped strand glass applied by chopper gun is allowed in lieu of mat layers in the structural laminates only:
   a. Chopper gun application of the corrosion liner is not allowed.
6. Coat non-mold surfaces with resin containing wax additive in the amount necessary to allow full cure of the surface. In the case of exterior surfaces, this wax coat shall also contain an ultraviolet stabilizer in the type and amount recommended by the resin manufacturer.
7. The exterior surface of equipment shall be resin-rich and reinforced with 1 layer C glass surfacing veil, unless otherwise specified.
8. When specified, the exterior coat shall be an opaque pigmented surface coat, applied only after Engineer's inspection. Color shall be selected by the Engineer.

C. Corrosion liner laminates:
   1. The inner surface of laminates shall be resin-rich and reinforced with surfacing veil of the type and number of layers as shown on the fabrication drawings.
   2. The interior layer of the corrosion liner shall consist of 1-1/2 ounces per square foot mat in the number of layers specified on the fabrication drawings. An exotherm interruption is specifically prohibited within the corrosion liner.
   3. Chopped glass applied by chopper gun is not allowed in the corrosion liner.
   4. Plies of the inner surface and interior layer are to gel completely before proceeding with the structural laminates.
   5. Completed corrosion liner as described above shall contain not less than 20 percent nor more than 30 percent glass by weight:
      a. Use no thixotropic material in the resin for the liner, nor in the fabrication of fiberglass reinforced plastic components intended for internal service.
      b. The completed liner shall be the minimum thickness specified or indicated on the Drawings.
   6. Do not use a separately cured unreinforced gel coat.

D. Hand lay-up structural laminates:
   1. The corrosion liner laminate shall be followed by hand lay-up structural laminates of varying reinforcement sequences as indicated on the fabrication drawings.
   2. For hand lay-up structural laminates, reinforcement shall consist of mat and woven roving in the sequence specified on the fabrication drawings.
   3. Woven roving shall have a ply of mat on each side. Two adjacent plies of woven roving are not permitted.
   4. Laminates containing primarily 1-1/2 ounces per square foot mat layers in conjunction with woven roving shall contain not less than 35 percent or more than 45 percent glass (by weight).
   5. Laminates containing primarily 3/4-ounce per square foot mat layers in conjunction with woven roving are considered to be high strength laminates

and shall contain not less than 45 percent or more than 55 percent glass by weight.

E. Filament wound structural laminates:
   1. The corrosion liner laminate shall be followed by filament wound structural laminates as indicated on the fabrication drawings.
   2. For filament wound structural laminates, reinforcement shall consist of continuous strand fiberglass roving applied with a minimum of interruptions until the specified minimum thickness is attained:
      a. This laminate shall contain 55 to 70 percent glass by weight as indicated on the fabrication drawings.
   3. Each complete cycle of filament winding shall form a closed pattern of winding bands which completely covers the surface with 2 bi-directional layers:
      a. Each layer shall be a maximum of 1 roving in thickness.
      b. Uniformly space the filaments across the winding band without bunching or gaping.
   4. Specify the helix angle of winding on the approved fabrication drawings, as measured from the centerline of revolution of the equipment shell.
   5. Tolerance on helix angle is plus or minus 2 degrees, unless otherwise specified.
   6. The fabrication drawings may require that layers of unidirectional roving be interspersed within the continuous filament winding.
   7. Apply the unidirectional roving with the glass strand aligned in the axial direction, to within plus or minus 5 degrees.
   8. If layers of mat or chopped glass are needed to ensure proper bonding of unidirectional roving, or within the filament winding to accommodate the Fabricator's manufacturing methods, consider the layers' extra material that will result in a thickness greater than specified. The amount of filament winding and unidirectional roving specified must still be applied.

F. Joining laminates:
   1. Fiberglass reinforced plastic joining laminates are subject to applicable requirements specified in other sections for laminates.
   2. Reinforce fiberglass reinforced plastic joints with an overlay of glass reinforcement and resin which extends equally within plus or minus 1/2 inch on each side of the joint. Use minimum thickness, ply sequence, and ply widths of fiberglass reinforced plastic joints as indicated on fabrication drawings.
   3. Restrain parts to be joined to prevent movement until completion and cure of the joint overlay.
   4. Fit-up parts and verify that tolerances and assembly requirements are satisfied. Completely fill the void between component parts with resin putty, taking care not to extrude an excessive amount of putty into the interior.

G. Environment:
   1. The fabrication process and materials at the point of fabrication are to be maintained within a range of 60 to 95 degrees Fahrenheit. This temperature must also be at least 5 degrees greater than wet bulb temperature, as measured with a sling psychrometer.
   2. Store materials in a dry area and within the temperature and humidity limits recommended by the manufacturers.

H. Flanges:
   1. Make flanges by hand lay-up construction with nozzle neck and flange made integrally in 1 piece and fabricated in accordance with the dimensions indicated on the fabrication drawings. Extend layers of reinforcement in the nozzle neck and hub uninterrupted into the flange.
   2. Build-up additional hub thickness using alternating layers of 1-1/2 ounces per square foot mat and 24 ounces per square yard woven roving.
   3. Build-up additional thickness in the flange using "ring" cutouts of mat, evenly distributed throughout the flange thickness.
   4. Press molded or filament wound flanges are not allowed.
   5. Overall machine facing of the back of flanges is not permitted:
      a. To obtain proper seating, spotface bolt holes for SAE size washers.
      b. Resin coat bolt holes and other cut surfaces so that no fibers are exposed.
      c. Spotfacing shall not produce a flange thickness less than indicated in the fabrication drawings.
   6. Bolt holes in flanges shall straddle principal centerlines of the Equipment. Tolerance in bolt hole locations and in diameter of bolt circle shall be plus 1/16 inch.
   7. Depressions or projections in flange face shall be no greater than 1/32 inch.

I. Allowable visual defects:
   1. Visual defects in areas of the equipment shall not exceed the maximum allowable levels of visual defects set forth in Table A, unless acceptable to Engineer.
   2. Visual defects in accordance with ASTM D 2563.
   3. Presence of visual defects in excess of the allowable levels of Table A shall be grounds for rejection of the equipment. Listed quantities apply to small, localized areas and shall not be averaged over larger areas.
   4. For the purpose of Table A, use of the following definitions apply:
      a. INNER surface - Interior process surface, thickness of surfacing veil(s), and interface between veils and mat layers. Includes surfacing veils on internal joints.
      b. Interior mat layers - Layers of mat following the inner surface, and interface between liner and structural wall. Includes mat layers on internal joints.
      c. Structural wall - Layers of filament winding or alternating layers of mat and woven roving following the corrosion liner, and layers of mat and woven roving in internal overlays.
      d. Exterior surface - The exterior surface of the laminate and the thickness of the surfacing veil.
      e. Dimensions listed in Table A refer to the largest dimension measured for defects:

TABLE A MAXIMUM ALLOWABLE LEVELS OF VISUAL DEFECTS				
Condition/ Defect	**Inner Surface**	**Interior Mat Layers**	**Structural Wall**	**Exterior Surface**
Chip	None	None	None	
Crack	None	None	None	
Crazing	None	None	None	
Delamination	None	None	See Air Bubble	
Dry Spot	None	See Air Bubble	See Air Bubble	
Foreign Inclusion	None	Maximum Diameter 1/32"	See Air Bubble	
Fracture	None	None	None	None
Air Bubble/ Void	Less than 1/64" Ø unlimited. 1/64" to 1/16" Ø 2 / sq. in. Maximum Diameter 1/16"	Less than 1/32" Ø unlimited. 1/32" to 1/8" Ø 5 / sq. in. Maximum Diameter 1/8"	Less than 3/16" Ø unlimited. 3/16" to 1/4" Ø 2 / sq. in. Maximum Diameter 1/4"	
Blister	See Air Bubble	See Air Bubble	See Air Bubble	
Burned	None	None	None	
Pit (Pinhole)	Less than 1/32" Ø 50/square feet 1/32" to 1/16" Ø 10/square feet Maximum Diameter 1/16" Maximum Depth 1/32"	N/A	N/A	
Resin Pocket	None	Maximum 1 square inch per occurrence.	Maximum 1 square inch per occurrence.	
Wrinkle	Allowable if laminate is glass reinforced. No sharp edges allowed.	Allowable if laminate is glass reinforced and full mat layer thickness and total thick- ness are maintained.	Allowable if laminate is glass reinforced and full mat layer thickness and total thick- ness are maintained.	
Scratch	None	N/A	N/A	
Fiber Prominence	None	Maximum 10 fibers visible per square inch	Maximum 20 fibers visible per square inch	

2.03 SOURCE QUALITY CONTROL

A. Inspection:
   1. Owner's inspection: Permit the Engineer access to the equipment during fabrication and upon completion for the purpose of verifying compliance to the

Contract Documents. The inspection is not intended to replace the Fabricator's own quality control procedures.

2. In no respect does inspection of equipment by Engineer relieve the Fabricator of compliance with the Contract Documents:
   a. A final inspection will be performed by the Engineer.
3. The Fabricator shall notify the Engineer at the completion of particular milestones during fabrication. The milestones are as follows:
   a. View tooling prior to fabrication.
   b. Beginning application of corrosion liner for each part, extraction of each part prior to beginning assembly.
   c. Upon completion of each separate assembly, Engineer reserves the right to include additional milestones.
4. Allow Engineer to photograph the equipment while in process and/or upon completion.
5. Engineer may use magnification or other special viewing or measurement devices during inspection.
6. Evidence of poor workmanship or lack of compliance with aspects of the Contract Documents will be grounds for rejection of the equipment.
7. Subsequent repair of rejected equipment may, at the Engineer's option, be undertaken in an attempt to bring the equipment to an acceptable state:
   a. Repair procedures must be accepted by the Engineer prior to implementation.

2.04 TESTING

A. The Engineer may employ destructive testing, such as ultimate tensile or flexure strength tests or glass content ignition tests, on available samples or use other non-destructive test methods, such as acoustic emission or ultrasonic polygauge thickness measurement, on the completed equipment for verification of compliance to the contract documents.

B. Testing performed by the Engineer will be accomplished through use of applicable ASTM test methods when appropriate.

C. Hardness tests will be made for acceptance by the Engineer on the liner surface using the Barcol impressor, Model GYZJ 934 1, calibrated at 2 points in accordance with ASTM D 2583:
   1. Ten readings will be taken in a localized area, deleting the 2 highest and 2 lowest, and averaging the remaining 6.
   2. Minimum acceptable Barcol hardness will be a reading of 30 unless otherwise specified.

D. An acetone sensitivity test will also be performed by the Engineer as an acceptance criteria. Evidence of a sticky or tacky surface following rubbing with an acetone-saturated cloth will be grounds for rejection of the equipment.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 06611

FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fiberglass reinforced plastic fabrications including:
   1. Weirs.
   2. Baffles.
   3. Stop plates.
   4. Parshall flume liners.
   5. Grating.
   6. Stair treads.
   7. Covers.
   8. Troughs.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01600 - Product Requirements.
      b. Section 01612 - Seismic Design Criteria.
      c. Section 01614 - Wind Design Criteria.
      d. Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      e. Section 17206 - Level Measurement - Ultrasonic.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. F 102 - Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles, and Mounting Brackets.

B. ASTM International (ASTM):
   1. D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   2. D 638 - Standard Test Method for Tensile Properties of Plastics.
   3. D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   4. D 2583 - Standard Test Method for Indentation of Hardness of Rigid Plastics by Means of a Barcol Impressor.
   5. E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. United States, Department of Agriculture (USDA).

D. United States, Department of the Interior:
   1. Bureau of Reclamation (USBR):
      a. ISO 9826 - Water Measurement Manual, Measurement of Liquid Flow in Open Channel.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Parshall flume liner: Provide temporary bracing for liner to assure maintenance of dimensions during shipment. Maintain bracing in place for installation.

PART 2 PRODUCTS

A. Accessories:
   1. Washers: Of same material as weirs, with surfaces smooth, free of voids, and without dry spots and crazes.
   2. Assembly hardware: Concrete anchors as specified in Section 05190.

2.02 WEIR PLATES WITH SCUM BAFFLES

A. Manufacturers: One of the following or equal:
   1. MFG Water Treatment Products.
   2. Warminster Fiberglass Company.

B. Materials:
   1. Match die molded construction.
   2. Minimum Corrosion Liner:
      a. One "C" or Nexus veil as specified for the service environment.
      b. Remainder 1-1/2 ounce per square foot mat to total minimum thickness of 0.096 inches on surface exposed to the service environment.
   3. Ultraviolet Stabilizer: Added to the exterior surface coat of fabrications intended for outside service, in the type and amount recommended by the resin manufacturer.
   4. Resin: Premium grade vinyl ester, manufactured by one of the following or equal as recommended by the resin manufacturer for the specific operating environment:
      a. Dow Chemical Company, Derakane 411.
      b. Ashland Chemical Company, Hetron 922.
      c. Reichhold Inc., Reichhold Dion VER 9100.
      d. Interplastic Corporation, Interplastic VE 8300.
   5. Color: Natural, unless otherwise specified.

C. Fabrication:
   1. Baffles: Match die molded components to specified shape and dimensions.
   2. Weirs:
      a. Compression molded in matched metal die molds. Fabrications from plate stock with cut-in edges, ends, or V-notches will not be accepted.
      b. Tolerances: In accordance with AWWA F 102, except as follows:
         1) Deviation between top elevations of V-notches in a line: Maximum 1/32 inch in 6-foot length of weir plate.

2) Deviations between bottom elevations of V-notches in a line: Maximum 1/32 inch in 6-foot length of weir plate.
3) Deviations in depth of V-notches in a line: Maximum 1/32 inch in 6 foot length of weir plate.

c. Weir Plates:
1) Of shape and dimensions specified.
2) Provide 2-3/8 inch diameter holes for adjustment.
3) Resin coat cut edges, and drilled and countersunk holes in fiberglass reinforced plastic fabrications.

d. Furnish fiberglass reinforced plastic butt plates for joints.

D. Design Criteria and Chemical Exposure: Suitable for installation in a secondary clarifier in a municipal wastewater treatment plant.

E. Accessories:
1. Washers: Of same material as weirs, with surfaces smooth, free of voids, and without dry spots and crazes.
2. Assembly hardware: Concrete anchors as specified in Section 05190.

2.03 PARSHALL FLUME LINER

A. General:
1. Size(s)/Dimensions: As indicted on the Drawings with interior dimensions in accordance with USBR/ISO 9826.
2. Performance requirements:
a. Accuracy of flow: Plus or minus 5 percent of rate with plus or minus 0.5 percent of rate repeatability.
b. Chemical exposure:
c. Suitable for outdoor use in contact with Primary Effluent at ambient temperatures ranging from 20 to 120 degree Fahrenheit.

B. Manufacturers: One of the following or equal:
1. BIF Industries.
2. F. B. Leopold Company, Inc.
3. Plasti-Fab.
4. TRACOM, Inc., Alpharetta, Georgia.
5. Warminster Fiberglass.

C. Parshall flume (concrete):
1. Composition: Sufficient embedded galvanized steel to produce substantial, self-supporting rigid structure requiring no external supporting structure.
2. Throat with fiberglass reinforced plastic liner installed: 24 inches.
3. Interior dimensions with fiberglass reinforced plastic liner installed: In accordance with USDA Circular 843.a.

D. Materials:
1. Glass fiber reinforced plastic, having the following properties:

Test	Standard	Requirement:
Tensile strength	ASTM D 638	14,000 psi, minimum
Flexural strength	ASTM D 790	25,000 psi, minimum

Test	Standard	Requirement:
Flexural modulus	ASTM D 790	1,000,000 psi, minimum
Indentation hardness (Barcol)	ASTM D 2583	40 minimum, average

2. Minimum corrosion liner:
   a. On interior surface of flume.
   b. Two "C" or Nexus veils as specified for the service environment.
   c. Remainder 1-1/2 ounce per square foot mat to a total minimum thickness of 0.106 inches.
3. Ultraviolet stabilizer: Added to the corrosion liner in the type and amount recommended by the resin manufacturer.
4. Minimum 3/8-inch total thickness.
5. Resin: Premium grade vinyl ester:
   a. Manufacturers: One of the following or equal: As recommended by the resin manufacturer for the specific operating environment:
      1) Derakane 411.
      2) Hetron 922.
      3) Reichhold Dion VER 9100.
      4) Interplastic VE 8300.
6. Color: Natural.

E. Fabrication:
   1. Fabricated with integral stiffening ribs.
   2. Sectioned:
      a. Flumes larger than 84 inches may be fabricated in 2 pieces for shipping. Provide Type 304 stainless steel connection hardware and seals as required to ensure a watertight assembly.
      b. Locking clips: Type 316 stainless steel, integral part of liner, minimum 16 per liner sufficient to assure permanent alignment.

F. Accessories:
   1. Ultrasonic level transmitter:
      a. As specified in Section 17206 for transmitter and mounting requirements.
      b. Bushing/coupling for mounting bracket.
      c. Fixed position bracket of Type 316 stainless steel.
      d. Bracket, adjustable horizontally and vertically and fabricated of Type 316 stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for installation of products as specified in Section 01600.

3.02 ERECTION AND INSTALLATION, GENERAL

A. Install products where indicated on the Drawings in accordance with manufacturer's printed instructions.

3.03 WEIRS AND BAFFLES

A. Carefully install weirs and baffles, aligning and leveling to the elevations indicated on the Drawings.

B. Installation tolerances:
   1. V-notch weirs. In the completed installation:
      a. The variation in elevation between any 2 notches of the weir plate in a tank shall not exceed 1/8 inch.
      b. In a round tank, the variation from elevation between any one quadrant of the weir and that of any other quadrant shall not exceed 1/16 inch.

3.04 PARSHALL FLUME

A. Install by grouting into place.

B. Set covers in place and bolt down.

END OF SECTION

SECTION 07110

DAMPPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Dampproofing.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 1227 - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Conform to volatile organic compound limits.

1.06 PROJECT/SITE CONDITIONS

A. Environmental requirements: Do not apply bituminous dampproofing when temperatures are 40 degrees Fahrenheit or lower or when rain is forecast for the 24 hours following application.

PART 2 PRODUCTS

2.01 MATERIALS

A. Dampproofing: ASTM D 1227, Asbestos Free, Emulsified Asphalt Coatings:
   1. Manufacturers: One of the following or equal:
      a. Karnak Corp., Karnak 220 AF.
      b. W.R. Meadows, Inc., Sealmastic Type 2 Asphalt Emulsion Dampproofing.

B. Sealing mastic: Type compatible with dampproofing and free of toxic solvents with thick mastic consistency and smooth and uniform in composition product as recommended by dampproofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for application of products in accordance with manufacturer's recommendations.

B. Verify that surfaces to receive dampproofing are clean, dry, reasonably smooth, free of dust, dirt, voids, cracks, or sharp projections.

3.02 APPLICATION

A. Completely cover surfaces to receive dampproofing with 2 coats:
   1. Applied by brush or spray.
   2. Apply dampproofing at manufacturer's recommended rate of application or minimum 2 gallons per square per coat, whichever is greater.

B. Extend dampproofing to 6 inches above finish grade.

C. Apply each coat evenly so surfaces have uniform black appearance.

D. Apply second coat at right angles to first, allowing not less than 24 hours between coats.

E. Seal around items and services projecting through dampproofing surfaces in accordance with manufacturer's recommendations.

F. Ensure sealed areas are moisture tight.

G. Backfill completely against dampproofing application within time recommended by manufacturer.

END OF SECTION

SECTION 07900

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Acrylic-Latex sealant.
   2. Precast concrete joint sealant.
   3. Silicone sealant.
   4. Synthetic rubber sealing compound.
   5. Synthetic sponge rubber filler.
   6. Related materials.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. M 198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. ASTM International (ASTM):
   1. C920 - Standard Specification for Elastomeric Joint Sealants.
   2. C990 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   3. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
   4. C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
   5. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   6. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

1.03 SUBMITTALS

A. Product data.

B. Samples, include color selections.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 PROJECT/SITE CONDITIONS

A. Environmental requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 100 degrees Fahrenheit or lower than recommended by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

B. Code date packages. Do not use material older than manufacturer’s published shelf life. Store materials at temperatures lower than 80 degrees Fahrenheit. Condition materials in accordance with manufacturer’s instructions prior to installation.

1.07 SEQUENCING AND SCHEDULING

A. Caulk joints prior to painting.

1.08 WARRANTY

A. Warrant to correct defective products for minimum 1 year in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 SEALANTS

A. General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Nonsagging sealant for vertical and overhead horizontal joints.
   4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
   5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
   6. Sealant backer rod and/or compressible filler made from closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
      a. Control joint depth.
      b. Break bond of sealant at bottom of joint.
      c. Provide proper shape of sealant bead.
      d. Serve as expansion joint filler.

2.02 ACRYLIC-LATEX SEALANT

A. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by Engineer from manufacturer's standard options. Manufacturers: One of the following or equal:
   1. Tremco, Tremflex 834.
   2. Pecora Corp., Number AC-20.
   3. Sonneborn, Sonolac.

2.03 PRECAST CONCRETE JOINT SEALANT

A. Preformed, cold-applied, ready-to-use, flexible joint sealant in accordance with ASTM C990 and AASHTO M 198. Manufacturers: One of the following or equal:
   1. Henry Corporation, Ram-Nek.
   2. Concrete Sealants Division, ConSeal.

2.04 SILICONE SEALANT

A. ASTM C920, Type S, Grade NS, Class 25, single component silicone sealant. Manufacturers: One of the following or equal:
   1. Tremco, Proglaze.
   2. Pecora Corp., Number 864.
   3. Dow Corning, Number 795.
   4. General Electric, Number 1200 Series.

2.05 SYNTHETIC RUBBER SEALING COMPOUND

A. Manufacturer: One of the following or equal:
   1. Sika Corporation, Sikaflex 2c NS or SL.
   2. Pacific Polymers, Elastothane 227R.

B. Material: In accordance with ASTM C920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient polymer; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:
   1. Base: Polyurethane rubber.
   2. Application time: Minimum 2 hours.
   3. Cure time: Maximum 3 days.
   4. Tack free time: Maximum 24 hours.
   5. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.
   6. Tensile strength: Non-sag 95 pounds per square inch minimum and self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D412.
   7. Ultimate elongation: Minimum 340 percent when tested in accordance with ASTM D412.
   8. Tear resistance: Non-sag 45 pounds per inch minimum and self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D624, Die C.
   9. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.

C. Color: Gray to match concrete, unless indicated on the Drawings.

2.06 SYNTHETIC SPONGE RUBBER FILLER

A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. In accordance with ASTM C1330, Type O:
   1. Manufacturers: One of the following or equal:
      a. Presstite, Number 750.3 Ropax Rod Stock.
   2. Rubatex Corp., Rubatex-Cord.

B. Characteristics:
   1. Suitable for application intended.
   2. Strength: As necessary for supporting sealing compound during application.
   3. Resiliency: Resistance to environmental conditions of installation.
   4. Bonding: No bonding to the sealing compound.
   5. Structure: Cellular, prevents absorption of water.
   6. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.
   7. Size: Minimum 25 percent greater than nominal joint width.

2.07 RELATED MATERIALS

A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.

C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify acceptability of joint dimensions, physical, and environmental conditions.

B. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

3.02 PREPARATION

A. Allow concrete to cure thoroughly before caulking.

B. Synthetic sponge rubber filler:
   1. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.
   2. Do not stretch filler beyond its normal length during installation.

C. Caulking:
   1. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of sealant.
   2. Concrete, masonry, wood, and steel surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.

D. Synthetic rubber sealing compound:
   1. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.
   2. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.

E. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less than 3/8 inches deep.

F. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.

G. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.

H. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

I. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.

J. Do not stretch filler beyond normal length during installation.

K. Apply bond breaker when recommended by joint sealer manufacturer.

3.03 INSTALLATION

A. Synthetic sponge rubber filler: Install filler in accordance with manufacturer's installation instructions.

B. Caulking, joints, and sealing:
   1. Construct expansion, contraction, and construction joints as indicated on the Drawings.
   2. Install pipe and conduit in structures as indicated on the Drawings.
   3. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.
   4. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.
   5. Complete caulking prior to painting.
   6. Verify that concrete is thoroughly cured prior to caulking.
   7. When filler compressible material is used, use untreated type.
   8. Apply caulking with pneumatic caulking gun.
   9. Use nozzles of proper shape and size for application intended.
   10. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.
   11. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.

12. To hasten curing of compound when used on wide joints subject to movement, apply heat with infrared lamps or other convenient means.
13. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

3.04 CLEANING

A. Clean surfaces adjacent to sealant as work progresses.

B. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.

C. Remove excess cured sealant by sanding with Number 80 grit sandpaper.

D. Leave finished work in neat, clean condition.

3.05 SCHEDULE

A. Acrylic latex:
1. Use where indicated on the Drawings.
2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.

B. Silicone:
1. Use where indicated on the Drawings.
2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
3. Door threshold bedding.
4. Moist or wet locations, including joints around plumbing fixtures.
5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
6. Plenum joints.

C. Synthetic rubber sealing compound, non-sag Type II:
1. Use where indicated on the Drawings.
2. Water-bearing and earth-bearing concrete structures.
3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.
4. Joints between sheet metal flashing and trim.
5. Joints between sheet metal flashing and trim, and vertical wall surfaces.
6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
8. Expansion and control joints in masonry vertical surfaces.

D. Synthetic rubber sealing compound, self-leveling Type I:
1. Use where indicated on the Drawings.
2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.
3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.

4. Pavement joints.
5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

3.06 FIELD QUALITY CONTROL

A. Adhesion testing:
   1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
      a. Water bearing structures: 1 test per every 1,000 LF of joint sealed.
      b. Exterior precast concrete wall panels: 1 test per every 2,000 LF of joint sealed.
      c. Chemical containment areas: 1 test per every 1,000 LF of joint sealed.
      d. Building expansion joints: 1 test per every 500 LF of joint sealed.
      e. All other type of joints except butt glazing joints: 1 test per every 3,000 LF of joint sealed.
      f. Manufacturer's authorized factory representative provide written recommendations for remedial measures on failing tests.

END OF SECTION

SECTION 08320

FLOOR ACCESS DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Non-fire-rated floor access doors.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO).

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Show the following:
   1. Access door installation recommendations.
   2. Locations of access doors.
   3. Door size and configuration.
   4. Liveload capacity.
   5. Materials of construction and finishes provided.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Identify type and size of each floor door in way not to damage finish prior to delivery.

B. Deliver products only after proper facilities are available.

C. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.

D. Handle carefully to prevent damage and store on clean concrete surface or raised platform in safe, dry area:
   1. Do not dump onto ground.

E. Protect floor access doors during shipment and storage to prevent warping, bending, and corrosion.

1.05 WARRANTY

A. Provide manufacturer's warranty against defects in material and workmanship for a period of 5 years.

PART 2 PRODUCTS

2.01 MEDIUM DUTY FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Model J or JD (double leaf).
   2. Babcock Davis Associates, Inc., Model B-FG.

B. Style: Single or double leaf as indicated on the Drawings, aluminum, capable of withstanding minimum live load of 300 pounds per square foot, channel frame, with drainage couplings. Provide gasketed seal to prevent emission of odors from the interior of the structure.

C. Door leaf: Minimum 1/4 inch, diamond pattern plate reinforced with stiffeners as required to meet specified live load.

D. Frame: 1/4-inch channel with anchor flange around perimeter.

E. Hardware:
   1. Hinges: Each leaf equipped with a minimum of 2 heavy forged brass hinges with stainless steel pins.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
   4. Operating mechanism: Spring operators designed for ease of operation and automatic hold open arm with release handle.
   5. Drainage assembly: Provide 1-1/2-inch drainage coupling located in corner of the channel frame.
   6. Recessed padlock hasp: Provide receptacle designed to receive a standard padlock featuring a flush hinged lid.
   7. Concrete anchors: Type 316 stainless steel.
   8. Seal: Provide neoprene gasket for odor tight seal.

F. Doors at Existing Openings:
   1. Provide frame with anchor flange that overlaps opening edges.
   2. Provide anchor holes for bolting into existing concrete opening.
   3. Design frame and anchors for specified live load.

2.02 HEAVY DUTY FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Model JH-20 or JDH-20 (double leaf).
   2. Babcock Davis Associates, Inc., Model B-FG (H-20 loading).

B. Style: Single or double leaf as indicated on the Drawings, aluminum, capable of withstanding minimum AASHTO H-20 wheel load with a maximum deflection of 1/150 of the span, live load channel frame, with drainage couplings. Provide gasketed seal to prevent emission of odors from the interior of the structure.

C. Door leaf: Minimum 1/4 inch, diamond pattern plate reinforced with stiffeners as required to meet specified live load.

D. Frame: 1/4-inch channel with anchor flange around perimeter.

E. Hardware:
   1. Hinges: Each leaf equipped with a minimum of 2 heavy forged brass hinges with stainless steel pins.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
   4. Operating mechanism: Spring operators designed for ease of operation and automatic hold open arm with release handle.
   5. Drainage assembly: Provide 1-1/2-inch drainage coupling located in corner of the channel frame.
   6. Recessed padlock hasp: Provide receptacle designed to receive a standard padlock featuring a flush hinged lid.
   7. Concrete anchors: Type 316 stainless steel.
   8. Seal: Provide neoprene gasket for odor tight seal.

F. Doors at Existing Openings:
   1. Provide frame with anchor flange that overlaps opening edges.
   2. Provide anchor holes for bolting into existing concrete opening.
   3. Design frame and anchors for specified live load.

2.03 SAFETY ACCESSORIES

A. Fall Prevention Grating:
   1. General: Provide fall prevention grating at all floor access doors. Grating shall be located below hatch, within opening. Grating shall be a hinged, spring assisted, lockable assembly, and shall operate independently of hatch cover.
   2. Design Criteria: 300 pounds per square foot load rating.
   3. Hardware: 316 stainless steel.
   4. Color: Safety orange.
   5. Material: Aluminum or FRP.
   6. Model:
      a. Fall Protection Grating by Bilco.
      b. SG-Series Safety Grating by Babcock-Davis.

2.04 FINISHES

A. Floor access door finishes:
   1. Aluminum: Provide with grey colored non-slip coating on top surfaces. Coordinate color selection with OWNER.
   2. Aluminum in contact with dissimilar metals and concrete: Manufacturer's standard bituminous coating.
   3. Steel: Provide with grey colored non-slip coating on top surfaces. Coordinate color selection with OWNER.

B. Hardware finishes:
   1. Provide optional Type 316 stainless steel hardware throughout, including parts of the latch and lifting mechanism assemblies, hold open arms and all brackets, hinges, pins, and fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine construction to receive floor access door and verify correctness of dimensions and other supporting or adjoining conditions.

B. Field verify dimensions of all existing opening receiving floor access doors. Provide verified dimensions as part of submittal process for ENGINEER's review.

3.02 PREPARATION

A. Coordinate details with other work supporting, adjoining, or requiring access doors.

B. Verify dimensions and profiles for each opening.

C. Verify that location will serve portion of work to which access is required:
   1. Where proposed functional location conflicts with other work, notify the ENGINEER before installation.

D. Apply coating to aluminum surfaces that will be in contact with dissimilar metals or concrete when there is none.

3.03 INSTALLATION

A. Install access doors in accordance with manufacturer's instructions.

B. Ensure correct types and adequate sizes at proper locations.

C. Securely attach frames to supporting work and ensure doors, frames, and hardware operate smoothly and are free from warp, twist, and distortion.

D. Attach drain pipe to coupling provided:
   1. Drainage shall be routed to drain into structure covered by the access door.

3.04 ADJUSTING

A. Adjust doors, frames and hardware to operate smoothly, freely, and properly, without binding.

3.05 CLEANING

A. Thoroughly clean surfaces of grease, oil, or other impurities; touch up abraded prime coat where applicable.

END OF SECTION

SECTION 09960

HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Field-applied coatings.

B. Related sections:
   1. Section 01140 - Work Restrictions.
   2. Section 01312 - Project Meetings.
   3. Section 01330 - Submittal Procedures.
   4. Section 01600 - Product Requirements.
   5. Section 01770 - Closeout Procedures.
   6. Section 15075 - Equipment Identification.
   7. Section 16075 - Identification for Electrical Systems.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   2. D 4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

B. International Concrete Repair Institute (ICRI):
   1. Guideline 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

C. NACE International (NACE):
   1. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
   2. SP0188 - Discontinuity (Holiday) Testing of Protective Coatings.

D. National Association of Pipe Fabricators (NAPF):
   1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.

E. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

F. Society for Protective Coatings (SSPC):
   1. SP COM - Surface Preparation Commentary for Steel and Concrete Substrates.
   2. SP 1 - Solvent Cleaning.
   3. SP 2 - Hand Tool Cleaning.
   4. SP 3 - Power Tool Cleaning.
   5. SP 5 - White Metal Blast Cleaning.
   6. SP 6 - Commercial Blast Cleaning.

7. SP 7 - Brush-Off Blast Cleaning.
8. SP 10 - Near-White Blast Cleaning.
9. SP 13 - Surface Preparation of Concrete.

G. United States Environmental Protection Agency (EPA):
1. Method 24 - Surface Coatings.

1.03 DEFINITIONS

A. Submerged metal: Steel or iron surfaces below tops of channel or structure walls that will contain water even when above expected water level.

B. Submerged concrete and masonry surfaces: Surfaces that are or will be:
1. Underwater.
2. In structures that normally contain water.
3. Below tops of walls of water-containing structures.

C. Exposed surface: Any metal or concrete surface, indoors or outdoors, that is exposed to view.

D. Dry film thickness (DFT): Thickness of fully cured coating, measured in mils.

E. Volatile organic compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.

F. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

G. Where SSPC surface preparation standards are specified or implied for ductile iron pipe or fittings, the equivalent NAPF surface preparation standard shall be substituted for the SSPC standard.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials shall be especially adapted for use in wastewater treatment plants.

B. Coating materials used in contact with potable water supply systems shall be certified to NSF 61.

1.05 SUBMITTALS

A. General: Submit as specified in Section 01330.

B. Shop drawings:
1. Schedule of proposed coating materials.
2. Schedule of surfaces to be coated with each coating material.

C. Product data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips:
   1. Regulatory requirements: Submit data concerning the following:
      a. VOC limitations.
      b. Coatings containing lead compounds and polychlorinated biphenyls.
      c. Abrasives and abrasive blast cleaning techniques, and disposal.
      d. NSF certification of coatings for use in potable water supply systems.

D. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number, sheen name, and gloss units.

E. Certificates: Submit in accordance with requirements for Product Data.

F. Manufacturer's instructions: Include the following:
   1. Special requirements for transportation and storage.
   2. Mixing instructions.
   3. Shelf life.
   4. Pot life of material.
   5. Precautions for applications free of defects.
   6. Surface preparation.
   7. Method of application.
   8. Recommended number of coats.
   9. Recommended DFT of each coat.
   10. Recommended total DFT.
   11. Drying time of each coat, including prime coat.
   12. Required prime coat.
   13. Compatible and non-compatible prime coats.
   14. Recommended thinners, when recommended.
   15. Limits of ambient conditions during and after application.
   16. Time allowed between coats (minimum and maximum).
   17. Required protection from sun, wind, and other conditions.
   18. Touch-up requirements and limitations.
   19. Minimum adhesion of each system submitted in accordance with ASTM D 4541.
   20. Material Safety Data Sheet.

G. Manufacturer's Representative’s Field Reports.

H. Operations and Maintenance Data: Submit as specified in Section 01770:
   1. Reports on visits to project site to view and approve surface preparation of structures to be coated.
   2. Reports on visits to project site to observe and approve coating application procedures.
   3. Reports on visits to coating plants to observe and approve surface preparation and coating application on items that are “shop coated.”

I. Quality Assurance Submittals:
   1. Quality assurance plan.
   2. Qualifications of coating applicator including List of Similar Projects.

J. Certifications:
   1. Submit notarized certificate that:
      a. All paints and coatings to be used on this project comply with current federal, state, and local VOC regulations.
   2. California certifications:
      a. All paints and coatings to be used on this project comply with the current VOC regulations of the State of California Air Management District in which the coatings will be used.

1.06 QUALITY ASSURANCE

A. Applicator qualifications:
   1. Minimum of 5 years of experience applying specified type or types of coatings under conditions similar to those of the Work:
      a. Provide qualifications of applicator and references listing 5 similar projects completed in the past 2 years.
   2. Manufacturer-approved applicator when manufacturer has approved applicator program.
   3. Approved and licensed by polymorphic polyester resin manufacturer to apply polymorphic polyester resin coating system.
   4. Approved and licensed by elastomeric polyurethane (100-percent solids) manufacturer to apply 100-percent solids elastomeric polyurethane system.
   5. Applicator of off-site application of coal-tar epoxy shall have successfully applied coal-tar epoxy on similar surfaces in material, size, and complexity as on the Project.

B. Regulatory requirements: Comply with governing agencies regulations by using coatings that do not exceed permissible VOC limits and do not contain lead:
   1. Do not use coal-tar epoxy in contact with drinking water or exposed to ultraviolet radiation.

C. Certification: Certify that applicable pigments are resistant to discoloration or deterioration when exposed to hydrogen sulfide and other sewage gases and product data designates coating as suitable for wastewater service.

D. Field samples:
   1. Prepare and coat a minimum 100-square-foot area between corners or limits such as control or construction joints of each system.
   2. Approved field sample may be part of the Work.
   3. Obtain approval before painting other surfaces.

E. Pre-installation conference: Conduct as specified in Section 01312.

F. Compatibility of coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

G. Services of coating manufacturer’s representative: Arrange for coating manufacturer’s representative to attend pre-installation conferences. Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be “shop-primed and coated.”

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products as specified in Section 01600.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver new unopened containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions:
   1. Do not deliver materials aged more than 12 months from manufacturing date.

D. Store coatings in well-ventilated facility that provides protection from the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.08 PROJECT CONDITIONS

A. Surface moisture contents: Do not coat surfaces that exceed manufacturer-specified moisture contents, or when not specified by the manufacturer, with the following moisture contents:
   1. Plaster and gypsum wallboard: 12 percent.
   2. Masonry, concrete, and concrete block: 12 percent.
   3. Interior located wood: 15 percent.
   4. Concrete floors: 7 percent.

B. Do not apply coatings:
   1. Under dusty conditions or adverse environmental conditions, unless tenting, covers, or other such protection is provided for structures to be coated.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
   4. When relative humidity is higher than 85 percent.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer's recommendation.
   7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
   8. Apply clear finishes at minimum 65 degrees Fahrenheit.

C. Provide fans, heating devices, dehumidifiers, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.

D. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 55 degrees Fahrenheit for 24 hours before, during, and 48 hours after application of finishes.

E. Dehumidification and heating for coating of digester interiors, wet wells, and high humidity enclosed spaces:
   1. Provide dehumidification and heating of digester interior spaces in which surface preparation, coating application, or curing is in progress according to the following schedule:
      a. October 1 to April 30: Provide continuous dehumidification and heating as required to maintain the tanks within environmental ranges as specified in this Section and as recommended by the coating material manufacturer. For the purposes of this Section, “continuous” is defined as 24 hours per day and 7 days per week.
      b. May 1 to September 30: Provide temporary dehumidification and heating as may be required to maintain the tanks within the specified environmental ranges in the event of adverse weather or other temporary condition. At Contractor’s option and at his sole expense, Contractor may suspend work until such time as acceptable environmental conditions are restored, in lieu of temporary dehumidification and heating. Repair or replace any coating or surface preparation damaged by suspension of work, at Contractor’s sole expense.
   2. Equipment requirements:
      a. Capacity: Provide dehumidification, heating, and air circulation equipment with minimum capacity to perform the following:
         1) Maintain the dew point of the air in the tanks at a temperature at least 5 degrees Fahrenheit less than the temperature of the coldest part of the structure where work is underway.
         2) Reduce dew point temperature of the air in the tanks by at least 10 degrees Fahrenheit in 20 minutes.
         3) Maintain air temperature in the tanks at 60 degrees Fahrenheit minimum.
      b. Systems:
         1) Site electrical power: Not available for Contractor’s use.
         2) Internal combustion engine generators: May be used; Contractor shall obtain all required permits and provide air pollution and noise control devices on equipment as required by permitting agencies.
         3) Dehumidification: Provide desiccant or refrigeration drying. Desiccant types shall have a rotary desiccant wheel capable of continuous operation. No liquid, granular, or loose lithium chloride drying systems will be allowed.
         4) Heating: Electric, indirect combustion, or steam coil methods may be used. Direct-fired combustion heaters will not be allowed during abrasive blasting, coating application, or coating cure time.
   3. Design and submittals:
      a. Contractor shall prepare dehumidification and heating plan for this project, including all equipment and operating procedures.
      b. Suppliers of services and equipment shall have not less than 3 years experience in similar applications:
         1) Supplier: The following or equal:
            a) Cargocaire Corporation (Munters) or equal.
      c. Submit dehumidification and heating plan for Engineer’s review.
   4. Monitoring and performance:
      a. Measure and record relative humidity and temperature of air, and structure temperature twice daily (beginning and end of work shifts) to verify that proper humidity and temperature levels are achieved inside the

work area after the dehumidification equipment is installed and operational. Test results shall be made available to the Engineer upon request.

b. Interior space of the working area and tank(s) shall be sealed, and a slight positive pressure maintained as recommended by the supplier of the dehumidification equipment.

c. The filtration system used to remove dust from the air shall be designed so that it does not interfere with the dehumidification equipment's ability to control the dew point and relative humidity inside the reservoir:

1) The air from the tank, working area, or dust filtration equipment shall not be recirculated through the dehumidifier during coating application or when solvent vapors are present.

1.09 SEQUENCING AND SCHEDULING

A. Sequence and Schedule: As specified in Section 01140.

1.10 MAINTENANCE

A. Extra materials: Deliver as specified in Section 01770. Include minimum 1 gallon of each type and color of coating applied:

1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.
2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type, and color.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Special coatings: One of the following or equal:

1. Carboline: Carboline, St. Louis, MO.
2. Ceilcote: International Protective Coatings, Berea, OH.
3. Dampney: The Dampney Company, Everett, MA.
4. Devoe: International Protective Coatings, Louisville, KY.
5. Dudick: Dudick, Inc., Streetsboro, OH.
6. GET: Global Eco Technologies, Pittsburg, CA.
7. Henkel: Henkel North America, Madison Heights, MI.
8. IET: Integrated Environmental Technologies, Santa Barbara, CA.
9. PPC: Polymorphic Polymers Corp., North Miami, FL.
10. PPG Amercoat: PPG Protective & Marine Coatings, Brea, CA.
11. Rustoleum: Rustoleum Corp., Sommerset, NJ.
12. Sanchem: Sanchem, Chicago, IL.
13. Superior: Superior Environmental Products, Inc., Addison, TX.
14. S-W: Sherwin-Williams Co., Cleveland, OH.
15. Tnemec: Tnemec Co., Kansas City, MO.
16. Wasser: Wasser High Tech Coatings, Kent, WA.
17. ZRC: ZRC Worldwide Innovative Zinc Technologies, Marshfield, MA.

2.02 PREPARATION AND PRETREATMENT MATERIALS

A. Metal pretreatment: As manufactured by one of the following or equal:
   1. Henkel: Galvaprep 5.
   2. International: AWLGrip Alumiprep 33.

B. Surface cleaner and degreaser: As manufactured by one of the following or equal:
   1. Carboline Surface Cleaner No. 3.
   2. Devoe: Devprep 88.
   3. S-W: Clean and Etch.

2.03 COATING MATERIALS

A. Alkali-resistant bitumastic: As manufactured by one of the following or equal:
   1. Carboline: Bitumastic No. 50.
   2. S-W: Targuard.
   3. Wasser: MC-Tar.

B. Wax coating: As manufactured by the following or equal:
   1. Sanchem: No-Ox-Id A special.

C. High solids epoxy (self-priming) not less than 72 percent solids by volume: As manufactured by one of the following or equal:
   1. Carboline: Carboguard 891.
   2. Devoe: Bar Rust 233H.
   3. PPG Amercoat: Amerlock 2.
   4. S-W: Macropoxy 646.
   5. Tnemec: HS Epoxy Series 104.

D. Aliphatic or aliphatic-acrylic polyurethane: As manufactured by one of the following or equal:
   1. Carboline: Carbothane 134 VOC.
   2. Devoe: Devthane 379.
   3. PPG Amercoat: Amershield VOC.
   4. Non-submerged: S-W High Solids Polyurethane CA.
   5. Tnemec: Endura-Shield II Series 1075 (U).

E. Polymorphic polyester resin coating system: 2-component, modified styrene based thermoset resin, EPA approved for potable water, with 100 percent solids and maximum 10 grams per liter VOC. As manufactured by one of the following or equal:
   1. IET: IET Prime Coat DS-101, Intermediate Coat DS-301, and Finish Coat DS 401.
   2. PPC: PPC Prime Coat, IC-Filler Coat, and FC-Final Coat.

F. High-temperature coating 150 to 350 degrees Fahrenheit: As manufactured by one of the following or equal:
   1. Carboline: Thermaline 4900.
   2. Dampney: Thermalox 245 Silicone - Zinc Dust.
   3. PPG Amercoat: Amerlock 2/400 GFK.

G. High-temperature coating 400 to 1,000 degrees Fahrenheit (dry): As manufactured by one of the following or equal:
   1. Carboline: Thermaline 4700.
   2. Dampney: Thermolox 230C Series Silicone.
   3. Devoe: HT-12, High Heat Silicone.

H. High-temperature coating up to 1,400 degrees Fahrenheit: As manufactured by the following or equal:
   1. Dampney: Thermalox 240 Silicone Ceramix.

I. Asphalt varnish: AWWA C 500.

J. Protective coal tar: As manufactured by one of the following or equal:
   1. Carboline: Bitumastic No. 50.
   2. PPG Amercoat: 78HB.

K. Coal-tar epoxy: As manufactured by one of the following or equal:
   1. Carboline: 300-M, Bitumastic.
   2. PPG Amercoat: 78HB.
   3. S-W: Tar Guard 100.
   4. Tnemec: Series 46H-413.

L. Vinyl ester: Glass mat reinforced, total system 125 mils DFT. As manufactured by one of the following or equal:
   1. Carboline: Semstone 870.
   2. Ceilcote: 6640 Ceilcrete.
   3. Dudick: Protecto-Flex 800.
   4. Tnemec: Chembloc Series 239SC.

M. Elastomeric polyurethane, 100-percent solids, ASTM D 16, Type V, (Urethane P): As manufactured by the following or equal:
   1. GET: Endura-Flex EF-1988.

N. Concrete floor coatings: As manufactured by one of the following or equal:
   1. Carboline: Semstone 140SL.
   2. Devoe: Devran 124.
   3. Dudick: Polymer Alloy 1000.
   4. Tnemec: Tneme-Glaze Series 282.

O. Waterborne acrylic emulsion: As manufactured by one of the following or equal:
   1. S-W: DTM Acrylic B66W1.
   2. Tnemec: Tneme-Cryl Series 6.

P. Galvanizing zinc compound: As manufactured by one of the following or equal:
   1. ZRC: Cold Galvanizing Compound.

2.04 MIXES

A. Mix in accordance with manufacturer's instructions.

PART 3 EXECUTION

3.01 GENERAL PROTECTION

A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection.

B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings:
   1. Mask off surfaces of items not to be coated or remove items from area.

C. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and, in particular, surfaces within storage and preparation areas.

D. Place cotton waste, cloths, and material that may constitute a fire hazard in closed metal containers and remove daily from site.

E. Remove electrical plates, surface hardware, fittings, and fastenings prior to application of coating operations. Carefully store, clean, and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.02 GENERAL PREPARATION

A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Section.

B. Protect the following surfaces from abrasive blasting by masking or other means:
   1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
   2. Machined surfaces for sliding contact.
   3. Surfaces to be assembled against gaskets.
   4. Surfaces of shafting on which sprockets are to fit.
   5. Surfaces of shafting on which bearings are to fit.
   6. Machined surfaces of bronze trim, including slide gates.
   7. Cadmium-plated items except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
   8. Galvanized items, unless scheduled to be coated.

C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.

D. Concrete:
   1. Allow new concrete to cure for minimum of 28 days before coating.
   2. Clean concrete surfaces of dust, mortar, fins, loose concrete particles, form release materials, oil, and grease. Fill voids so that surface is smooth. Prepare concrete surface for coating in accordance with SSPC SP 13. Provide ICRI 310.2 CSP-3 surface profile, or as recommended by coating manufacturer. All concrete surfaces shall be vacuumed clean prior to coating application.

E. Ferrous metal surfaces:
   1. Remove grease and oil in accordance with SSPC SP 1.
   2. Remove rust, scale, and welding slag and spatter, and prepare surfaces in accordance with appropriate SSPC standard as specified.
   3. Abrasive blast surfaces prior to coating:
      a. When abrasive blasted surfaces rust or discolor before coating, abrasive blast surfaces again to remove rust and discoloration.
      b. When metal surfaces are exposed because of coating damage, abrasive blast surfaces and feather in to a smooth transition before touching up.
      c. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC SP 10, unless blasting may damage adjacent surfaces, prohibited, or specified otherwise. Where not possible to abrasive blast, power tool clean surfaces in accordance with SSPC SP 3.
      d. Ferrous metal surfaces to be submerged: Unless specified otherwise, abrasive blast in accordance with SSPC SP 5 to clean and provide roughened surface profile of not less than 2 mils and not more than 4 mils in depth when measured with Elcometer 123, or as recommended by the coating manufacturer.
   4. All abrasive blast cleaned surfaces shall be blown down with clean dry air and/or vacuumed.

F. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.

G. Sherardized, aluminum, copper, and bronze surfaces: Prepare in accordance with coating manufacturer's instructions.

H. Galvanized surface:
   1. Degrease or solvent clean (SSPC SP 1) to remove oily residue.
   2. Power tool or hand tool clean or whip abrasive blast.
   3. Test surface for contaminants using copper sulfate solution.
   4. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded physically, such as bolts, nuts, or preformed channels.

I. Shop-primed metal:
   1. Certify that primers applied to metal surfaces in the shop are compatible with coatings to be applied over such primers in the field.
   2. Remove shop primer from metal to be submerged by abrasive blasting in accordance with SSPC SP 10, unless greater degree of surface preparation is required by coating manufacturer’s representative.
   3. Correct abraded, scratched, or otherwise damaged areas of prime coat by sanding or abrasive blasting to bare metal in accordance with SSPC SP 2, SP 3, or SP 6, as directed by the Engineer. When entire shop priming fails or has weathered excessively (more than 25 percent of the item), or when recommended by coating manufacturer’s representative, abrasive blast shop prime coat to remove entire coat and prepare surface in accordance with SSPC SP 10.
   4. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting in accordance with SSPC SP 10.

5. When prime coat not authorized by Engineer is applied, remove unauthorized prime coat by abrasive blasting in accordance with SSPC SP 10.
6. Shop applied bituminous paint or asphalt varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.

J. Cadmium-plated, zinc-plated, or sherardized fasteners:
1. Abrasive blast in the same manner as unprotected metal when used in assembly of equipment designated for abrasive blasting.

K. Abrasive blast components that are to be attached to surfaces that cannot be abrasive blasted before components are attached.

L. Grind sharp edges to approximately 1/16-inch radius before abrasive blast cleaning.

M. Remove and grind smooth all excessive weld material and weld spatter before blast cleaning in accordance with NACE SP0178.

N. Poly vinyl chloride (PVC) and FRP surfaces:
1. Prepare surfaces to be coated by light sanding (de-gloss) and wipe-down with clean cloths, or by solvent cleaning in strict accordance with coating manufacturer's instructions.

O. Cleaning of previously coated surfaces:
1. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces:
   a. Cleaning agent: Biodegradable non-flammable and containing no VOC.
   b. Manufacturer: The following or equal:
      1) CHLOR*RID International, Inc.
2. Steam clean and degrease surfaces to be coated to remove oils and grease.
3. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, steam cleaning, high-pressure washing, or hand washing as approved by the coating manufacturer's representative and the Engineer.
4. Test cleaned surfaces in accordance with the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.
5. Final surface preparation prior to application of new coating system shall be made in strict accordance with coating manufacturer's printed instructions.

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION

A. Identify equipment, ducting, piping, and conduit as specified in Section 15075 and Section 16075.

B. Remove grilles, covers, and access panels for mechanical and electrical system from location and coat separately.

C. Prepare and finish coat primed equipment with color selected by the Engineer.

D. Prepare and prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with prefinished coating.

E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

F. Prepare and coat interior surfaces of air ducts, and convector and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.

G. Prepare and coat dampers exposed immediately behind louvers, grilles, and convector and baseboard heating cabinets to match face panels.

H. Prepare and coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.

I. Prepare and coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

J. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming, and numbering, in accordance with the Contract Documents.

3.04 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Coat metal unless specified otherwise:
   1. Aboveground piping to be coated shall be empty of contents during application of coatings.

C. Verify metal surface preparation immediately before applying coating in accordance with SSPC SP COM.

D. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

E. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

F. Prime shop-primed metal surfaces. Spot prime exposed metal of shop-primed surfaces before applying primer over entire surface.

G. Multiple coats:
   1. Apply minimum number of specified coats.
   2. Apply additional coats when necessary to achieve specified thicknesses.
   3. Apply coats to thicknesses specified, especially at edges and corners.
   4. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.
   5. Lightly sand and dust surfaces to receive high-gloss finishes, unless instructed otherwise by coating manufacturer.
   6. Dust coatings between coats.

H. Coat surfaces without drops, overspray, dry spray, runs, ridges, waves, holidays, laps, or brush marks.

I. Remove spatter and droppings after completion of coating.

J. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.

K. Plural component application: Drums shall be premixed each day. All gauges shall be in working order prior to the start of application. Ratio checks shall be completed prior to each application. A spray sample shall be sprayed on plastic sheeting to ensure set time is complete prior to each application. Hardness testing shall be performed after each application.

L. Spray application:
   1. Stripe coat edges, welds, nuts, bolts, and difficult-to-reach areas by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.
   2. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for spray application.
   3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
   4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.

M. Drying and recoating:
   1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
   2. For submerged service, the Contractor shall provide a letter to the Engineer that the lining system is fully cured and ready to be placed into service.
   3. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
   4. Do not allow excessive drying time or exposure, which may impair bond between coats.
   5. Recoat epoxies within time limits recommended by coating manufacturer.
   6. When time limits are exceeded, abrasive blast clean and de-gloss clean prior to applying another coat.
   7. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces that cannot be abrasive blasted, coat components before attachment.
   8. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
   9. Touch-up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
   10. Leave no holidays.
   11. Sand and feather in to a smooth transition and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to the naked eye.

N. Concrete:
   1. Apply first coat (primer) only when surface temperature of concrete is decreasing in order to eliminate effects of off-gassing on coating.

3.05 ALKALI-RESISTANT BITUMASTIC

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
   1. Apply in accordance with general application requirements and as follows:
      a. Apply at least 2 coats, 8 to 14 mils DFT each.

3.06 WAX COATING

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
   1. Apply in accordance with general application requirements and as follows:
      a. Apply at least 1/32-inch thick coat with 2-inch or shorter bristle brush.
      b. Thoroughly rub coating into metal surface with canvas covered wood block or canvas glove.

3.07 HIGH SOLIDS EPOXY SYSTEM

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:
      a. Abrasive blast ferrous metal surfaces to be submerged at jobsite in accordance with SSPC SP 5 prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP 10.
      b. Abrasive blast non-submerged ferrous metal surfaces at jobsite in accordance with SSPC SP 10, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP 6.
      c. Abrasive blast clean ductile iron surfaces at jobsite in accordance with SSPC SP 7.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum 2-coat system with minimum total DFT of 12 mils.
      b. Recoat or apply succeeding epoxy coats within time limits recommended by manufacturer. Prepare surfaces for recoating in accordance with manufacturer's instructions.
      c. Coat metal to be submerged before installation when necessary, to obtain acceptable finish, and to prevent damage to other surfaces.
      d. Coat entire surface of support brackets, stem guides, pipe clips, fasteners, and other metal devices bolted to concrete.
      e. Coat surface of items to be exposed and adjacent 1 inch to be concealed when embedded in concrete or masonry.

3.08 HIGH SOLIDS EPOXY AND POLYURETHANE COATING SYSTEM

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:
      a. Prepare concrete surfaces in accordance with general preparation requirements.
      b. Touch up shop-primed steel and miscellaneous iron.
      c. Abrasive blast ferrous metal surfaces at jobsite prior to coating. Abrasive blast clean rust and discoloration from surfaces.
      d. Degrease or solvent clean, whip abrasive blast, power tool, or hand tool clean galvanized metal surfaces.
      e. Lightly sand (de-gloss) fiberglass and PVC pipe to be coated and wipe clean with dry cloths, or solvent clean in accordance with coating manufacturer's instructions.
      f. Abrasive blast clean ductile iron surfaces.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply a 3-coat system consisting of:
         1) Primer: 4 to 5 mils DFT high solids epoxy.
         2) Intermediate coat: 4 to 5 mils DFT high solids epoxy.
         3) Topcoat: 2.5 to 3.5 mils DFT aliphatic or aliphatic-acrylic polyurethane topcoat.
   2. Recoat or apply succeeding epoxy coats within 30 days or within time limits recommended by manufacturer, whichever is shorter. Prepare surfaces for recoating in accordance with manufacturer's instructions.

3.09 POLYMORPHIC POLYESTER RESIN SYSTEM

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows.
   2. Prepare concrete to obtain clean, open pore with exposed aggregate in accordance with manufacturer's instructions.
   3. Prepare ferrous metal surfaces in accordance with SSPC SP 5, with coating manufacturer's recommended anchor pattern.
   4. Complete abrasive blast cleaning within 6 hours of applying prime coat. Dew point shall remain 5 degrees above dew point 8 hours after application of coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP 5.
   5. When handling steel, wear gloves to prevent hand printing.
   6. Adjust pH of concrete to within 5.5 to 8.0 before applying prime coat.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum DFT system consisting of primer, tie coat and top coat in accordance with manufacturer's instructions as follows:
         1) Steel: 35 mils.
         2) Concrete: 45 mils.

3.10 HIGH-TEMPERATURE COATING

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:
      a. Abrasive blast surface in accordance with SSPC SP 10.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply number of coats in accordance with manufacturer's instructions.

3.11 ASPHALT VARNISH

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum 2 coats.

3.12 PROTECTIVE COAL TAR

A. Preparation:
   1. Prepare surfaces in accordance with general preparation of coal-tar requirements.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum 20 mils DFT coating.

3.13 VINYL ESTER

A. Preparation:
   1. Prepare surfaces in accordance with coating manufacturer's recommendations and as directed and approved by coating manufacturer's representative.

B. Application:
   1. Apply prime coat, as required by coating manufacturer, base coat, glass mat, and topcoat to total dry film thickness of 125 mils minimum:
      a. Final topcoat on floors shall include non-skid surface, applied in accordance with manufacturer's instructions.
   2. Perform high-voltage holiday detection test in accordance with NACE SP0188, over 100 percent of coated surface areas to ensure pinhole-free finished coating system.
   3. All work shall be accomplished in strict accordance with coating manufacturer's instructions and under direction of coating manufacturer's representative.

3.14 ELASTOMERIC POLYURETHANE (100 PERCENT SOLIDS)

A. Preparation:
   1. Prepare surfaces in strict accordance with coating manufacturer's instructions and as directed and approved by coating manufacturer's representative.

B. Application:
   1. Apply epoxy primer at DFT of 1 to 2 mils, in strict accordance with manufacturer's instructions.
   2. Apply polyurethane coating at minimum total DFT as follows:
      a. Steel: 60 mils DFT.
      b. Ductile iron and ductile iron pipe coating and lining: 30 mils DFT.
      c. Concrete: 120 mils DFT.
      d. Or as recommended by the coating manufacturer and accepted by the Engineer.
   3. For concrete application, provide saw cutting for coating terminations in strict accordance with manufacturer's instructions.
   4. Perform high voltage holiday detection test in accordance with NACE SP0188, over 100 percent of coated surface areas to ensure pinhole free finished coating system.

3.15 CONCRETE FLOOR COATINGS

A. Preparation:
   1. Prepare surfaces in accordance with general application requirements and in strict accordance with coating manufacturer’s instructions.

B. Application:
   1. Apply primer if required by coating manufacturer.
   2. Apply 1 or more coats as recommended by coating manufacturer to receive a minimum total DFT of 25 mils; color as selected by the Owner.

C. Final topcoat shall include non-skid surface, applied in strict accordance with coating manufacturer's instructions.

3.16 WATERBORNE ACRYLIC EMULSION

A. Preparation:
   1. Remove all oil, grease, dirt, and other foreign material by solvent cleaning in accordance with SSPC SP 1.
   2. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.

B. Application:
   1. Apply 2 or more coats to obtain a minimum DFT of 5.0 mils.

3.17 FIELD QUALITY CONTROL

A. Each coat will be inspected. Strip and remove defective coats, prepare surfaces, and recoat. When approved, apply next coat.

B. Control and check DFT and integrity of coatings.

C. Measure DFT with calibrated thickness gauge.

D. DFT on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-Off Gauge or PosiTector® 6000.

E. Verify coat integrity with low-voltage sponge or high-voltage spark holiday detector, for submerged service, in accordance with NACE SP0188. Allow Engineer to use detector for additional checking.

F. Check wet film thickness before coal-tar epoxy coating cures on concrete or non-ferrous metal substrates.

G. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface preparation of facilities and items to be coated, and to ensure proper application and curing:
   1. Notify Engineer 24 hours in advance of each visit by coating manufacturer's representative.
   2. Provide Engineer with a written report by coating manufacturer's representative within 48 hours following each visit.

3.18 SCHEDULE OF ITEMS NOT REQUIRING COATING

A. General: Unless specified otherwise, the following items do not require coating:
   1. Items that have received final coat at factory and are not listed to receive coating in field.
   2. Aluminum, brass, bronze, copper, plastic (except PVC pipe), rubber, stainless steel, chrome, Everdur, or lead.
   3. Buried or encased piping or conduit.
   4. Exterior concrete.
   5. Galvanized steel wall framing, galvanized electrical conduits, galvanized pipe trays, galvanized cable trays, and other galvanized items:
      a. Areas on galvanized items or parts where galvanizing has been damaged during handling or construction shall be repaired as follows:
         1) Clean damaged areas by SSPC SP 1, SP 2, SP 3, or SP 7 as required.
         2) Apply 2 coats of a galvanizing zinc compound in strict accordance with manufacturer’s instructions.
   6. Grease fittings.
   7. Fiberglass ducting or tanks in concealed locations.
   8. Steel to be encased in concrete or masonry.

3.19 SCHEDULE OF SURFACES TO BE COATED IN THE FIELD

A. In general, apply coatings to steel, iron, galvanized surfaces, and wood surfaces unless specified or otherwise indicated on the Drawings. Coat concrete surfaces and anodized aluminum only when specified or indicated on the Drawings. Color coat all piping as specified in Section 15075.

B. The following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Verify questionable surfaces.

C. Concrete:
   1. High solids epoxy:
      a. Safety markings.

D. Metals:
   1. Alkali-resistant bitumastic:
      a. Aluminum surfaces to be placed in contact with wood, concrete, or masonry.
   2. Wax coating:
      a. Sliding faces of sluice and slide gates and threaded portions of gate stems.
   3. High solids epoxy and polyurethane system: Interior and exterior non immersed ferrous metal surfaces including:
      a. Doors, doorframes, ventilators, louvers, grilles, exposed sheet metal, and flashing.
      b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
      c. Motors and motor accessory equipment.
      d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment.
      e. Valve and gate operators and stands.
      f. Structural steel including galvanized structural steel.
      g. Crane and hoist rails.
      h. Exterior of tanks and other containment vessels.
      i. Mechanical equipment supports, drive units, and accessories.
      j. Pumps not submerged.
      k. Other miscellaneous metals.
   4. High solids epoxy system:
      a. Field priming of ferrous metal surfaces with defective shop-prime coat where no other prime coat is specified; for non-submerged service.
      b. Bell rings, underside of manhole covers and frames.
      c. Sump pumps and grit pumps, including underside of base plates and submerged suction and discharge piping.
      d. Chlorine diffuser supports.
      e. Exterior of submerged piping and valves other than stainless steel or PVC piping.
      f. Submerged pipe supports and hangers.
      g. Stem guides.
      h. Vertical shaft mixers and aerators below supports.
      i. Other submerged iron and steel metal unless specified otherwise.
      j. Interior surface of suction inlet and volute of submersible pumps. Apply coating prior to pump testing.
      k. Submerged piping.
      l. Exterior of pumps and pump submerged discharge piping.
   5. High-temperature coating 150 to 350 degrees Fahrenheit:
      a. High temperature equipment and piping operating that may above 150 degrees but less than 350 degrees Fahrenheit.
   6. High-temperature coating 400 to 1,000 degrees Fahrenheit:
      a. High temperature equipment and piping operating that may above 350 degrees but less than 1000 degrees Fahrenheit.

7. Asphalt varnish:
    a. Underground valve boxes.
8. Protective coal tar:
    a. Underground pipe flanges, excluding pipe, corrugated metal pipe couplings, flexible pipe couplings and miscellaneous underground metals not otherwise specified to receive another protective coating.

E. Fiberglass and PVC pipe surfaces:
1. Waterborne acrylic emulsion.
    a. Exterior of fiberglass ducting and fan housings.
    b. Fiberglass expose to sunlight.
    c. PVC piping exposed to view.
    d. ABS piping as determined by Engineer.

END OF SECTION

SECTION 10400

SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Plastic and metal signs for building and site use.

1.02 SUBMITTALS

A. Product data.

B. Shop drawings: Include lists of sign types, sizes, text, and colors; mounting details; locations; and cast metal plaque rubbings and templates.

C. Samples: Include actual materials.

D. Manufacturer's installation instructions.

1.03 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed products for minimum 5 years with satisfactory performance record of minimum 5 years.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 10 projects of similar scope as Project with satisfactory performance record.

C. Regulatory requirements: Provide signage in accordance with Americans with Disabilities Act as published in the Federal Register, Volume 56, No. 144, Friday, July 26, 1991.

PART 2 PRODUCTS

2.01 PLASTIC SIGNAGE SYSTEM

A. Manufacturers:
   1. One of the following or equal:
      a. Best Manufacturing Sign Systems, Montrose, CO; System 900013.
      b. Andco Industries Corp., Greensboro, NC; equivalent product.
      c. Vomar Products, Inc., Sepulveda, CA; equivalent product.

B. Attachment:
   1. Vinyl tape, self-adhering.

C. Lettering:
   1. Helvetica medium, 3/4 inches high.

D. Material for interior use:
   1. Plastic 1/8-inch thick raised letters.

E. Material for exterior use:
   1. Fiberglass 1/4 inch thick with high gloss finish, raised letters, blasted from single piece of fiberglass for integral letter and background.
   2. No adhesive as mechanical fastening of letters shall be allowed.

F. Colors:
   1. As selected by Engineer from manufacturer's standard colors.

G. See Schedule A for specific sign size, location, text, pictogram, and quantity.

2.02 METAL SAFETY SIGNS

A. Manufacturer: Meeting OSHA Requirements; 40-mil thick aluminum with baked enamel finish. One of the following or equal:
   1. Seton Name Plate Co., Branford, Connecticut, Special Wording.
   2. Emedco, Buffalo, New York.

B. Danger sign colors:
   1. Background: White.
   2. Heading: White lettering on red oval with white border in black rectangular panel.
   3. Message: Black lettering on white.
   4. Size: As scheduled.

C. Caution sign colors:
   1. Background: Yellow.
   2. Heading: Yellow lettering on black rectangular panel.
   3. Message: Black lettering on yellow.
   4. Size: As scheduled.

D. Safety instruction signs:
   1. Background: White.
   2. Heading: White lettering on green rectangular panel.
   3. Message: Black lettering.
   4. Size: As scheduled.

E. Warning sign colors:
   1. Background: Orange.
   2. Heading: Black lettering on orange diamond in black rectangular panel.
   3. Message: Flack lettering on orange.
   4. Size: As scheduled.

F. Notice information signs:
   1. Background: White.
   2. Heading: White lettering on blue rectangular panel.
   3. Message: Black lettering.
   4. Size: As scheduled.

G. Fasteners: Round head stainless steel bolts or screws.

H. See Schedule B for specific sign size, location, text, and quantity.

2.03 EXTERIOR INFORMATION SIGNS

A. Able to withstand 100 miles per hour wind load without damage:
   1. Manufacturers: One of the following or equal:
      a. Best Manufacturing Sign Systems, Montrose, CO; equivalent product.
      b. Andco Industries Corp., Greensboro, NC; equivalent product.
      c. Vomar Products, Inc., Sepulveda, CA; equivalent product.

B. Sign panel: Nominal 3 inches thick, consisting of 1/8-inch thick fiberglass material with integral returns fully encapsulating wood and foam core, 1/8-inch radius edges and corners, size as indicated on the Drawings.

C. Text: Helvetica medium, size and wording as indicated on the Drawings. Signs and text in accordance with Schedule C.

D. Posts: Nominal 3 inch square extruded aluminum sections with aluminum fillers at top and bottom, mounting hardware, and aluminum baseplates drilled for anchor bolts.

E. Fasteners: Manufacturer's standard, suitable for application.

F. Colors: As selected from manufacturer's standard colors.

2.04 CAST ALUMINUM LETTERS

A. Manufacturers:
   1. One of the following or equal:
      a. Metal Arts, Mandan, ND.
      b. Southwell Company, San Antonio, TX.
      c. OMC Industries, Bryan, TX.

B. Material:
   1. Cast aluminum.

C. Text size and font:
   1. As indicated on the Drawings.

D. Finish:
   1. Black duranodic coating.

E. Mounting:
   1. Projected jamb nut mounting, concealed.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect adjacent surfaces which may be damaged by installation of signs.

B. Prepare substrates in accordance with sign manufacturer's instructions.

C. Remove scale, dirt, grease, and other contaminates from substrates.

3.02 INSTALLATION

A. Install signs in accordance with sign manufacturer's instructions.

B. Fasten signs securely in level, plumb, and true to plane positions.

C. Install signs as indicated in the following schedules.

3.03 SCHEDULES

A. Plastic Signage System Schedule.

B. Metal Safety Sign Schedule.

END OF SECTION

SCHEDULE A

PLASTIC SIGNAGE SYSTEM SCHEDULE

A. Room Numbers:
   1. Location: On wall outside room adjacent to latch side of doors or when not enough space on latch side, on nearest adjacent wall.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square.
   4. Colors: As selected by the Engineer.
   5. Text: Room number as indicated on the Drawings.

B. Stair Landings:
   1. Location: At each floor landing in stairwells.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square.
   4. Colors: As selected by Engineer.
   5. Text: Stair number, access or no access to roof to suit application, and floor level, as follows:

C. Fire Extinguishers:
   1. Location: Adjacent to fire extinguishers.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square.
   4. Colors: White letters on OSHA Red background.
   5. Text: FIRE EXTINGUISHER.

D. Nonpotable Water:
   1. Location: At impure water and nonpotable water hose valves in accordance with Typical Detail M276.
   2. Height: In accordance with Typical Detail.
   3. Size: 10 inches wide by 7 inches high.
   4. Heading: CAUTION
   5. Text: IMPURE WATER
DO NOT DRINK

E. Exterior Structure:
   1. Secondary Clarifier No. 5
   2. Mixed Liquor Flume No. 5
   3. Mixed Liquor Flume No. 6
   4. RAS Pump Station No. 2
   5. RAS Pump Station No. 1

F. Construction Instruction

END OF SCHEDULE A
PLASTIC SIGNAGE SYSTEM SCHEDULE

SCHEDULE B

METAL SAFETY SIGN SCHEDULE

A. NONPOTABLE WATER:
   1. Location: At impure water and nonpotable water hose valves in accordance with Typical Detail M276.
   2. Height: In accordance with Typical Detail.
   3. Size: 10 inches wide by 7 inches high.
   4. Heading: DANGER
   5. Wording: DO NOT DRINK THIS WATER

B. REMOTELY CONTROLLED AUTOMATIC EQUIPMENT:
   1. Location: On front and back of equipment that starts automatically by remote control.
   2. Height: At eye level.
   3. Size: 20 inches wide by 14 inches high.
   4. Heading: DANGER
   5. Wording: THIS EQUIPMENT STARTS AUTOMATICALLY
BY REMOTE CONTROL

C. HIGH VOLTAGE WARNING:
   1. Location: On front and back of equipment, adjacent to doors to rooms containing devices, and devices that operate at 600 volts or greater.
   2. Height: 60 inches above floor to center of sign. Where metal safety signs are also located adjacent to entry points, place no smoking signs below these signs.
   3. Size: 6 inches square.
   4. Heading: DANGER
   5. Wording: HIGH VOLTAGE
KEEP OUT

D. NO SMOKING WITHIN 25 FEET OF BUILDING ENTRY:
   1. Location: As indicated on the Drawings.
   2. Height: Pole mounted with top of sign at 5 feet above grade.
   3. Size: 14 inches wide by 10 inches high.
   4. Heading: NOTICE
   5. Wording: NO SMOKING WITHIN 25 FEET OF BUILDING.
   6. Pictogram: International “No Smoking” symbol.

END OF SCHEDULE B
METAL SAFETY SIGN SCHEDULE

SCHEDULE C

EXTERIOR INFORMATION SIGNS SCHEDULE

A. DIRECT PROJECT DELIVERIES TO S. KILROY ROAD ENTRANCE:
   1. Location: S Walnut Rd entrance and S. Kilroy Rd.
   2. Height: Pole mounted with top of sign at 5 feet above grade.
   3. Size: 14 inches wide by 10 inches high.
   4. Heading: NOTICE
   5. Wording: Direct Project Deliveries To S. Kilroy Road Entrance.
   6. Schedule: This sign shall be installed within 30 days of Contractor being on site.

END OF SCHEDULE C
EXTERIOR INFORMATION SIGNS SCHEDULE

SECTION 11292A

FLAP GATES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Framed flap gates.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01756 - Commissioning and Process Start-Up.
      b. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A 48 - Standard Specification for Gray Iron Castings.
   2. A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   3. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. B 139 - Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
   5. B 584 - Standard Specification for Copper Alloy Sand Castings for General Application.
   6. D 2000 - Standard Classification System for Rubber Products in Automatic Applications.

1.03 DESIGN REQUIREMENTS

A. Flap gates shall open when there is a differential pressure across the flap of 0.2 feet or less.

B. With the flap gate submerged, the head loss shall not exceed 0.3 feet at all existing velocities for gates 60 inches or smaller.

C. Seating head: 0 to 3 feet; unseating head: 3 to 5 feet.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings.

C. Manufacturer's installation instructions.

D. Design data and calculations substantiating conformance with the drawings and Specifications.

E. Manufacturer shall certify in writing that installed flap gates meet specified leakage and headloss requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Waterman Industries.
   2. Whipps, Inc.

B. Anchor bolts and wall thimbles: Provided by flap gate manufacturer.

2.02 MATERIALS

A. Cast iron: ASTM A 126, Class B ASTM, A 48, Class 30.

B. Bronze:
   1. Bronze subject to submersion or splash: Not more than 6 percent zinc and no aluminum.
   2. Manganese bronze: ASTM B 584, UNS No. C86500.
   3. Phosphor bronze: ASTM B 139, UNS No. C51000.
   4. Silicon bronze: ASTM B 584 UNS No. C87200.

C. Stainless steel: ASTM A 276, Type 304, 304L, 316, or 316L.

D. Neoprene: ASTM D 2000, BC 615 to 625.

2.03 GATE COMPONENTS

A. Body frame and cover: Material as specified in Flap Gate Schedule:
   1. Frame:
      a. Size(s) as indicated on the Drawings.
      b. Mount as specified in the Flap Gate Schedule.
   2. Cover:
      a. Cast in one piece or welded and shall be of a dished or reinforced design to maximize strength, rigidity, and minimize weight.
      b. Cast a lifting eye at the top of the cover for manual operation.

B. Seats: Material(s) as specified in Flap Gate Schedule.

C. Hinge arms:
   1. Double pivot-point design:
      a. The lower pivot shall allow the cover and the frame to lie in the same plane.
      b. The upper pivot shall be adjustable to vary sensitivity to unseating heads.
   2. Materials: Material as specified in Flap Gate Schedule.

D. Hinge pins: Material as specified in Flap Gate Schedule.

E. Bolts, nuts, and fittings: Type 316 stainless steel.

2.04 WALL THIMBLES

A. F-section of a depth equal to the thickness of the structure wall upon which the gate is mounted:
   1. Modify when required for pipe connections in a wall:
      a. Provide a flange-by-mechanical joint wall thimble where ductile iron piping connects to the wall thimble.
      b. Provide flange-by-bell ring wall thimble insert where reinforced concrete piping connects to the wall thimble.

B. Material: Cast iron of sufficient section to resist permanent distortion due to casting and installation stresses.

C. Width of mounting flange of wall thimble: 1/2-inch wider than mounting flange of gate.

D. Machine front flange, drill, and tap to match drilling on gate frame.

E. Mark top center of each thimble.

F. Provide stainless steel studs for attaching the gate frame.

G. Seal joint between thimble and gate frame watertight.

H. To permit entrapped air to escape as the thimble is being cast in concrete, cast or drill holes in each entrapment zone formed by ribs, flanges, and water stops.

2.05 ANCHOR BOLTS

A. When required, hooked end type, of sufficient quantity and length to anchor the gate.

B. Material: Type 316 stainless steel.

2.06 COATING

A. Coat flap gates in the factory prior to testing.

B. Coat with surface tolerant high solids epoxy. As specified in Section 09960.

C. Repair or touch-up damaged areas of the factory applied coating in the field.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Mount thimbles and gates plumb in both vertical planes and level in horizontal plane.

C. Provide factory-trained personnel to:
   1. Check the complete installation.
   2. Make necessary adjustments.
   3. Conduct field-testing.

D. Coat seating surfaces between frame and wall thimble with a waterproof plastic compound prior to tightening of frame studs.

3.02 FIELD QUALITY CONTROL

A. Testing:
   1. Leakage tests: Demonstrate compliance with allowable leakage limits set forth herein.
   2. After the gate installation and checking, exercise each gate from the closed position to fully open position and back to the closed position at least twice and verify gate is properly seated.
   3. Provide certificate of proper installation. As specified in Section 01756.

3.03 FLAP GATE SCHEDULE

A. The Flap Gate Schedule is not a gate take-off list.

Equipment Number	Reference Drawing (Note 1)	Frame and Gate Material	Opening Size, Inches	Seal	Hinge Arm Material	Hinge Pin Material	Mounting	Design Pressure, Seating, Feet
GAT-0101, 0102, 0201, 0202, 0301, 0302, 0401, 0402, 0501, 0502, 0601, 0602, 0701, 0702	04M01, 04M02, 04M03, 04M07, 05M01, 05M03, 06M01	304 SST	(Note 2)	Neoprene	304 SST	304 SST	Wall Thimble Pipe Flange (Note 3)	0 - 3 feet

Notes:
(1) Gate numbers not shown on drawings. There are two gates per aeration basin associated with each MLR pump.
(2) Coordinate with MLR pump manufacturer, Specifications Section 11315.
(3) Wall thimble to be provided by MLR pump manufacturer, Specifications Section 11315.

END OF SECTION

SECTION 11294A

CAST-IRON SLIDE GATES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-iron slide gates.

B. As specified in Section 01600.

C. Related sections:
1. Section 01330 - Submittal Procedures.
2. Section 01600 - Product Requirements.
3. Section 01756 - Commissioning.
4. Section 01782 - Operation and Maintenance Data.
5. Section 01783 - Warranties and Bonds.
6. Section 09960 - High-Performance Coatings.
7. Section 11294B - Heavy-Duty Fabricated Stainless Steel Slide Gates.
8. Section 11294C - Owner Supplied Heavy-Duty Fabricated Stainless Steel Slide Gates.
9. Section 13446 - Manual Actuators.
10. Section 15050 - Common Work Results for Mechanical Equipment.

1.02 REFERENCES

A. ASTM international (ASTM):
1. A36 - Standard Specification for Carbon Structural Steel.
2. A48 - Standard Specification for Gray Iron Castings.
3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
5. A276 - Standard Specification for Stainless Steel Bars and Shapes.
6. B139 - Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
7. B584 - Standard Specification for Copper Alloy Sand Castings for General Application.
8. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

B. American Water Works Association (AWWA):
1. C560 - Standard for Cast-Iron Slide Gates.

1.03 DEFINITIONS

A. Slenderness ratio: The largest ratio obtained by dividing the unsupported length of the stem by the radius of gyration of the stem cross section.

1.04 DESIGN REQUIREMENTS

A. In accordance with AWWA C560, as complemented and modified in this Section.

B. Design to meet seating and unseating pressures listed in Slide Gate Schedule.

C. Gate components:
   1. Slide and guides: Design for minimum safety factor of 5 with regard to tensile, compressive, and shear strength.
   2. Lifts, general: Provide tandem lifts with interconnecting shaft on all gates with an aspect ratio (width divided by height) equal to or exceeding 2.0.
   3. Stem: Select stem diameter, stem guide quantity, and stem guide spacing based on following criteria:
      a. Slenderness ratio (l/r): Not exceeding 200.
      b. Maximum diameter: Provide stem guides at a spacing to maintain stem diameter of 2 inches or less.
      c. Tensile strength: Suitable to withstand the force generated by the operator with the application of a 200-pound force applied to the crank or handwheel or a 250 foot-pound torque applied to the wrench nut.
      d. Compressive strength:
         1) Suitable to withstand buckling due to the force generated by the operator with the application of an 80-pound force applied to the crank or handwheel or a 100 foot-pound torque applied to the wrench nut.
         2) Determine buckling load using Euler Column formula defined in AWWA C560.
      e. Design force for power actuators:
         1) Hydraulic cylinder operators: 1.25 times the output thrust at maximum hydraulic fluid operating pressure.
         2) Electric motor operators: 1.25 times the output thrust in the stalled-motor condition.
   4. Thrust nut:
      a. Suitable to withstand thrust developed by operator with the application of a 40-pound force on the crank or handwheel with safety factor of 5.
      b. Base design on ultimate strength of material used.
   5. Yokes for self-contained gates:
      a. Design yoke using design loading criteria for stem.
      b. Maximum deflection at design load: Not to exceed 1/360 of the span.

1.05 SUBMITTALS

A. Submit as specified in Section 01330.

B. Product data: As specified in Section 15050.

C. Shop drawings: As specified in Section 15050.

D. Vendor operation and maintenance manuals: As specified in Section 01782.

E. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756.

F. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

G. Calculations:
   1. Calculations and design data substantiating conformance with the drawings and specifications.

1.06 QUALITY ASSURANCE

A. Factory markings:
   1. Mark gates according to the schedule numbers when such numbers are used.
   2. Where thimbles, frames, and other components are not interchangeable, match mark components.

1.07 WARRANTY

A. Provide warranty as specified in Section 01783.

PART 2 PRODUCT

2.01 MANUFACTURER

A. One of the following or equal:
   1. Rodney Hunt Company.
   2. Waterman Industries, Inc.

B. Operators, anchor bolts, and wall thimbles: Provided by cast iron slide gate manufacturer.

2.02 MATERIALS

A. Cast iron:
   1. ASTM A126, Class B.
   2. ASTM A48, Class 30.

B. Bronze:
   1. Bronze subject to submersion or splash: Not more than 6 percent zinc and no aluminum.
   2. Manganese bronze: ASTM B584, UNS Number C86500.
   3. Phosphor bronze: ASTM B139, UNS Number C51000.
   4. Silicon bronze: ASTM B584 UNS Number C87300.

C. Galvanized structural steel: ASTM A36, Galvanized in accordance with ASTM A123.

D. Stainless steel: ASTM A276, Type 316 or Type 304.

E. Neoprene: ASTM D2000, BC 615 to 625.

2.03 COMPONENTS

A. Slide:
   1. Cast iron.
   2. Rectangular or square.
   3. One piece with integrally cast vertical and horizontal ribs.
   4. Machined dovetail grooves on the seat surfaces into which is forced a phosphor bronze or silicon bronze seat facing, machine-finished in accordance with AWWA C560, after installation in the slide.
   5. Machine tongues on vertical sides with maximum 1/16-inch clearance between tongue and guide groove.
   6. Integrally cast wedge pads machined to receive wedges.
   7. Reinforced thrust nut pocket cast integrally on front face above horizontal center, shape as required to receive thrust nut, and with provisions for drainage of pocket.

B. Frame:
   1. Cast iron, 1-piece.
   2. Flanged back section with rectangular, square, or round opening as indicated on the Drawings.
   3. Machined dovetail grooves on the front face into which is forced a phosphor bronze or silicon bronze seat facing, machined in accordance with AWWA C560, after installation in the frame.
   4. Machine surfaces which contact slide and wall thimble.

C. Guides:
   1. Cast iron, 1-piece.
   2. Attachment to frame:
      a. Gates smaller than 54 inches: Cast integrally with frame.
      b. Gates 54 inches and larger: Bolt to frame with studs and nuts and pinned to prevent lateral movement.
   3. Length: Sufficient to retain at least half the height of the slide in the full open position.
   4. Grooves for tongues on slide:
      a. Full length of guide.
      b. Machined on all contact surfaces.
      c. Maximum 1/16-inch clearance between tongue and groove wall.

D. Wedges and wedge seats:
   1. Sufficient quantity to result in full contact between slide and frame when slide is in closed position and subjected to design pressure specified in slide gate schedules.
   2. Locations:
      a. Both vertical sides.
      b. Top and bottom: When gates 24 inches or more in width are subject to unseating head conditions.
   3. Wedges:
      a. Adjustable to allow alignment with seat.
      b. Silicon bronze with machined mating and contact surfaces.
      c. Type 316 stainless steel holddown bolt.

d. Stainless steel adjustment bolt and lock nut that allows proper field adjustment and permanently maintains position of wedge after final adjustment.
e. Side wedges: Keyed and bolted to machined pads on slide.
f. Top and bottom wedges: Hook shaped and bolted to machine pads on slide.

4. Wedge seats:
   a. Side wedges seats:
      1) Gates smaller than 54 inches: Keyed and bolted to machined pad on guide.
      2) Gates 54 inches and larger:
         a) Integrally cast with guide and machined to match wedge face.
         b) Provide support ribs on guide at each seat location to resist wedging forces.
   b. Top and bottom wedge seats:
      1) Keyed to prevent movement under force.
      2) Attach to frame with 2 Type 316 stainless steel bolts.
      3) Machined contact surfaces.

E. Stem:
1. Type 316 stainless steel.
2. Machine cut or rolled threads.
3. Stem couplings:
   a. Silicon bronze.
   b. Threaded and keyed to stem or threaded and bolted to stem.
4. Stem guides:
   a. Cast iron.
   b. Split collar.
   c. Adjustable in 2 directions.
   d. Silicon bronze bushings.
5. Provide manganese bronze stop collar on stem above actuator.
6. Connect stem to slide with thrust nut and nut pocket.

F. Thrust nut:
1. Silicon bronze.
2. Construct thrust nut and slide to prevent turning of thrust nut in the thrust nut pocket.
3. Rising-stem gates: Thread and key, or thread and pin thrust nut to stem.
4. Nonrising-stem gates: Thread thrust nut to stem without keys or pins, so that nut and slide can move up and down the stem as the stem turns.

G. Gate operators: As specified in Section 13446.

H. Bolts, nuts, and fittings: Type 316 stainless steel.

I. Anchor bolts:
1. Type 316 stainless steel.
2. Hooked end type.

2.04 SELF-CONTAINED SLIDE GATES

A. Conform to requirements for cast-iron slide gates and following additional provisions:
   1. Extend guides and frame so that bottom of yoke is at least 12 inches above top of slide at full open position.
   2. Machine pads at top of guide for mounting yoke.
   3. Machine pads on bottom of yoke where faces contact pads on guides.
   4. Machine top of yoke where operating mechanism is mounted.
   5. Yoke: Cast iron or galvanized structural steel.
   6. Bolt yoke to guide with stainless steel bolts.
   7. Unless otherwise indicated on the Drawings, position handwheel or geared operator 36 inches (nominal) above walking surface.

2.05 SLIDE GATES WITH FLUSH BOTTOM CLOSURE

A. Conform to requirements for cast-iron slide gates and following additional provisions:
   1. Provide gates designed for flush bottom seal with a strip of neoprene along the bottom of the gate frame or slide.
   2. Accomplish sealing action when the gate is closed by contact and compression of the neoprene seal between the gate slide and the gate frame.
   3. Seal retainer bar: Type 316 stainless steel.
   4. When seal is on slide, provide machined cast-iron stop bar attached to frame.

2.06 WALL THIMBLES

A. F-section, of a depth equal to the thickness of the structure wall upon which the gate is mounted:
   1. Modify when required for pipe connections in a wall:
      a. Provide a flange-by-mechanical joint or flange-by-push on joint wall thimble where ductile iron piping connects to the wall thimble:
         1) Restrain piping to wall thimble where required.
      b. Provide flange-by-bell ring wall thimble insert where reinforced concrete piping connects to the wall thimble.

B. Cast iron of sufficient section to resist permanent distortion due to casting and installation stresses.

C. Width of mounting flange of wall thimble: 1/2 inch wider than mounting flange of gate.

D. Machine front flange, drill, and tap to match drilling on gate frame.

E. Mark top center of each thimble.

F. Provide stainless steel studs for attaching the gate frame.

G. Seal joint between thimble and gate watertight, in accordance with AWWA C560.

H. To permit entrapped air to escape as the thimble is being cast in concrete, cast or drill holes in each entrapment zone formed by ribs, flanges, and water stops.

2.07 ANCHOR BOLTS

A. Hooked end type, of sufficient quantity and length to anchor the unit.

B. Material: Type 316 stainless steel.

2.08 COATING

A. Coat slide gates in the factory, prior to testing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount thimbles and gates plumb in both vertical planes and level in horizontal plane.

B. Coat seating surfaces between frame and wall thimble with a waterproof plastic compound prior to tightening of frame studs.

C. Adjust wedges or other parts of the gate to the point where it will not be possible to insert a 0.004-inch feeler gauge between the gate slide and the gate frame at any point:
   1. Securely lock wedges into position after adjustment.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

A. Functional testing:
   1. Cast Iron Slide Gate:
      a. Test witnessing: Witnessed.
      b. Test witnessing: Witnessed.
      c. After the gate installation and checking, exercise each gate from the closed position to fully open position and back to the closed position at least twice and verify gate is properly seated.
      d. Leakage tests:
         1) Conduct in accordance with AWWA C560.
         2) Comply with allowable leakage limits set forth in AWWA C560.

3.03 CAST IRON SLIDE GATE SCHEDULE

A. The Cast Iron Slide Gate Schedule is provided as a reference and not as a gate take-off list.

CAST IRON SLIDE GATE SCHEDULE											
Equipment Tag No.	**Opening Size**	**Opening Shape**	**Seating Head**	**Unseating Head**	**Wall Thimble**	**Type of Closure**	**Operator Mounting**	**Operator Type**	**Service**	**Stem Type**	**Notes**
GAT - 0201	8" x 8"	Square	6 ft	6 ft	Type F/ Wall Pipe	Flush Bottom	Self-Contained	Handwheel	Open/ Close	Rising Stem	

END OF SECTION

SECTION 11294B

HEAVY-DUTY FABRICATED STAINLESS STEEL SLIDE GATES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Heavy-duty fabricated stainless steel slide gates.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning and Process Start-Up.
   3. Section 09960 - High-Performance Coatings.
   4. Section 13446 - Manual Actuators.
   5. Section 13447 - Electric Motor Actuators.
   6. Section 15050 - Common Work Results For Mechanical Equipment.
   7. Section 15958 - Mechanical Equipment Testing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Water Works Association (AWWA):
   1. AWWA C 561 - Fabricated Stainless Steel Slide Gates.

C. American Welding Society (AWS):
   1. D1.6 - Structural Welding Code-Stainless Steel.

D. ASTM International (ASTM):
   1. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   2. B 584 - Standard Specifications for Copper Alloy Sand Castings for General Application.
   3. D 1248 - Standard Specification for Polyurethane Plastics Extrusion Materials for Wire and Cable.
   4. D 2000 - Standard Classification for Rubber Products in Automotive Applications.
   5. D4020 - Standard Specification for Ultra-High Molecular-Weight Polyethylene Molding and Extrusion Materials.

1.03 DEFINITIONS

A. Slenderness ratio (l/r): The largest ratio obtained by dividing the unsupported length of the stem by the radius of gyration of the stem cross section.

B. Design head: Depth from surface of water to centerline of gate. Use value specified in the gate schedule.

C. Seating head: Pressure applied to gate slide from weight of water column above gate centerline that forces gate slide into seat.

D. Unseating head: Pressure applied to gate slide from weight of water column above gate centerline that forces gate slide away from seat.

E. Substantially similar:
   1. Similar in size, design head, and service.
   2. Utilizes the proposed design for critical components including guides and seals.

1.04 DESIGN REQUIREMENTS

A. Except as modified or supplemented herein, all gates and operators shall conform to the requirements of AWWA C 561, latest edition.

B. Gate components:
   1. Frames:
      a. Design for the design head scheduled with a minimum safety factor of 5 with regard to ultimate tensile, compressive, and shear strength.
      b. Self-contained gates: Where frames extend above the operating floor, design to be self-supporting so that no further reinforcing or support is required.
   2. Stem: Select stem diameter, stem guide quantity and stem guide spacing based on following criteria:
      a. Slenderness ratio (l/r): Shall not exceed 200.
      b. Tensile strength: Suitable to withstand the force generated by the operator with the application of a 200 pound force applied to the crank or handwheel or a 250 foot-pound torque applied to the wrench nut.
      c. Compressive strength:
         1) Suitable to withstand buckling due to the force generated by the operator with the application of an 80 pound force applied to the crank or handwheel or a 100 foot-pound torque applied to the wrench nut.
         2) Determine buckling load using Euler Column formula in accordance with AWWA C 561, where C = 2.
      d. Design force for power actuators:
         1) Hydraulic cylinder operators: 1.25 times the output thrust at maximum hydraulic fluid operating pressure.
         2) Electric motor operators: 1.25 times the output thrust in the stalled-motor condition.
      e. Gates having widths greater than 2 times the height: Provide with 2 lifting mechanisms connected by a tandem shaft.
   3. Thrust nut: Suitable to withstand thrust developed by operator with the application of a 40 pound force on the crank or handwheel with safety factor of 5. Base design on ultimate strength of material used.
   4. Yokes for self-contained gates:
      a. Design yoke using design loading criteria for stem with safety factor of 5 based on the ultimate strength of the material used.
      b. Maximum deflection at design load: Not to exceed 1/360th of the span.

5. Slide:
    a. Deflection shall be less than or equal to 1/1000 of the span of the gate or 1/16 inch, whichever is less, when under the design head.
    b. Design for the maximum design head specified with a minimum safety factor of 5 with regard to ultimate tensile, compressive, and shear strength.

1.05 PERFORMANCE REQUIREMENTS

A. Leakage shall comply with allowable limits set forth in AWWA C561.

1.06 SUBMITTALS

A. Submit information as specified in Section 01330 and Section 15050. In addition, submit information specified herein.

B. Layout and installation drawings for each gate size and type.

C. Complete bill of materials.

D. Gate operators: As specified in Section 13446 and 13447:
    1. Provide certification from both the motorized operator manufacturer and the gate manufacturer confirming that the proposed gate stem configuration has been coordinated with motorized operator selection:
        a. Confirm that the proposed gate stem configuration provides the most efficient combination of stem diameter, pitch and lead.
        b. Confirm the design will keep the operating temperature at the stem nut to a minimum during operation.
        c. Confirm the design will meet the specified motorized operator operating speed requirements.
    2. For coordination purposes, gate manufacturer shall supply calculations verifying the suitability of the selected motorized operator for the application. For each gate include:
        a. Open/close speed per Section 13447.
        b. The maximum torque required for operation of the gate (including breakaway from seat) with a safety factor of 1.4.
        c. The torque supplied by the motorized operator scheduled in Section 13447 for the operating speed specified in Section 13447.
        d. The thrust output capacity of the motorized operator with the furnished motor.

E. Wall thimbles design.

F. Manufacturer's installation instructions.

G. Design calculations:
    1. Submit calculations and design data substantiating conformance with the Drawings and Specifications.
    2. Gate opening and closing thrust forces that will be transmitted to the support structure with operator at extreme positions and load.
    3. Torque required to open and close the gate, including maximum torque at any point along gate travel. Indicate thrust valve and stem factor.
    4. Breakaway torque from seat. Indicate thrust valve and stem factor.

H. Detailed performance test procedures for factory and field-testing.

I. Operation and maintenance manual.

1.07 QUALITY ASSURANCE

A. Factory markings:
   1. Mark gates according to the scheduled equipment tag numbers when such numbers are used.
   2. Where thimbles, frames, and other components are not interchangeable, the components shall be match marked.

B. Manufacturer qualifications:
   1. Experience in production of substantially similar equipment during the 5 years prior to issuance of this contract, and able to submit evidence of satisfactory operation in at least 5 different installations.
   2. Manufacturer's shop welds, welding procedures, and welders: Qualified and certified in accordance with the requirements of AWS D1.6.
   3. Assembled gates: Shop inspected, adjusted, and tested before shipping.

1.08 WARRANTY

A. As specified in Section 15050 unless noted otherwise.

B. Warrant equipment free of defects in material and workmanship for 1 year from the date of acceptance or date of first beneficial use of the equipment by the Owner, whichever is later. Cover parts and labor.

C. Manufacturer’s warranty shall be issued in the Owner’s name.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: One of the following or equal:
   1. Golden Harvest, Series GH-100.
   2. Waterman Industries, Sentinel, III.
   3. Whipps, Series 900.

B. Operator anchor bolts and wall thimbles: Provided by manufacturer of slide gates.

2.02 MATERIALS

A. Stainless steel: ASTM A 276, Type 316:
   1. Components or structural shapes which are welded: ASTM A 276, Type 316L.
   2. All wetted and unwetted parts including all fasteners and hardware, except as specified herein, shall be stainless steel.

B. Ultra high molecular weight polyethylene: ASTM D 1248 and D 4020.

C. Neoprene: ASTM D 2000, Grade 2 BC 510.

D. Manganese bronze: ASTM B 584, UNS Number C86500 or Alloy 432.

E. Silicon bronze: ASTM B 584 UNS Number C87300.

2.03 COMPONENTS

A. Slide:
   1. Type 316L stainless steel.
   2. Rectangular or square.
   3. Fabricated with a flat plate reinforced with formed plates or structural members.

B. Frame:
   1. Construct gate frame of Type 316L stainless steel structural members or formed plate welded to form a rigid 1-piece frame.
   2. Mounting: As scheduled on the Drawings.
   3. Adjustable ultra high molecular weight polyethylene pressure pads.
   4. Flush bottom type unless otherwise scheduled on the Drawings.
   5. Allow replacement of top, side, and bottom seals without removing the gate frame from concrete or wall thimble.
   6. Machine surfaces matching with thimble. Provide seal between gate frame and thimble that will meet leakage performance requirements.
   7. Embedded gates: Extend frame to provide access to pressure pad adjusting screws (For seal design alternatives A and B only).

C. Yoke for self-contained gates:
   1. Type 316L stainless steel.
   2. Extend guides and frame so that bottom of yoke is at least 12 inches above top of slide at full open position.
   3. Bolt or weld to frame.
   4. Provide mounting plate on top of yoke to mount operator.
   5. Design yoke to allow removal of gate slide.

D. Guides:
   1. Type 316L stainless steel with ultra high molecular weight polyethylene insert in contact with gate.
   2. Minimum face width of 1 inch.
   3. Length: To support the slide fully in the open position.
   4. Anchor bolts shall not pass through the guides and seals.

E. Seals:
   1. Designed to achieve the specified leakage requirements.
   2. Sealing and sliding surfaces shall provide a low coefficient of friction with the surface of the slide.
   3. Field replaceable without removing gate from concrete or wall thimble.
   4. Anchor bolts shall not pass through the guides and seals.
   5. J-bulb seals are not acceptable.
   6. Minimum seating surface width: 3/4 inch in contact with slide.
   7. Bottom seal:
      a. Resilient neoprene, minimum durometer of 45.
      b. Attached to the bottom of the slide or embedded in gate frame invert.

8. Side and top seals:
    a. Neoprene crown seal with UHMWPE bearing bars.
    b. Attached to the slide with Type 304 stainless steel fasteners.
    c. Crown seal shall be actuated by water pressure in either the seating or unseating direction.
    d. Primary contact with the slide shall be through the UHMWPE bearing bar. The neoprene shall not be solely relied upon for the contact seal.
    e. Seal compression may be maintained by UHMWPE field adjustable pressure pads mounted to the guide with Type 304 stainless steel fasteners.

F. Stem:
1. Type 316 stainless steel.
2. Machine cut or rolled threads.
3. Stem couplings:
    a. Silicon bronze or Type 316 stainless steel.
    b. Threaded and keyed to stem or threaded and bolted to stem.
4. Stem guides:
    a. Type 316 stainless steel.
    b. Split collar.
    c. Adjustable in 2 directions.
    d. Ultra high molecular weight polyethylene bushing.
5. Provide manganese bronze stop collar on stem above actuator.
6. Drill and connect stem to slide structural sections with Type 316 stainless steel bolts.
7. Minimum Stem Diameter: 1-1/2 inch.
8. Coordinate the selection of the gate stem configuration with the gate operator and operating speed:
    a. The selected gate stem configuration shall provide the most efficient combination of stem diameter/pitch/lead and keep the operating temperature at the stem nut to a minimum during operation.
    b. For motorized applications, if the proposed gate stem configuration would result in any deviation from the operating rise rate specified in Section 13447, submit proposed deviation for approval by the Engineer.

G. Operating nut:
1. Locate at operator level.
2. Material: Manganese bronze.

H. Gate operators: As specified in Section 13446 and 13447.

I. Coordination with motorized operator supplier:
1. Sizes and model numbers of motorized operators for gates are estimated in Section 13447. Gate manufacturer’s responsibility shall extend to confirming these sizes and model numbers for each gate based on:
    a. Design seating and unseating head.
    b. Open/close speed specified in Section 13447.
    c. Torque safety factor of 1.4, minimum, applied to the maximum torque requirement, including breakaway from seat.
2. Verify, in writing, that the motorized operators are adequately sized.

3. If the motorized operators are not properly sized for each furnished gate, notify the Engineer immediately.
4. In the event that a different size or model is required for any gate, gate manufacturer shall advise Contractor of the proper selection and Contractor shall provide, at no additional cost, the proper operator.
5. The gate supplier shall machine the stem nuts, provide proper mounting adaptation, and adaptation hardware to ensure adequate interface between the motorized operators and the slide gates.

J. Bolts, nuts, and fittings: Type 316 stainless steel.

K. Anchor bolts:
1. Type 316 stainless steel.

2.04 WALL THIMBLES

A. Provide wall thimbles for gates where scheduled and as indicated on the Drawings.

B. F-section of a depth equal to the thickness of the structure wall upon which the gate is mounted:
1. Modify F-sections where required for F-section and pipe bell ring connections in a wall:
a. Provide flange-by-mechanical joint or flange by push on joint wall thimble where ductile iron piping connects to the wall thimble. Ensure that joint wall thimble has sufficient embedment to resist pipe thrust.
b. Provide flange-by-bell ring wall thimble insert where reinforced concrete piping connects to the wall thimble.

C. Fabricated Type 316L stainless steel of sufficient section to resist permanent distortion; minimum 3/8 inch thick plate.

D. Width of mounting flange of wall thimble: 1/2 inch wider than mounting flange of gate.

E. Fully machine front flange of thimble to a plane Drill and tap to match the drilling on the flange back gate seat.

F. Clearly mark top center of each thimble for installation.

G. Provide Type 316 stainless steel studs for attaching the gate frame.

H. Seal joint between thimble and gate watertight, in accordance with AWWA C 561.

I. To permit entrapped air to escape as the thimble is being cast in concrete, drill holes in each entrapment zone formed by ribs, flanges, and water stops.

J. Provide annular weep ring to control seepage and resist thrust, where needed to anchor the pipe thrust restraint system:
1. Continuously weld weep ring to outside of the wall thimble.
2. Weep ring shall be minimum 1/4 inch thick and minimum 2 inches deep.

2.05 FINISHES

A. Stainless steel:
   1. Shot blast gates and wall thimbles after fabrication to remove weld splatter and to polish scratches.
   2. Clean the entire surface to produce an even color and sheen.

B. Operators, stands, and other accessory equipment: Surface preparation, factory prime, field prime, and finish coats as specified in Section 09960.

2.06 FABRICATION

A. Shop assembly:
   1. Gates shall be factory assembled, adjusted, and tested.
   2. Mount all accessories and appurtenances including, but not limited to, motor operators and limit switches so that the complete system may be tested at the factory.

2.07 SOURCE QUALITY CONTROL

A. Factory testing:
   1. All gates shall be factory assembled and tested before shipment.
   2. Test equipment as specified in Section 15958.
   3. Operational testing:
      a. Test functionality of all controls and limit switches.
   4. Leakage test:
      a. Verify compliance with allowable leakage limits as specified.
      b. Conduct in accordance with AWWA C 561.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as indicated on the Drawings and in strict conformance with the manufacturer's installation instructions, shop drawings, and recommendations.

B. Mount thimbles and gates plumb in both vertical planes and level in horizontal plane.

C. Coat seating surfaces between frame and wall thimble with a waterproof plastic compound or provide EPDM gasket prior to tightening frame studs.

D. Adjust wedges or other parts of the gate to the point where it will not be possible to insert a 0.004 inch feeler gauge between the gate slide and the gate frame at any point:
   1. Securely lock wedges into position after adjustment.

E. Adjust limit switches in electric and hydraulic operators in accordance with manufacturer's instructions.

F. Face mounted gates:
   1. Where wall thimbles are not provided, mount gate to wall with anchor bolts and provide a 1-inch grout pad in accordance with manufacturer's recommendations.

G. Embedded gates:
   1. Provide blockouts in sidewalls and channel bottom for installation of gates.
   2. After gate placement, adjustment, and alignment in accordance with manufacturer's recommendations, grout frame with non-shrink grout.

3.02 FIELD QUALITY CONTROL

A. Testing:
   1. Leakage tests: Conduct in accordance with AWWA C 561. Comply with specified allowable leakage limits.
   2. After gate installation and checking, run gates through at least 2 full cycles from the closed position to full open position and back to the closed position.
   3. Verify functionality of all switches and controls.
   4. Provide certificate of proper installation. Comply with Section 01756.

B. Manufacturer's field services:
   1. Contractor shall furnish services of a qualified manufacturer's representative experienced in installation and operation of the gates.
   2. Contractor shall coordinate field service work with the manufacturer's representative, Owner, and Engineer prior to initiating field service work.
   3. Manufacturer's representative shall perform the services described below and specified in Section 01756:
      a. Installation assistance and inspection:
         1) Advise/observe the Contractor on the installation of the gates.
         2) Check and verify that installation of the gates is in accordance with the Drawings and manufacturer's installation instructions.
      b. Field testing.
      c. Certification of proper installation.
      d. Training of Owner's personnel.

3.03 SCHEDULE

A. The Slide Gate Schedule is included on the following page. The Slide Gate Schedule is not a take-off list. Contractor shall provide additional gates per specifications and as indicated on the Drawings.

HEAVY-DUTY FABRICATED STAINLESS STEEL SLIDE GATE SCHEDULE													
Gate Tag Number or Mark Number	**Drawing Number**	**Location**	**Opening Size W X H (inches)**	**Wall Opening Shape**	**Gate Opening Direction**	**Type of Closure[1]**	**Gate Design Pressure[2]**		**Gate Mounting[3]**	**Type of Frame[4]**	**Stem Type[5]**	**Type of Operator[6]**	**Minimum Gate Travel (inch)**
							Seating (feet)	**Unseating (feet)**					
GAT-0441	01YS02/01 YS03	Mixed Liquor Flume 4	66×52	Rectangular	Downward	DO	15	15	FM	SC	RS	MO, FS	52"
GAT-0451	01YS02/01 YS03	Mixed Liquor Flume 5	66×52	Rectangular	Downward	DO	15	15	FM	SC	RS	MO, FS	52"
GAT-2701	03M01/03 M02	RAS PUMP STATION NO.2	40×40	Rectangular	Upward	FB	20	20	FM	NSC	RS	CO, FS	48“
GAT-2702	03M01/03 M02	RAS PUMP STATION NO.2	40×40	Rectangular	Upward	FB	20	20	FM	NSC	RS	CO, FS	40”
GAT-2703	03M01/03 M02	RAS PUMP STATION NO.2	24×24	Rectangular	Upward	FB	20	20	FM	NSC	RS	CO, FS	24“
GAT-2711	03M01/03 M02	RAS PUMP STATION NO.2	40×40	Rectangular	Upward	FB	20	20	FM	NSC	RS	CO, FS	40"
GAT-2721	03M01/03 M02	RAS PUMP STATION NO.2	40×40	Rectangular	Upward	FB	20	20	FM	NSC	RS	CO, FS	40"
GAT-2731	03M01/03 M02	RAS PUMP STATION NO.2	40×40	Rectangular	Upward	FB	20	20	FM	NSC	RS	CO, FS	40"

HEAVY-DUTY FABRICATED STAINLESS STEEL SLIDE GATE SCHEDULE													
Gate Tag Number or Mark Number	**Drawing Number**	**Location**	**Opening Size W X H (inches)**	**Wall Opening Shape**	**Gate Opening Direction**	**Type of Closure(1)**	**Gate Design Pressure(2)**		**Gate Mounting(3)**	**Type of Frame(4)**	**Stem Type(5)**	**Type of Operator(6)**	**Minimum Gate Travel (inch)**
							Seating (feet)	**Unseating (feet)**					
Notes: (1) Closure: DO = Downward Opening; FB = Flush Bottom; STD = Standard. See Typical Details P718 and P720 for additional installation details. (2) Gate design pressure applied at centerline of gate. (3) Mounting: FM = Face Mounted; EC = Inside Existing Channel; EMB = Embedded; SP = Spigotback; FWT = "F" Wall Thimble; EWT = "E" Wall Thimble; See Typical Details P716 and P717 for additional installation details. (4) Frame: SC = Self-Contained; NSC = Non-Self Contained; F = Flatback; FL = Flangeback. (5) Stem: RS = Rising Stem; NRS = Non-Rising Stem. (6) Operator: CO = Handcrank operator with 2-inch AWWA nut for portable operator; HW = Handwheel; HC = Handcrank; MO = Motor Operator; MOD = Modulating Motor Operator; HO = Hydraulic Operator; MHO = Manual Hydraulic Operator (Hand Pump); BS = Bench Stand; FS = Floor Stand; IFS = Interconnect Floor Stand; PS = Pedestal Support.													

END OF SECTION

SECTION 11294C

OWNER SUPPLIED HEAVY-DUTY FABRICATED STAINLESS STEEL SLIDE GATES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Owner supplied heavy-duty fabricated stainless steel slide gates installed at the Aeration Basin Nos. 4-7 splitter box.

B. Related sections:
   1. Section 01756 - Commissioning and Process Start-Up.
   2. Section 15050 – Common Work Results for Mechanical Equipment.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

B. American Water Works Association (AWWA):
   1. AWWA C 561 - Fabricated Stainless Steel Slide Gates.

C. American Welding Society (AWS):
   1. D1.6 - Structural Welding Code-Stainless Steel.

D. ASTM International (ASTM):
   1. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   2. B 584 - Standard Specifications for Copper Alloy Sand Castings for General Application.
   3. D 1248 - Standard Specification for Polyurethane Plastics Extrusion Materials for Wire and Cable.
   4. D 2000 - Standard Classification for Rubber Products in Automotive Applications.
   5. D4020 - Standard Specification for Ultra-High Molecular-Weight Polyethylene Molding and Extrusion Materials.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Gate supplied by Owner. See appendix for details.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as indicated on the Drawings and in strict conformance with the manufacturer's installation instructions, shop drawings, and recommendations.

B. Mount thimbles and gates plumb in both vertical planes and level in horizontal plane.

C. Coat seating surfaces between frame and wall thimble with a waterproof plastic compound or provide EPDM gasket prior to tightening frame studs.

D. Adjust wedges or other parts of the gate to the point where it will not be possible to insert a 0.004 inch feeler gauge between the gate slide and the gate frame at any point:
   1. Securely lock wedges into position after adjustment.

E. Adjust limit switches in electric and hydraulic operators in accordance with manufacturer's instructions.

F. Face mounted gates:
   1. Where wall thimbles are not provided, mount gate to wall with anchor bolts and provide a 1-inch grout pad in accordance with manufacturer’s recommendations.

G. Embedded gates:
   1. Provide blockouts in sidewalls and channel bottom for installation of gates.
   2. After gate placement, adjustment, and alignment in accordance with manufacturer’s recommendations, grout frame with non-shrink grout.

3.02 FIELD QUALITY CONTROL

A. Testing:
   1. Leakage tests: Conduct in accordance with AWWA C 561. Comply with specified allowable leakage limits.
   2. After gate installation and checking, run gates through at least 2 full cycles from the closed position to full open position and back to the closed position.
   3. Verify functionality of all switches and controls.
   4. Provide certificate of proper installation. Comply with Section 01756.

B. Manufacturer’s field services:
   1. Contractor shall furnish services of a qualified manufacturer’s representative experienced in installation and operation of the gates.
   2. Contractor shall coordinate field service work with the manufacturer’s representative, Owner, and Engineer prior to initiating field service work.
   3. Manufacturer’s representative shall perform the services described below and specified in Section 01756:
      a. Installation assistance and inspection:
         1) Advise/observe the Contractor on the installation of the gates.
         2) Check and verify that installation of the gates is in accordance with the Drawings and manufacturer’s installation instructions.

b. Field testing.
c. Certification of proper installation.
d. Training of Owner's personnel.

3.03 SCHEDULE

A. The Slide Gate Schedule is included on the following page. Shop drawing for Owner Supplied Gate at Aeration Basin Nos. 4-7 Splitter Box is provided in Appendix A.

OWNER SUPPLIED HEAVY-DUTY FABRICATED STAINLESS STEEL SLIDE GATE SCHEDULE

Gate Tag Number or Mark Number	Drawing Number	Location	Opening Size W X H (inches)	Wall Opening Shape	Gate Opening Direction	Type of Closure(1)	Gate Design Pressure(2)		Gate Mounting(3)	Type of Frame(4)	Stem Type(5)	Type of Operator(6)	Minimum Gate Travel (inch)
							Seating (feet)	Unseating (feet)					
GAT-YS03	01YS11	Aeration Basin Nos. 4-7 Splitter Box	See Appendix A	See Appendix A	See Appendix A	See Appendix A	See Appendix A	See Appendix A	See Appendix A	See Appendix A	See Appendix A	See Appendix A	See Appendix A

Notes:

(1) Closure: DO = Downward Opening; FB = Flush Bottom; STD = Standard. See Typical Details P718 and P720 for additional installation details.

(2) Gate design pressure applied at centerline of gate.

(3) Mounting: FM = Face Mounted; EC = Inside Existing Channel; EMB = Embedded; SP = Spigotback; FWT = "F" Wall Thimble; EWT = "E" Wall Thimble; See Typical Details P716 and P717 for additional installation details.

(4) Frame: SC = Self-Contained; NSC = Non-Self Contained; F = Flatback; FL = Flangeback.

(5) Stem: RS = Rising Stem; NRS = Non-Rising Stem.

(6) Operator: CO = Handcrank operator with 2-inch AWWA nut for portable operator; HW = Handwheel; HC = Handcrank; MO = Motor Operator; MOD = Modulating Motor Operator; HO = Hydraulic Operator; MHO = Manual Hydraulic Operator (Hand Pump); BS = Bench Stand; FS = Floor Stand; IFS = Interconnect Floor Stand; PS = Pedestal Support.

APPENDIX A

LETTER OF TRANSMITTAL
GOLDEN HARVEST, INC.

APPENDIX A

LETTER OF TRANSMITTAL

GOLDEN HARVEST, INC.
"GOLDEN GATES"
11944 WESTAR LANE
BURLINGTON, WA 98233
360-757-4334
sherryd@goldenharvestinc.com
Goldenharvestinc.com

TO: Overaa Construction			Submittal #1
200 Parr Blvd.			
Richmond, CA 94801			
PHONE: 510-234-0926			**SENT VIA: richp@overaa.com**
JOB NAME: Headworks & Secondary Treatment Capacity Expansion / Turlock, CA			
GH JOB NO.	**DATE**	**CUSTOMER P.O.**	**ATTENTION**
14-0642	9-25-14	3250-229	Rich Pappas

REMARKS:

→ **These documents are submitted for your approval. Manufacturing of this project will not proceed until we receive submittal approvals. FOR RECORD drawing submittals do not need to be approved.**

→ **You may approve submittals by email or fax, by noting the approval on this form and returning it to Golden Harvest, Attn: Sherry at 360-757-1135 (fax) or sherryd@goldenharvestinc.com.**

→ **If you have any questions about the status of your project, please contact Sherry at 800-338-6238 or sherryd@goldenharvestinc.com.**

COPIES	PAGES	DESCRIPTION
1	1-6	Lift & Stem and Gate Calculations
1	1-1	Stainless Steel Sluice Gate Drawing

Lift and Stem Calculations

Project Type: Water Control Facility
Project Location: Turlock, CA
GHI Job Number: 12-0506
Tag #'s GAT-SB01
GHI Drawing Number 14-0642

Date: September 19th, 2014

Force to operate is equal to:
62.4#/ft^3(weight density of water) x Area (ft^2) x Water Depth to Center line (ft) x .35 (operating coefficient of friction) + Slide weight + stem weight
Fo=

62.4	lbs/cu-ft*	12.25	sq-ft*	13.25	ft*	0.35	+	237	lbs+	150	lbs=	**3932**	lbs

The lift capacity for the unit offered is 3,950 lbs with a 25 lb pull
(the proposed lift meets the specification requirements to operate the gate)

The maximum unsupported stem length for the threaded section of stem is 59 inches.
The resultant l/r ratio for a 1.5 inch diameter stem is: 192
The calculated critical load for a 1.5 diameter threaded stem at an l/r of 192 is: **17,836 lbs**

Dividing the critical load by the lift capacity yields the safety factor:
17,836÷3,950=4.51

Run Torque requirement: =31 ft-lbs
Start torque requirement: =39 ft-lbs

GOLDEN HARVEST, INC. **Yoke Section Properties**
BURLINGTON, WA.

Sheet: of
Page: 1 of 1
By: JRN
Date: 9/23/2014
Checked by:
Date:

Project Location: Turlock, Ca.
GHI Job#: 14-0642
REF GHI Drawing #: 1 Tag# GAT-SB01

Material: 316L Stainless Steel per ASTM A-240
Fu = 75,000 psi
Fy = 30,000 psi

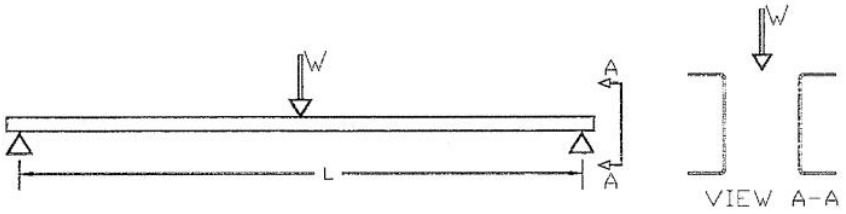
Allowed Stress(Sa) = 15000 psi
E = 28000000 psi
l/r = 720
Max. allowed deflection (δ)= 0.058 inches at center of span

**** Thrust Required (W):** 6320.0 lbs
Gate Width (L): 42 inches

$$Z_R = \left(\frac{W * L}{2*4 * S_A}\right) \qquad I_R = \frac{W*L^3}{2*48*E*\text{deflection}}$$

Required Section Properties	**(per member)**
Moment of Inertia req'd (Ir)	2.99 in^4
Section Modulus req'd (Zr)	2.21 in^3

The yoke members are simply supported beams with a load at the center of the span



Yoke Member is: 2.5 x 5 x 2.5 x 1/4" formed channel.

From computer analysis the section properties are

Ix	**Zx**
8.31 in^4	3.32 in^3

The section properties of the selected yoke members exceed the requirements

Calculated Stress : $S_A = \left(\frac{W * L}{2*4 * Z}\right)$ = 9994 psi < 15000 psi

Calculated Deflection at load: $\delta = \frac{W*L^3}{2*48*E*I}$ = 0.021 inches < 0.058 inches

** Thrust requirement is taken from the lift and stem calculations.

GATE HEAD CALCULATIONS

Project Location: Turlock, Ca.
GHI Job Number: 14-0642
GHI Drawing Number: 1 of 1

Date: September 23, 2014
By: JRN

INPUTS

Gate head stiffener at Invert

GATE PARAMETERS

GATE WIDTH, a =	42.00	in	[1067 mm]
GATE HEIGHT, b =	42.00	in	[1067 mm]
HEAD, H =	15.00	ft (to stiff.)	[4.57 m]

MATERIAL INFORMATION

MATERIAL: STAINLESS STEEL, TYPE 316
ALLOWABLE STRESS: Sa=1/5 Su

Sa =	15000	psi	[1055 kgf/cm²]
E =	28000000	psi	[1968601 kgf/cm²]

STRUCTURAL INFORMATION

PLATE THICKNESS, t =	0.25	in	[6.4 mm]
ZONE HEIGHT =	6	in	[152 mm]
L/r =	1000		
STIFFENING RIB =	Formed Angle, 3x2x1/4		
DOUBLE SKINNED	NO		
QTY RIBS =	4		
ZONE LOAD =	1,636	lbf	[742 kgf]
ALLOWABLE DEFLECT. =	0.04	in	[1.1 mm]

$< 1/16 = 0.063"$

RESULTS

STRESS AND DEFLECTION

PLATE STRESS =	1871	psi	[132 kgf/cm²]
MAX ZONE STRESS =	4863	psi	[342 kgf/cm²]
ZONE DEFLECTION =	0.014	in	[0.4 mm] OK
TOP RIB DEFLECTION=	0.011	in	[0.3 mm]

FRAME INFORMATION

FRAME LOAD =	136	lbf/in	[24.4 kgf/cm]

GH-46/66 FRAME = HEAVY
GH-100 FRAME = GH-100-150
GH-29 FRAME = GH-29-250
GH-27 FRAME = NA

ESTIMATED WEIGHT

HEAD WEIGHT =	272	lbf	[123 kgf]
10% :	27	lbf	[12 kgf]
TOTAL =	299	lbf	[136 kgf]

** Calculations use imperial units with a final conversion to metric values**

rev 1.4.1

ANALYSIS OF GATE HEAD

Gate head stiffener at Invert

DESIGN PARAMETERS

DESIGN HEAD TO STIFFENER (H)

15.00 ft [4.57 m]

MATERIAL: STAINLESS STEEL, TYPE 316

MATERIAL PROPERTIES

S_u = 75000 psi [5273 kgf/cm²]

S_y = 30000 psi [2109 kgf/cm²]

ALLOWABLE STRESS

Sa=1/5 Su = 15000 psi [1055 kgf/cm²]

ALLOWABLE DEFLECTION

$f = L/r = \frac{42.00}{1000} = 0.04$ in [1.1 mm]

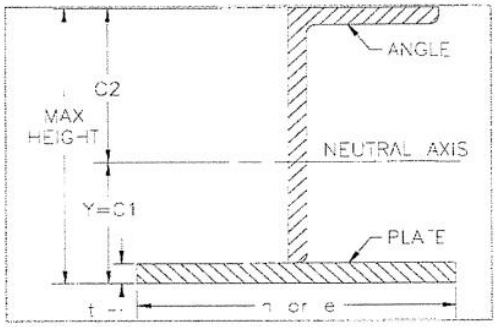
GATE CHARACTERISTICS

GATE WIDTH (a): 42.00 in [1067 mm]

GATE HEIGHT (b): 42.00 in [1067 mm]

STIFFENER SIZE: Formed Angle, 3x2x1/4

PLATE THICKNESS (t): 0.25 in [6.4 mm]



LOADING

ZONE HEIGHT (h): 6 in [152 mm]

WATER DENSITY (ω) 0.0361 lbf/in³ [1000 kgf/m³]

ZONE LOAD (P) = a*h*ω*H :

P = 1,636 lbf [742 kgf]

SUPPORTING PLATE WIDTH (e):

$e = \frac{2 \cdot 95 \cdot t}{\sqrt{S/_{1000}}} =$ 8.67 in [220 mm] (The lesser value of ***h*** or ***e*** will be used in section calculation)

SECTION CALCULATIONS

ELEMENT	Height in [cm]	Width in [cm]	A in² [cm²]	Dist. to N.A. (X) in [cm]	Moment (AX) in³ [cm³]	Moment (AX²) in⁴ [cm⁴]	I in⁴ [cm⁴]
Plate	0.25 [0.64]	6.00 [15.24]	1.50 [9.68]	0.125 [0.318]	0.19 [3.07]	0.02 [0.98]	0.01 [0.33]
Stiffener	3.00 [7.62]		1.15 [7.42]	2.22 [5.64]	2.55 [41.84]	5.67 [235.91]	1.05 [43.70]
Totals			2.65 [17.10]		2.74 [44.91]	5.69 [236.88]	1.06 [44.03]

$\bar{Y} = \frac{\sum A * X}{\sum A} =$ 1.03 in [2.63 cm] DISTANCE TO NEUTRAL AXIS

$I = \sum I_o + \sum A * X^2 - \sum A * \bar{Y}^2 =$ 3.91 in⁴ [162.9 cm⁴] MOMENT OF INERTIA

$C1 = \bar{Y} =$ 1.03 in [2.63 cm]

$C2 = MAXHEIGHT - \bar{Y} =$ 2.22 in [5.63 cm]

$Z1 = \frac{I_o}{C1} =$ 3.79 in³ [62.0 cm³] SECTION MODULUS '1'

$Z2 = \frac{I_o}{C2} =$ 1.77 in³ [29.0 cm³] SECTION MODULUS '2'

STRESS AND DEFLECTION

$S_{MAX} = \frac{P * a}{8 * Z} =$ 4863 psi [342 kgf/cm²] MAX ZONE STRESS

$f = \frac{5 * P * a^3}{384 * E * I} =$ 0.014 in [0.4 mm] MAX DEFLECTION

GATE HEAD CALCULATIONS

Project Location: Turlock, Ca. **Date:** September 23, 2014
GHI Job Number: 14-0642 **By:** JRN
GHI Drawing Number: 1 of 1 Page 3 of 4

INPUTS

Gate head stiffener at 12" above invert

GATE PARAMETERS

GATE WIDTH, a =	42.00	in	[1067 mm]
GATE HEIGHT, b =	42.00	in	[1067 mm]
HEAD, H =	14.00	ft (to stiff.)	[4.27 m]

MATERIAL INFORMATION

MATERIAL:	STAINLESS STEEL, TYPE 316		
ALLOWABLE STRESS:	Sa=1/5 Su		
Sa =	15000	psi	[1055 kgf/cm²]
E =	28000000	psi	[1968601 kgf/cm²]

STRUCTURAL INFORMATION

PLATE THICKNESS, t =	0.25	in	[6.4 mm]
ZONE HEIGHT =	12	in	[305 mm]
L/r =	1000		
STIFFENING RIB =	Formed Angle, 3x2x1/4		
DOUBLE SKINNED	NO		
QTY RIBS =	4		
ZONE LOAD =	3,055	lbf	[1385 kgf]
ALLOWABLE DEFLECT. =	0.04	in	[1.1 mm]

< 1/16 = 0.063

RESULTS

STRESS AND DEFLECTION

PLATE STRESS =	6983	psi	[491 kgf/cm²]
MAX ZONE STRESS =	8825	psi	[620 kgf/cm²]
ZONE DEFLECTION =	0.024	in	[0.6 mm] OK
TOP RIB DEFLECTION=	0.019	in	[0.5 mm]

FRAME INFORMATION

FRAME LOAD =	127	lbf/in	[22.7 kgf/cm]
GH-46/66 FRAME =	HEAVY		
GH-100 FRAME =	GH-100-150		
GH-29 FRAME =	GH-29-250		
GH-27 FRAME =	NA		

ESTIMATED WEIGHT

HEAD WEIGHT =	224	lbf	[102 kgf]
10% :	22	lbf	[10 kgf]
TOTAL =	247	lbf	[112 kgf]

** Calculations use imperial units with a final conversion to metric values**

rev 1.4.1

ANALYSIS OF GATE HEAD

Gate head stiffener at 12" above invert

DESIGN PARAMETERS

DESIGN HEAD TO STIFFENER (H)
14.00 ft [4.27 m]

MATERIAL: STAINLESS STEEL, TYPE 316

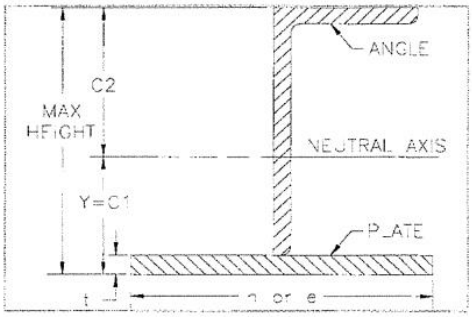
MATERIAL PROPERTIES
S_u = 75000 psi [5273 kgf/cm²]
S_y = 30000 psi [2109 kgf/cm²]

ALLOWABLE STRESS
Sa=1/5 Su = 15000 psi [1055 kgf/cm²]

ALLOWABLE DEFLECTION
$f = L/r = \frac{42.00}{1000} =$ 0.04 in [1.1 mm]

GATE CHARACTERISTICS

GATE WIDTH (a): 42.00 in [1067 mm]
GATE HEIGHT (b): 42.00 in [1067 mm]
STIFFENER SIZE: Formed Angle, 3x2x1/4
PLATE THICKNESS (t): 0.25 in [6.4 mm]



LOADING

ZONE HEIGHT (h): 12 in [305 mm]
WATER DENSITY (ω) 0.0361 lbf/in³ [1000 kgf/m³]
ZONE LOAD (P) = a*h*ω*H :
P = 3,055 lbf [1385 kgf]
SUPPORTING PLATE WIDTH (e):

$$e = \frac{2 \cdot 95 \cdot t}{\sqrt{S_y / 1000}} =$$ 8.67 in [220 mm] (The lesser value of ***h*** or ***e*** will be used in section calculation)

SECTION CALCULATIONS

ELEMENT	Height in [cm]	Width in [cm]	A in² [cm²]	Dist. to N.A. (X) in [cm]	Moment (AX) in³ [cm³]	Moment (AX²) in⁴ [cm⁴]	I in⁴ [cm⁴]
Plate	0.25 [0.64]	8.67 [22.02]	2.17 [13.98]	0.125 [0.318]	0.27 [4.44]	0.03 [1.41]	0.01 [0.47]
Stiffener	3.00 [7.62]		1.15 [7.42]	2.22 [5.64]	2.55 [41.84]	5.67 [235.91]	1.05 [43.70]
Totals			3.32 [21.40]		2.82 [46.28]	5.70 [237.32]	1.06 [44.17]

$$\bar{Y} = \frac{\sum A*X}{\sum A} =$$ 0.85 in [2.16 cm] DISTANCE TO NEUTRAL AXIS

$$I = \sum I_o + \sum A*X^2 - \sum A*\bar{Y}^2 =$$ 4.36 in⁴ [181.4 cm⁴] MOMENT OF INERTIA

$C1 = \bar{Y} =$ 0.85 in [2.16 cm]

$C2 = MAXHEIGHT - \bar{Y} =$ 2.40 in [6.09 cm]

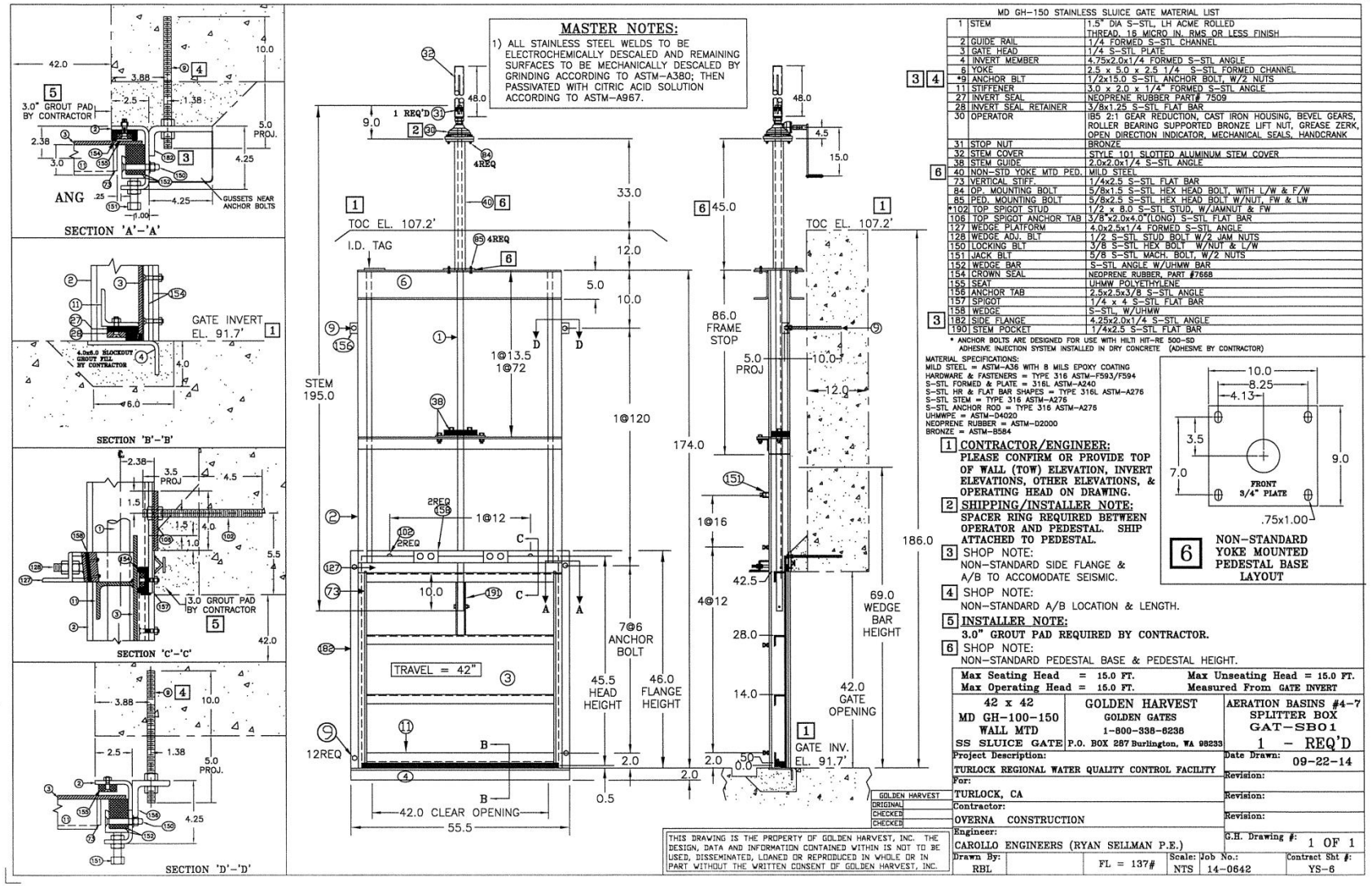
$$Z1 = \frac{I_o}{C1} =$$ 5.12 in³ [83.9 cm³] SECTION MODULUS '1'

$$Z2 = \frac{I_o}{C2} =$$ 1.82 in³ [29.8 cm³] SECTION MODULUS '2'

STRESS AND DEFLECTION

$$S_{MAX} = \frac{P*a}{8*Z} =$$ 8825 psi [620 kgf/cm²] MAX ZONE STRESS

$$f = \frac{5*P*a^3}{384*E*I} =$$ 0.024 in [0.6 mm] MAX DEFLECTION



END OF SECTION

SECTION 11312G

SUBMERSIBLE LARGE CAPACITY CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for provision of pump systems including submersible non-clog motor-driven pumps for service as scheduled.

B. Related sections:
1. Section 01140 - Work Restrictions.
2. Section 01600 - Product Requirements.
3. Section 01610 - Project Design Criteria.
4. Section 01756 - Commissioning.
5. Section 01782 - Operation and Maintenance Data.
6. Section 01783 - Warranties and Bonds.
7. Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
8. Section 09960 - High-Performance Coatings.
9. Section 15050 - Common Work Results for Mechanical Equipment.
10. Section 15958 - Mechanical Equipment Testing.
11. Section 16222 - Low Voltage Motors up to 500 Horsepower.
12. Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower.

C. The Owner has pre-qualified and pre-negotiated with Xylem Flygt (this arrangement is referred to herein as “Supplier/Manufacturer”) a cost proposal for providing the Submersible Large Capacity Centrifugal Pumps. Unless stated otherwise, the cost proposal for the Submersible Large Capacity Centrifugal Pumps includes equipment and accessories as specified in this section. The pre-negotiated price quotation for the Submersible Large Capacity Centrifugal Pumps is $103,505. A copy of the cost proposal from the Supplier datedMarch 16, 2017, is for the Contractor’s informational use and reference only. The price quotation is valid until 120 days from Bid Opening. A copy is attached at the end of this Section. The Contractor shall purchase the equipment from the Supplier/Manufacturer and shall install the equipment as part of this Project. However, the Contractor is allowed, prior to opening bid, to negotiate with the Supplier/Manufacturer the cost, terms, and conditions for the purchase of the system and accessories to be furnished by the Contractor as part of this project to provide a complete working system.

D. Cost of Pre-negotiated Items:
1. The Contractor shall carefully review the applicable pre-negotiated proposal to determine those items required by the Contract Documents which are not part of the proposal or specified Supplier/Manufacturer’s scope of supply. In addition to the cost indicated for the applicable bid item in the pre-negotiated proposal, the Contractor shall include in his bid the costs for the following:
    a. All items not specifically itemized in the Supplier/Manufacturer’s Scope of Supply provided as part of the pre-negotiated proposal, but required by the Contract Documents and/or necessary to provide a complete and operational system.

b. All items specifically itemized in the Supplier/Manufacturer's Scope of Supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by customer, provided by Owner, or any similar designation.
c. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.
d. Any additional cost required by the supplier due to any charges the Contractor may wish to make to the terms and/or conditions of the pre-negotiated proposal, including but not limited to payment terms, delivery schedule, scope or work, etc.

1.02 REFERENCES

A. American Bearing Manufacturers' Association (ABMA):
1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. ASTM International (ASTM):
1. A48 - Standard Specification for Gray Iron Castings.
2. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
4. A582 - Standard Specification for Free-Machining Stainless Steel Bars.
5. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant, for General Application.
6. B148 - Standard Specification for Aluminum-Bronze Sand Castings.
7. B505 - Standard Specification for Copper Alloy Continuous Castings.
8. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
9. E10 - Standard Test Method for Brinell Hardness of Metallic Materials.
10. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
11. F594 - Standard Specification for Stainless Steel Nuts. CSA International (CSA).

C. Food and Drug Administration (FDA).

D. FM Global (FM).

E. Hydraulic Institute (HI):
1. 1-1.2 - Centrifugal Pumps for Nomenclature and Definitions.
2. 1.3 – Rotodynamic (Centrifugal) Pumps for Design and Application.
3. 9.1-9.5 – Pumps - General Pump Standards for Types, Definitions, Application, and Sound Measurements and Decontamination.
4. 14.6 - Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

F. Insulated Cable Engineer's Association (ICEA).

G. National Electrical Code (NEC).

H. National Electrical Manufacturers Association (NEMA).

I. Underwriters Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.2, 1.3, 9.1-9.5 and 14.06 and as modified in the Specifications.

B. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 SYSTEM DESCRIPTION

A. Submersible pumps and components: Submersible pump, motor driver, electrical cable, lifting eyes, lifting chain and guide rails, guide rail supports, self-aligning discharge connection, and other items specified in the Pump Schedule as required for complete operational units.

B. Design requirements:
   1. Pump performance characteristics:
      a. As specified in the Pump Schedule.
      b. Performance tolerances shall be the same as the test tolerances specified in Section 15958.
   2. Motor characteristics: As specified in the Pump Schedule.

1.05 SUBMITTALS

A. Submit as specified in Sections 15050.

B. Furnish motor submittals as specified in Section 16222.

C. Manufacturer's Representatives qualifications as specified in Section 01756.

D. Provide vendor operation and maintenance manual as specified in Section 01782.

1.06 QUALITY ASSURANCE

A. As specified in Section 15050.

B. Provide pumps in this Section from same manufacturer.

C. Manufacture's Certificate of Installation and Functionality Compliance as specified in Section 01756.

D. Pump manufacturer shall coordinate with variable frequency drive supplier. Provide all necessary motor data to the variable frequency drive supplier to allow certification that the variable frequency drive is sized for the full nameplate motor horsepower, full load current, torque and starting characteristics of the driven load at the installed altitude and ambient temperature.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050.

1.08 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 01610.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate with restrictions as specified in Section 01140.

B. Coordinate work with Commissioning and Start-up as specified in Section 01756.

1.10 WARRANTY

A. As specified in Section 01783.

1.11 MAINTENANCE

A. Special tools: Deliver 1 set for every furnished pump type and size needed to assemble and disassemble pump system.

B. Spare parts: Provide 1 of the following for each size or type of pump; deliver as specified in Section 01600.

C. Spare parts: Deliver the following as specified in Section 01600:
   1. Upper bearing set.
   2. Lower bearing set.
   3. Upper and lower mechanical seal set.
   4. Wear ring set (rotating and stationary).
   5. Casing seal gaskets or O-rings.
   6. Power cable entry seal set.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pump: By the following manufacturer, no equal:
   1. Xylem Flygt, NP series.

2.02 MATERIALS

A. General: When materials are referenced in this Section or on the pump schedule, the compositions shall be the UNS Alloys, Types, or Grades unless specified or scheduled otherwise.

B. Cast iron: ASTM A48, Class 35 B minimum.

C. Nickel cast iron: ASTM A48, Class 35 minimum with 3 percent nickel added.

D. Steel: ASTM A108, Grade or UNS Alloy as specified or scheduled.

E. Stainless steel: ASTM A276 or ASTM A582, Type or UNS Alloy as specified or scheduled.

F. Bronze: ASTM B505 or ASTM B584, UNS Alloy C83600.

G. Zincless bronze: ASTM B505 or ASTM B584, Leaded Tin Bronze, UNS Alloy C92700.

H. Aluminum bronze: ASTM B148, ASTM B505 or ASTM B584, UNS Alloy C95200.

I. Fasteners: Stainless steel, ASTM F593 or ASTM F594, type or grade as specified.

J. Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron.

2.03 PUMP CASINGS

A. Type: 2 piece; pump and motor casing bolted together; machined seal faces with Nitrile or Buna N rubber O-ring seal; Type 304 stainless steel bolting.

B. Material: As scheduled.

C. Construction: Of sufficient strength, weight, and thickness to provide accurate alignment and watertightness.

D. Design working pressure: Minimum 1.10 times maximum shutoff total dynamic head with maximum installable impeller diameter at maximum operating speed plus maximum suction static head; suitable for submergence in up to 65 feet of water.

E. Discharge interface:
   1. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact.
   2. Self-aligning without bolting or having to enter the wet well.

2.04 IMPELLERS

A. Type: As scheduled.

B. Material: As scheduled.

C. Maximum number of vanes: As scheduled.

D. Water passages: Smooth, able to prevent clogging by stringy or fibrous and to pass spherical solids of size scheduled.

E. Method of securing to shafts: Keyed and secured by bronze or stainless steel nut or allen head bolt locked in place, but readily removable without use of special tools.

F. Rotation: Clockwise looking from driver, unless otherwise indicated on the Drawings.

G. Balance: As specified in Section 15050 to meet the vibration criteria as specified in Section 15958.

2.05 WEAR RINGS AND WEAR PLATES

A. Provide one of the following systems:

1. Wear plate system:
    a. Material:
        1) The pump volute shall be a single piece grey cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller.
        2) Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s).
        3) The insert ring shall be cast of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi-vane semi-open impeller and the volute housing.
    b. Attached to the pump volute to prevent rotation.
    c. Replaceable and adjustable to maintain proper clearances between the wear plate and the impeller.

2.06 PUMP SHAFTS

A. Material: As scheduled at the end of Execution section of this Section, turned, ground, and polished.

B. Strength: Able to withstand minimum 1.5 times maximum operating torque and other loads.

C. Resonant frequency: As specified in Sections 15050 and 15958.

D. Deflection: Maximum 0.002 inches under operating conditions.

2.07 MECHANICAL SEALS

A. Provide dual tandem mechanical seal system with oil for seal lubrication and cooling:
    1. Shaft sealing system shall be capable of withstanding volute pressure up to 1.5 times pump shutoff head.
    2. No seal damages shall result from operating the pumping unit in its liquid environment, from running pump dry, or from reverse pump operation.

B. Oil chamber:
    1. Provide oil chamber for shaft sealing system. Design oil chamber to assure that air is left in the oil chamber to absorb the expansion of the oil due to temperature variations.
    2. Provide drain and inspection plug, with positive anti-leak seal, easily accessible from the outside.
    3. Oil in oil chamber shall be FDA approved, paraffin type, colorless, odorless, and non-toxic.
    4. Provide capacitive type leakage sensor for the detection of water in the oil chamber or a moisture sensor in the lower motor chamber to detect any fluid in the motor.

C. Upper seal:
    1. Tungsten carbide rotating seal and tungsten carbide stationary seal as specified in Section 15050.
    2. Submerged in oil chamber located below the stator housing.

D. Lower seal:
   1. Tungsten Carbide rotating and stationary seals as specified in Section 15050.

E. Springs and other hardware: Stainless steel, 300 or 400 series.

2.08 BEARINGS

A. Pump shaft shall rotate on a minimum of 2 permanently sealed, grease lubricated bearings:
   1. Upper bearing for radial forces.
   2. Lower bearing for combined axial and radial forces.

B. Bearing type: Anti-friction in accordance with ABMA standards.

C. Bearing life: Minimum L10 life of 100,000 hours at rated design point or 24,000 hours in accordance with ABMA 9 or 11 at bearing design load imposed by pump shutoff with maximum sized impeller at rated speed, whichever provides longest bearing life in intended service.

2.09 MOTORS AND POWER CABLES

A. Motors: Features as specified and as scheduled:
   1. Provide motors that are rated suitable for continuous operation in 40 degrees Celsius ambient temperature at project site altitude.
   2. Horsepower:
      a. As scheduled in the Pump Schedule:
         1) Listed motor horsepower is the minimum to be supplied. Increase motor horsepower if required to prevent motor overload while operating at any point on the supplied pump operating head-flow curve, including runout. However, variable frequency drives, generator, and other electrical equipment are sized for scheduled motor horsepower.
         2) Make all structural, mechanical, and electrical changes required to accommodate increased horsepower.
   3. Revolutions per minute: As scheduled in the Pump Schedule.
   4. Enclosure: As scheduled in the Pump Schedule.
   5. Electrical characteristics: As scheduled in the Pump Schedule.

B. Motor Construction:
   1. Squirrel cage induction motor, shell design.
   2. If explosion proof motor is scheduled, provide motor that is UL or FM listed for NEC Class I, Division 1, Groups C and D service, whether submerged or unsubmerged.
   3. NEMA design type: B.
   4. Motor insulation: Class H, moisture resistant, rated for 185 degrees Celsius.
   5. The motor shall be designed for continuous duty handling pumped media of 40 degrees Celsius and capable of a minimum of 15 evenly spaced starts per hour.
   6. The motor shall be capable of continuous operation under load with the motor submerged, partially submerged, or exposed, without derating the motor.
   7. Motor cooling system:
      a. Design to provide adequate cooling:
         1) At the minimum operating speed with a variable frequency drive.

2) With motor submerged.
3) With motor dry.

b. Provide external motor cooling water jacket:
1) Material: As scheduled.
2) With non-clogging ports and channels.
3) Each unit shall be provided with an integral motor cooling system. A stainless steel motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket.
4) With inspection ports or other means of access for cleaning/flushing.

c. Provide capability to relieve entrapped air from the system.

d. Shall be upgradable to include connections for external seal flushing and cooling water.

e. Spray systems, air moving equipment or other secondary cooling systems are not acceptable.

8. Motor sealing: Design motor case and seals to withstand 65 feet of submergence.
9. When variable frequency drive is scheduled, motor shall be capable of continuous inverter duty over the speed range specified.

C. Power cables:
1. Submersible to same water depth as motor casing.
2. Type SPC with Hypalon/Buna N jacket. All power cable shall have shielded wire.
3. The power cable shall be sized according to the NEC and ICEA standards and shall be of sufficient length to reach the junction box without the need of any splices.
4. The power cable shall be of a shielded design in which an overall tinned copper shield is included and each individual phase conductor is shielded with an aluminum coated foil wrap.
5. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber.
6. The cable shall be capable of continues submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.
7. Insulation rated for 90 degrees Celsius.
8. Non-wicking fillers.
9. Length: Sufficient to connect to surface junction box (without the need of splices) as indicated on the Drawings or 30 feet, whichever is greater.
10. Sized to conform to NEC, ICEA, and CSA specifications.
11. Provide stainless steel cable and stainless steel wire braid sleeve to support power cable from underside of wet well roof slab or access frame.

D. Cable entry seal and junction chamber:
1. Cable entry seal design shall not require specific torque requirements to insure a watertight and submersible seal.
2. Cable entry seal shall consist of dual cylindrical elastomer grommets, flanked by stainless steel washers.
3. The cable entry seal shall provide strain relief for the cable.
4. The cable entry junction chamber shall be separate from the motor chamber to prevent foreign material from gaining access to the top of the pump.

5. Provide a moisture detection sensor in the cable junction chamber. If leakage is detected, the sensor shall activate an alarm and shut down the pump/motor.

E. Control/protection module:
   1. Each pump shall be supplied with its own self-contained control/protection module to provide for the direct connection to all internal pump monitoring devices, including:
      a. Thermal protection: Provide automatic reset motor stator temperature detectors, 1 switch in each phase winding. If any detector is activated, the sensor shall activate an alarm and shut down the motor. The thermal detectors shall activate when the stator temperature exceeds 125 degrees Celsius.
      b. Moisture detection: One of the following:
         1) Provide capacitive type leakage sensor for the detection of water in the oil chamber or a moisture sensor in the lower motor chamber to detect any fluid in the motor. The sensor shall have an explosion proof rating.
         2) Provide a small float to detect the presence of water in the stator chamber.
      c. The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump control panel.
   2. The module shall signal an alarm condition if any of the internal monitoring devices is activated as described in section 17101.

2.10 SUPPORT BASE AND DISCHARGE ELBOW

A. Provide cast iron support base and discharge elbow for installation in wet pit.

B. Discharge elbow to mate to pump discharge and transition to discharge piping.

C. The entire weight of the pump/motor shall be borne by the pump discharge elbow.

2.11 GUIDE RAILS AND LIFTING DEVICES

A. General: Provide guide rails and lifting devices suitable for wet pit installation as scheduled in Execution and as indicated on the Drawings.

B. Materials:
   1. Guide rails, lifting cable or chain and wall supports: Type 304 stainless steel.
   2. Anchor bolts: As specified in Section 05190.

C. Wet pit guide rails:
   1. Type: Dual pipe or dual rail able to accurately guide the pump to mate with the discharge elbow.
   2. Strength: Withstand the greater of a minimum of 1.5 times the maximum imposed operating loads or seismic loads in accordance with building code as specified in Section 01410 seismic loads.
   3. Intermediate supports: Provide at 10-foot maximum intervals; less as required to provide specified support.

D. Lifting device:
   1. Type: Stainless steel chain attached to lifting eye on the pump casing.

2. Length: Able to lower pump from top of wet well to operating position as indicated on the Drawings plus 5 additional feet of length.
3. Retainer: Provide Type 316 stainless steel locking hook or clasp at top of wet well to securely retain the upper end of the lifting chain or cable during pump operation.
4. Lifting device shall be sized for combined weight of pump and motor.

2.12 FINISHES

A. Pump manufacturer to factory prime the pump and the contractor shall coat pump/motor and discharge elbow as specified in Section 09960.

B. Contractor to provide touch-up field coatings as specified in Section 09960.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be as indicated on the Drawings, in accordance with written instructions of the manufacturer, and as specified in Section 15050.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:

			Manufacturer Rep Onsite					
	Training Requirements		Installation Testing		Functional Testing		Process Operational Period	
Source Testing (Witnessed or Non-witnessed)	Maintenance (hrs per session)	Operation (hrs per session)	Trips	Days (each trip)	Trips	Days (each trip)	Trips	Days (each trip)
Witnessed	4	2	1	1	1	1	24 hour on-call	

C. Source Testing:
1. Pump:
   a. Test witnessing: As scheduled and as specified in Section 01756.
   b. Performance test: Test level as scheduled; test as specified in Section 15958.
   c. Vibration test: Test level as scheduled; test as specified in Section 15958.
   d. Noise test: Test level as scheduled; test as specified in Section 15958.
2. Pump casing: Hydrostatic pressure tests if specified in this Section.
3. Motor: Test as specified in Section 16222.

D. Functional Testing:
1. Pump assembly:
   a. Performance test: Test level as scheduled; test as specified in Section 15958.

b. Vibration test: Not required for wet pit pump. Otherwise, Test level as scheduled; test as specified in Section 15958.
c. Noise test: Not required for wet pit pump. Otherwise, Test level as scheduled; test as specified in Section 15958.

2. Motor: Test as specified in Section 16222.

3.03 PUMP SCHEDULE

Tag Numbers	**PMP-2711 PMP-2721**
General Characteristics:	
Service	Return Activated Sludge (RAS)
Quantity	2
Max. Noise, dBA at 3 Feet	Not Required
Torsional Analysis	Not Required
Minimum Pumped Fluid Degrees Fahrenheit	60
Normal Pumped Fluid Degrees Fahrenheit	70
Max. Pumped Fluid Degrees Fahrenheit	90
Discharge Size, Inch	12
Installation Configuration	Wet Pit
Pump Characteristics:	
Impeller Type	Non-clog
Impeller, Maximum Number Vanes	2
Pass Minimum Sphere Size, Inch	3
Speed Control	Variable Frequency Drive
Maximum Pump Speed, rpm	1170
Minimum Pump Speed, rpm	760
Rated Design Point: (at Maximum rpm)	
Flow, gpm	4,164
Head, Feet	22.4
Minimum Overall Efficiency, Percent	75
Maximum Active Input Horsepower	33
Required Condition 2: (at Maximum rpm)	
Flow, gpm	3,817
Head, Feet	26 - 30
Minimum Overall Efficiency, Percent	60
Required Condition 3: (at Maximum rpm)	
Flow, gpm	5,500
Head, Feet	12-16
Minimum Hydraulic Efficiency, Percent	45
Required Condition 4: (at Intermediate Revolutions per Minute)	

Tag Numbers	PMP-2711 PMP-2721
Flow, Gallons per Minute	1,735
Head, Feet	18
Minimum Hydraulic Efficiency, Percent	50
Other Conditions:	
Shut Off Head, Feet	53
Maximum NPSHr at Every Specified Flow, Feet	26
Minimum NPSHa at Every Specified Flow, Feet	45
Minimum Suction Static Head, Feet	9
Maximum Suction Static Head, Feet	14
Minimum Discharge Size, Inches	12
Pump Materials:	
Pump and Motor Casing	Cast Iron
Impeller	ASTM A-532 (Alloy III A) 25% chrome cast iron
Shaft	420 Stainless Steel
Shaft Key	316 Stainless Steel
Water Jacket	Stainless Steel
Motor Characteristics:	
Variable Frequency Drive	As specified in Section 16262
Minimum Submergence	Exposed
Maximum Driver Speed, rpm	1,170
Motor Horsepower, Minimum	45
Voltage/Phases/hertz	460/3/60
Service Factor	1.15
Full Load Current, Amperes	55
Locked Rotor Current, Amperes	330
Motor Efficiency (At 100 Percent Load) Minimum	89%
Enclosure Type	Submersible, Explosion Proof
Source Testing:	
Test Witnessing	Not Witnessed
Performance Test Level	3
Vibration Test Level	None
Noise Test Level	None
Functional Testing:	
Performance Test Level	3
Vibration Test Level	None

Tag Numbers	PMP-2711 PMP-2721
Noise Test Level	None

END OF SECTION

PRE-NEGOTIATED PROPOSAL FROM SHAPE INCORPORATED

SECTION 11312G:

SUBMERSIBLE LARGE CAPACITY CENTRIFUGAL PUMPS

SHAPE INCORPORATED

QUOTATION

PLEASANTON

6600 Knoll Center Parkway, Ste. 220
Pleasanton, CA 94566
Phone (925) 485-9720
Fax (925) 485-6085

STOCKTON

119 Val Dervin Parkway #2
Stockton, CA 95206
Phone (209) 234--5909
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John Mohr mobile # 209-324-8058

TO: **City of Turlock / Carollo Engineering**

DATE: **12/22/2016, 02/13/2017 revised as of 03/16/2017**

QUOTE #: **96742 FL (11312G)**

JOB: **City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project – Spec. Section 11312G Large Capacity Pumps – RAS Pumps**

LOCATION: **Turlock, CA**

Page (1) of (2) - Quote based on 2017 Xylem/Flygt Prices and 90% Plans & Specifications dated January 2017

ATTN:

PHONE:
Fax:

WE ARE PLEASED TO QUOTE ON THE FOLLOWING EQUIPMENT

SUBJECT TO CONDITIONS PRINTED ON THE BACK HEREOF, THESE CONDITIONS MAY BE CHANGED ONLY BY A WRITTEN STATEMENT SIGNED BY AN OFFICER OF SHAPE, INCORPORATED.

☒ F.O.B.
☒ F.F.A. TO FIRST

QTY	ITEM	PRICE
	I) Specification Section: 11312G Submersible Large Capacity Pumps (RAS Pumps) - 4,164GPM @ 22.4 TDH**, EQUIPMENT TAG # PMP-2711 and PMP-2721**	
2	Flygt pump/motor unit: **12" NP3202.095-618LT, 45 HP, 1775 RPM**, 50 ft. power/sensor cord, 480- volt 3-phase, FLS, FM Explosion Proof Rated, FLS sensor / Moisture Intrusion and Thermal Overload monitoring system, **Hard Iron/High Chrome Impeller & Cutter/Wear Plate Factory Standard Paint /Finish**, 55 FLA @ 480 volts 3-phase, Pump/motor weight: 1745 lbs.	
2	Factory Non-Witnessed Hydraulic Performance Testing	
2	12" Flygt Base Discharge elbow	
2	3" Upper Guide Rail Bracket, 316 stainless-steel	
2	3" x 12" Intermediate Guide Rail Bracket, 316 Stainless-steel	
1	Cable Holder, 316 stainless-steel	
2	pieces of Lifting Chain & Connectors, 1/2" x 25 ft. - 316 stainless-steel	
2	Flygt Mini-cas relays (moisture intrusion & motor thermal overload monitoring relay) The responsibility to install the mini-cas relay into the pump's control panel supplied by others and any material or labor cost incurred is not Shape Inc. responsibility	
1	O & M Manual	

SHAPE INC.

John Mohr

John Mohr cell ph: 209-324-8058 OR jmohr@shapecal.com

QUOTATION DOES NOT INCLUDE ANY SALES OR USE TAX PAYABLE UNDER ANY STATE OR FEDERAL STATURE. THIS QUOTATION PRICE IS FOR MATERIAL LISTED ABOVE. ANY ADDITIONS OR MODIFICATIONS THAT BECOME NECESSARY FOR APPROVED SUBMITTALS, UPON AWARDING OF THIS CONTRACT, MAY RESULT IN NECESSARY PRICE CHANGES.

NOTE: ITEMS NOT SPECIFIED ON THIS QUOTATION ARE NOT INCLUDED IN OUR PRICE AND ARE TO BE SUPPLIED BY OTHERS. PRICES ARE FOR IMMEDIATE ACCEPTANCE AND SUBJECT TO CHANGE WITHOUT NOTICE. Rev. 01/98
SALE SUBJECT TO MANUFACTURERS STANDARD TERMS AND CONDITIONS.

See attached page for Shape, Inc. terms and conditions

SHAPE INCORPORATED

QUOTATION

	Page (2) of (2), City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project, March 16, 2017 based on 90% project plans & specifications, dated January 2017 Continued: **I) Specification Section: 11312G Submersible Large Capacity Pumps (RAS Pumps) -** 4,164GPM @ 22.4 TDH**, EQUIPMENT TAG # PMP-2711 and PMP-2721**	**I) - 11312G (2) Pumps Net Delivered Price: $ 103,505.00 Not including sales tax**
1	Spare Parts Item – Basic Repair Kit which includes one (1) set of following: upper & lower Bearings, inner/outer mechanical seal assembly, and "O" ring kit	
1	Spare Parts Item –Impeller 618LT, hard iron	
1	Spare Parts Item –Cutter/Wear/Relief Groove Insert Plate, 618LT, hard iron	
2	Spare Parts Item –Power/Sensor Cable grommet	
1	Seismic Calculations	
1	Start-up Service & Training, (two (2) week notice required) Contractor responsibility to have pumps pulled and sitting at grade for physical inspection, correct rotation check and then re-installed at time of start-up	
1	Freight Charges to Jobsite, FOB Factory	
	Important Notes / Not Included: No special coatings/finishes on the pump/motor units or base discharge elbows interior or Exterior surface, only factory standard finishes is being supplied. No level sensors, electrical junction boxes, motor control center (MCC), Variable Frequency Drives (VFD) are being supplied except for where noted above Prices include freight charges to one destination, FOB Factory Prices do not include any sales or use taxes concrete wet well or valve vault, access-cover & frames, grating, any other Factory special testing, pipe support brackets, equipment unloading, guide rails - 2" schedule 40, 316 or 304 stainless-steel welded pipe, discharge pipe, fitting, and valves, anchor bolts & nuts, kellum / cable grips, special coatings or finishes, pressure or vacuum gauges, control panels, electrical junction boxes, local or remote control panels unless noted is the material to be supplied, any other item not specifically noted in the list of items being supplied Extra length of Power/ Sensor cable is available at an additional cost	
	Estimated Delivery Schedule: Equipment submittals for pumping equipment and accessories is 4 weeks and after contract and credit approval Delivery of equipment to ship to address is 12 -14 weeks, based upon having an approved equipment submittal in hand Shape Inc. Terms and Conditions of Sale apply	

SHAPE INC.

John Mohr

John Mohr cell ph: 209-324-8058 OR jmohr@shapecal.com

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SECTION 11312J

SUBMERSIBLE PROCESS LIQUID SUMP PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Packaged submersible sump pumps, with a control panel and instrumentation.

B. Related sections:
1. Section 01140 - Work Restrictions.
2. Section 01600 - Product Requirements.
3. Section 01610 - Project Design Criteria.
4. Section 01756 - Commissioning.
5. Section 01782 - Operation and Maintenance Data.
6. Section 01783 - Warranties and Bonds.
7. Section 09960 - High-Performance Coatings.
8. Section 15050 - Common Work Results for Mechanical Equipment.
9. Section 15958 - Mechanical Equipment Testing.
10. Section 16222 - Low Voltage Motors up to 500 Horsepower.
11. Section 17201 - Level Measurement: Switches.
12. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

1.02 REFERENCES

A. ASTM International (ASTM):
1. A48 - Standard Specification for Gray Iron Castings.
2. A276 - Standard Specification for Stainless Steel Bars and Shapes.
3. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

B. Hydraulic Institute (HI):
1. 1.1-1.2 - Centrifugal Pumps for Nomenclature and Definitions.
2. 1.3 - Rotodynamic (Centrifugal) Pumps for Design and Application.
3. 9.1-9.5 - Pumps - General Guidelines for Types, Application, Definitions, Sound Measurement, and Documentation.
4. 11.6 - Submersible Pump Tests.

C. National Electrical Manufacturers Association (NEMA):
1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA:
1. Type 4X enclosures in accordance with NEMA 250.

B. Pump head (Total Dynamic Head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.2, 1.3, 9.1-9.5 and 11.6 and as modified in this Section.

C. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 SYSTEM DESCRIPTION

A. Components: Overhung impeller, close coupled, single stage, volute style, end suction submersible sewage pump. Other items include: Control panel, level control instrumentation, discharge piping, necessary valves, gauges, taps, lifting eyes, stands, and other items as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics: As specified in the Pump Schedule, Pump Performance Characteristics:
      a. As specified in the Pump Schedule.
      b. Performance tolerances shall be the same as the test tolerances specified in Section 15958.
   2. Motor characteristics: As specified in the Pump Schedule.
   3. Suitable for pumping raw sewage.

1.05 SUBMITTALS

A. Submit as specified in Section 15050.

B. Calculations per Section 15050 are not required for pumps specified in this Section.

C. Furnish motor submittals as specified in Section 16222.

D. Manufacturer's Representatives qualifications as specified in Section 01756.

E. Provide vendor operation and maintenance manual as specified in Section 01782.

1.06 QUALITY ASSURANCE

A. As specified in Section 15050.

B. Provide pumps specified in this Section from same manufacturer.

C. Manufacture's Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050.

1.08 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 01610.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions specified in Section 01140.

B. Coordinate work with Commissioning and Start-up as specified in Section 01756.

1.10 WARRANTY

A. As specified in Section 01783.

1.11 MAINTENANCE

A. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

B. Spare parts: Deliver the following as specified in Section 01600:
   1. Pump impeller, trimmed to match installed impeller.
   2. Mechanical seal set.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pumps: One of the following or equal:
   1. Barnes. (Crane Pumps & Systems), SE series.
   2. ITT Goulds Pumps, WS series.
   3. Hydromatic, SKHS series.
   4. Sulzer EJ Series

2.02 MATERIALS

A. Cast Iron: ASTM A48, Class 30 minimum.

B. Stainless Steel: ASTM A276 or equal.

C. Buna N: ASTM D2000.

2.03 PUMP CASING

A. Material: Cast iron.

B. Design Working Pressure: 1.5 times the shut off pressure.

C. Provide support legs on sump bottom and clearance for suction entrance.

D. The discharge connection shall be a 2 or 3-inch NPT vertical connection.

2.04 IMPELLERS

A. Material: Cast iron.

B. 2-vane; maximum enclosed; nonclogging; with pump-out vanes on backside; dynamically balanced; close coupled to motors.

C. Method of securing to shafts: Threaded lock nut or similar connection.

2.05 PUMP SHAFTS

A. Material: 400 series stainless steel.

2.06 BEARINGS

A. Upper bearing: Single row; oil lubricated.

B. Lower bearing: Single row; oil lubricated.

2.07 SHAFT SEAL

A. Single mechanical seal.

B. Materials:
   1. Silicon carbide versus silicon carbide seal faces.
   2. Carbon versus ceramic seal faces.

C. Elastomer and hardware: Buna-N and 300 series stainless steel.

2.08 DRIVERS

A. Motors:
   1. NEMA B design.
   2. Oil filled submersible motor.
   3. Insulation:
      a. 1.5 horsepower and above: Class B.
      b. Under 1.5 horsepower: Class F.
   4. Power: 230/460 volt, 3 phase, 60 hertz.
   5. 1.15 service factor.
   6. Pumps shall be able to operate continuously without exceeding pumps service capacity when immersed in water up to 104 degrees Fahrenheit.
   7. Cable: Minimum length sump depth to the VCP, plus 15 feet, armored, waterproof cable securely attached to motors with watertight fittings.

2.09 ACCESSORIES

A. Chains or cables: Stainless steel; attached to balance point of pump; suitable for lifting pump from sump; long enough to extend from sump cover or grating:
   1. Hooks: Suitable to provide storage of chain or cable at top of sump.

2.10 FINISHES

A. Pump manufacturer to factory prime and coat pump/motor and discharge elbow as specified in Section 09960.

B. Contractor to provide touch-up field coatings as specified in Section 09960.

2.11 CONTROLS

A. General:
1. Provide a vendor control panel at each installation for control of the pumps, except as indicated on the pump schedule.

B. Vendor control panel:
1. Construction and components as specified in Section 17710.
2. Enclosure:
   a. As indicated in the pump schedule.
3. Electrical components:
   a. Main circuit breaker:
      1) As specified in Section 16412.
      2) Flange-mounted operator:
         a) Pad-lockable in the off position.
      3) Disconnects all power to the panel.
      4) Interlock with the panel door:
         a) Defeat mechanism.
   b. Motor starter for each pump:
      1) Motor circuit protector circuit breaker.
      2) Full voltage non-reversing magnetic starter.
      3) Thermal or electronic overloads.
   c. Control power transformer:
      1) Primary voltage: 230/460 VAC, 3 phase, 60 hertz.
      2) Secondary voltages:
         a) Control and status points to the facility SCADA system: 120 volt.
         b) Additional voltages as required by the application.
      3) Sized for all panel components plus 10 percent spare capacity.
      4) Primary and secondary fuses.
4. Control components:
   a. Terminal strips:
      1) Provide terminal strips for landing all external wiring.
   b. Relays, timers, and other components as required providing the specified functionality and remote monitoring connections.
5. Duplex operation:
   a. Front Panel Controls:
      1) HAND/OFF/AUTO switch.
      2) START pushbutton for each pump.
      3) STOP pushbutton for each pump.
      4) DUTY-STANDBY selector switch which will permit operator selection of either Pump Number 1 or Pump Number 2 as the DUTY pump during automatic operation.
      5) Momentary LOW LEVEL OVERRIDE pushbutton.
      6) Running pilot light for each pump.

7) Stopped pilot light for each pump.
8) Power pilot light.
9) Pump fault pilot light for each pump.
10) HIGH-HIGH level alarm.
11) Audible alarm horn.
12) Alarm beacon:
    a) Alarm silence pushbutton.

b. Remote monitoring and control:
1) Provide dry relay contact outputs for the following:
    a) Pump Fault alarm: one for each pump.
    b) Pump Run status: each pump.
    c) HIGH-HIGH Level Alarm.

c. Operation:
1) Setpoints:
    a) LOW level Elevation 82.25 feet
    b) HIGH level Elevation 83.25 feet
    c) HIGH-HIGH level Elevation 84.25 feet
2) Hand:
    a) The pump shall run when the START pushbutton is pressed.
    b) The pump shall stop when the STOP pushbutton is pressed.
    c) The LOW level switch shall stop the pump.
    d) The LOW level switch shall be over ridden by the momentary LOW LEVEL OVERRIDE pushbutton.
3) Off: Pump shall stop operation:
    a) Placing the hand switch in the OFF position shall re-set all alarm conditions.
4) Auto: The pump shall operate automatically in response to level switch signals:
    a) The duty pump shall start when the rising water level in the sump causes level switch HIGH level switch to activate.
    b) The duty pump shall stop when the falling water level in the sump causes level switch LOW level switch to activate.
    c) If the duty pump fault alarm is activated the standby pump shall replace the duty pump.
    d) A high-high level shall cause the HIGH–HIGH level switch to activate and activate the HIGH–HIGH level alarm.

2.12 LEVEL SENSORS

A. Type: Ball float as specified in Section 17201.

B. Cable Length: The length of the cable shall be equal to sump depth to the VCP plus 5 feet.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be as indicated on the Drawings, in accordance with written instructions of the manufacturer, and as specified in Section 15050.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:

			Manufacturer Rep Onsite					
	Training Requirements		Installation Testing		Functional Testing		Process Operational Period	
Source Testing (Witnessed or Non-witnessed)	Maintenance (hrs per session)	Operation (hrs per session)	Trips	Days (each trip)	Trips	Days (each trip)	Trips	Days (each trip)
Non-Witnessed	4	2	1	1	1	1	24 hour on-call	

C. Source Testing:
1. Pump:
   a. Test witnessing: Not Required.
   b. Performance test: Not Required.
   c. Vibration test: Not required.
   d. Noise test: Not required.
2. Pump casing: Hydrostatic pressure tests if specified in this Section.
3. Motor: Test as specified in Section 16222.

D. Functional Testing:
1. Pump assembly:
   a. Performance test: Test level as scheduled; test as specified in Section 15958.
   b. Vibration test: Not required.
   c. Noise test: Not required.
2. Motor: Test as specified in Section 16222.

3.03 PUMP SCHEDULE

A. Pump characteristics:

Tag Numbers	**PMP-2701, PMP-2702**
Location	**RAS Pump Station No. 2**
Service	**Storm water and mixed liquor**
Number of pumps	2
Capacity, gpm each	50 gpm
Total Dynamic Head (TDH), Feet	20 feet
Motor Horsepower	1.0 minimum
Min. Shutoff Head, feet	44
Motor Speed, revolutions per minute	3405 rpm
VCP Required	Yes

VCP Enclosure	NEMA 4X Stainless Steel

END OF SECTION

SECTION 11312K

SUBMERSIBLE MEDIUM CAPACITY CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Submersible pump with features scheduled in the Pump Schedule.

B. Related sections:
1. Section 01140 - Work Restrictions.
2. Section 01600 - Product Requirements.
3. Section 01610 - Project Design Criteria.
4. Section 01756 - Commissioning.
5. Section 01782 - Operation and Maintenance Data.
6. Section 01783 - Warranties and Bonds.
7. Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
8. Section 09960 - High-Performance Coatings.
9. Section 15050 - Common Work Results for Mechanical Equipment.
10. Section 15958 - Mechanical Equipment Testing.
11. Section 16222 - Low Voltage Motors up to 500 Horsepower.

C. The Owner has pre-qualified and pre-negotiated with Xylem Flygt (this arrangement is referred to herein as “Supplier/Manufacturer”) a cost proposal for providing the Submersible Medium Capacity Centrifugal Pumps. Unless stated otherwise, the cost proposal for the Submersible Medium Capacity Centrifugal Pumps includes equipment and accessories as specified in this section. The pre-negotiated price quotation for the Submersible Medium Capacity Centrifugal Pumps is $44,111. A copy of the cost proposal from the Supplier dated March 16, 2017, is for the Contractor’s informational use and reference only. The price quotation is valid until 120 days from Bid Opening. A copy is attached at the end of this Section. The Contractor shall purchase the equipment from the Supplier/Manufacturer and shall install the equipment as part of this Project. However, the Contractor is allowed, prior to opening bid, to negotiate with the Supplier/Manufacturer the cost, terms, and conditions for the purchase of the system and accessories to be furnished by the Contractor as part of this project to provide a complete working system.

D. Cost of Pre-negotiated Items:
1. The Contractor shall carefully review the applicable pre-negotiated proposal to determine those items required by the Contract Documents which are not part of the proposal or specified Supplier/Manufacturer’s scope of supply. In addition to the cost indicated for the applicable bid item in the pre-negotiated proposal, the Contractor shall include in his bid the costs for the following:
    a. All items not specifically itemized in the Supplier/Manufacturer’s Scope of Supply provided as part of the pre-negotiated proposal, but required by the Contract Documents and/or necessary to provide a complete and operational system.

b. All items specifically itemized in the Supplier/Manufacturer's Scope of Supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by customer, provided by Owner, or any similar designation.
c. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.
d. Any additional cost required by the supplier due to any charges the Contractor may wish to make to the terms and/or conditions of the pre-negotiated proposal, including but not limited to payment terms, delivery schedule, scope or work, etc.

1.02 REFERENCES

A. American Bearing Manufacturers'' Association (ABMA):
1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. ASTM International (ASTM):
1. A48 - Standard Specification for Gray Iron Castings.
2. A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
4. A582 - Standard Specification for Free-Machining Stainless Steel Bars.
5. B148 - Standard Specification for Aluminum-Bronze Sand Castings.
6. B505 - Standard Specification for Copper Alloy Continuous Castings.
7. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
8. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
9. F594 – Standard Specification for Stainless Steel Nuts.

C. CSA International (CSA).

D. Food and Drug Administration (FDA).

E. FM Global (FM).

F. Hydraulic Institute (HI):
1. 1.1-1.2 - Centrifugal Pumps for Nomenclature and Definitions.
2. 1.3 - Rotodynamic (Centrifugal) Pumps for Design and Application.
3. 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, Sound Measurement, and Decontamination.
4. 14.6 – Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

G. Insulated Cable Engineer's Association (ICEA).

H. National Electrical Code (NEC).

I. National Electrical Manufacturers Association (NEMA):
1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

J. Underwriters Laboratories, Inc.

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.

B. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.2, 1.3, 9.1-9.5 and 14.6 and as modified in this Section.

C. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; when multiple suction pressure taps are used, average pressure shall be suction head regardless of variation in individual taps.

D. Tolerances: As stipulated in the listed HI standards, unless specified more restrictively.

1.04 SYSTEM DESCRIPTIONS

A. Submersible sump pumps with components: Pumps, motors, base elbows, guide rails and lifting devices, electrical devices internal to pump housing, all submersible cabling for power and control conductors, and Vendor Control Panels (if scheduled), and other items as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics: Refer to Sump Pump Schedule appended to this Section.
   2. Motor characteristics: Refer to Sump Pump Schedule appended to this Section.

1.05 SUBMITTALS

A. Submit as specified in Section 15050.

B. Furnish motor submittals as specified in Section 16222.

C. Furnish control panel submittals as specified in Section 17710.

D. Manufacturer's Representatives qualifications as specified in Section 01756.

E. Provide vendor operation and maintenance manual as specified in Section 01782.

1.06 QUALITY ASSURANCE

A. As specified in Section 15050.

B. Single source responsibility: Pumps specified in this Section shall be by 1 manufacturer.

C. Manufacture's Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050.

1.08 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 01610.

B. Match existing pump installation at Secondary Clarifier No. 4.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions as specified in Section 01140.

B. Coordinate work with Commissioning and Start-up as specified in Section 01756.

1.10 WARRANTY

A. As specified in Section 01783.

1.11 MAINTENANCE

A. Special tools: Deliver 1 set of special tools required for complete assembly or disassembly of pump system components for each type or size of pump specified.

B. Spare parts: Deliver the following as specified in Section 01600:
   1. Thrust bearing set.
   2. Radial bearing set.
   3. Mechanical seal: 1 each size and type.
   4. O-Ring set.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Submersible Pumps: By the following manufacturer, no equal:
   1. Xylem Flygt.

2.02 MATERIALS

A. General: When materials are referenced in this Section or on the pump schedule, the compositions shall be the UNS Alloys, Types, or Grades in this Article unless specified or scheduled otherwise.

B. Cast iron: ASTM A48, Class 35 B minimum.

C. Nickel cast iron: ASTM A48, Class 35 minimum with 3 percent nickel added.

D. Steel: ASTM A108, Grade or UNS Alloy as specified or scheduled.

E. Stainless steel: ASTM A276 or ASTM A582, Type or UNS Alloy as specified or scheduled.

F. Bronze: ASTM B505 or ASTM B584, UNS Alloy C83600.

G. Zincless bronze: ASTM B505 or ASTM B584, Leaded Tin Bronze, UNS Alloy C92700.

H. Aluminum bronze: ASTM B148, ASTM B505 or ASTM B584, UNS Alloy C95200.

I. Fasteners: Stainless steel, ASTM F593 or ASTM F594, type or grade as specified.

2.03 GENERAL PUMP CONSTRUCTION

A. The pump shall be an overhung impeller, close coupled, single stage, volute style, end suction submersible unit, capable of handling raw unscreened sewage, storm water and other solids laden fluids without clogging.

2.04 PUMP AND MOTOR CASING

A. Type: Watertight, air filled.

B. Material: ASTM A 48, minimum Class 30, cast iron.

C. Design working pressure: Minimum 1.10 times maximum shutoff total dynamic head with maximum diameter impeller at maximum operating speed plus maximum suction static head or minimum 20 pounds per square inch gauge.

D. O-ring seals: Capable of sealing mated surfaces (major components) watertight; with the following features:
   1. Machined surfaces and grooves.
   2. O-ring contact on 4 surfaces and O-ring compression on 2 surfaces.
   3. Does not require specific fastener torque or tension to obtain watertight joint.
   4. Does not require secondary sealing compounds, gasket, grease, or other devices.

2.05 IMPELLERS

A. General:
   1. Water passages: Smooth enough to prevent clogging by stringy or fibrous materials.
   2. Passage sizes: Large enough to pass solids with sphere size of 3 inches or smaller for motors larger than 2 horsepower.
   3. Casting: 1 piece, free of cracks and porosity.
   4. Balance vanes: On impeller back shrouds.
   5. Method for securing impeller to shafts:
      a. For pumps 5 horsepower and less, secured by bronze (or stainless steel) nut or allen head bolt locked in place, but readily removable without the use of special tools.

B. Rotation: As indicated on the Drawings; clockwise looking from top when not indicated.

C. Balance: As specified in Section 15050.

D. Vibration criteria: As specified in Section 15958.

E. Type: As specified in the Pump Schedule:
   1. Material: Hard iron - Cast Iron, Class 35B.
   2. Dynamically balanced, semi-open, multi-vane, backswept, non-clog design.
   3. The impeller vane leading edges shall mechanically self-clean as they pass a spiral groove on located on the volute section.
   4. Impeller vanes shall have a screw shaped leading edge hardened to Rockwell Rc 45.

2.06 WEAR RINGS

A. Provide one of the following systems:
   1. Wear ring system:
      a. General: Used to provide efficient sealing between the volute and suction inlet of the impeller.
      b. Volute wear ring:
         1) Material: Brass.
         2) Fitted to the volute inlet.
      c. Impeller wear ring:
         1) Material: Type 316 stainless steel.
         2) Heat-shrunk fitted onto the suction inlet of the impeller.
   2. Pump volute:
      a. Single piece gray cast iron, ASTM A-48, Class 35B, non-concentric design.
      b. Volute shall have a replaceable suction cover insert ring with cast spiral-shaped, sharp-edged groove(s).
   3. Insert ring:
      a. ASTM A-532 (Alloy III A) 25% chrome cast iron.
      b.

2.07 PUMP SHAFTS

A. Material: Type 420 stainless steel; turned, ground, and polished.

B. Features:
   1. Strength: Able to withstand minimum of 1.5 times maximum operating torque and other loads.
   2. Resonant frequency: As specified in Sections 15050 and 15958.
   3. Maximum deflection: Minimum 0.002 inches under operating conditions.

C. Tapered to fit at impeller with key and bolt for securing impeller.

D. Pump and motor shaft shall be a solid continuous shaft.

2.08 BEARINGS

A. Pump shaft shall rotate on a minimum of 2 permanently sealed, grease lubricated bearings:
   1. Upper bearing for radial forces shall be self-aligning spherical roller type.

2. Lower bearing for combined axial and radial forces shall be angular contact ball type.

B. Bearing type: Anti-friction in accordance with ABMA standards.

C. Bearing lubrication system shall be sized to safely absorb heat energy normally generated in bearing under maximum ambient temperature of 60 degrees Celsius.

D. Bearing life: 1 of the following whichever provides longer bearing life in intended service:
1. Minimum ABMA 9 or 11 L10 bearing life of 50,000 hours at rated design point.
2. Minimum 24,000 hours at bearing design load imposed by pump shutoff with maximum sized impeller at rated speed.

2.09 SHAFT SEALS

A. Upper seal unit material: 1 stationary tungsten-carbide ring and 1 positively driven rotating carbon ring or tungsten-carbide ring.

B. Lower seal unit material: 1 stationary and 1 positively driven rotating tungsten-carbide ring.

C. Features:
1. Tandem arrangement running in an oil chamber.
2. Design oil chamber to assure that air is left in the oil chamber to absorb the expansion of the oil due to temperature variations.
3. Oil in oil chamber shall be FDA approved, paraffin type, colorless, odorless, and non-toxic.
4. Independent spring system between seal interfaces able to withstand maximum suction submergences.
5. Does not require pressure differential to effect sealing.
6. Does not use pumped media for lubrication.
7. Lower mechanical seal effectively lubricated from oil chamber housings.
8. Not damaged when pump is run dry (unsubmerged) for extended periods.
9. Springs and other hardware: Stainless steel, 300 or 400 series.

D. Moisture sensing system: Intrinsically safe type that signals seal leakage.

E. Provide oil chamber with manufacturer=s standard drain and inspection plug, with positive anti-leak seal, easily accessible from the outside.

2.10 DISCHARGE BASE AND ELBOW

A. Materials: Same as pump casing.

B. Features:
1. Structurally capable of firmly supporting guide rails, discharge piping, and pumping unit under operating conditions.
2. Integral support legs or pads with bolting to sump floor provisions: 1 or more.
3. Incorporates 90 degree flanged elbow that receives horizontal flow from pump and discharges flow vertically.
4. Discharge interface:

a. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact.
b. Self-aligning without having to enter the wet well.
c. Discharge elbow to mate to pump discharge and transition to discharge piping.

5. Piping: Contractor to provide flanged piping connections as specified in Section 15052 and as indicated on the Drawings in accordance with ASME B16.1, minimum Class 125 or as required to meet specified design pressure, whichever is greater.

2.11 GUIDE RAILS, BRACKETS, FASTENERS, AND LIFTING CHAIN FOR EACH PUMP

A. Material: Type 316 stainless steel, with the following features:
1. Dual pipes or dual rails that extend from discharge base to upper bracket unless scheduled otherwise.
2. Rail wall thickness sufficient to suspend pump unit between brackets plus minimum 50 percent safety factor.
3. Sized to fit discharge base and sliding bracket of pump.
4. Integral, self-aligning, guide rail sliding brackets that seal pump to discharge base under operating conditions.
5. Upper guide rail bracket.
6. Intermediate guide rail brackets where indicated on the Drawings or at 10 foot maximum intervals.
7. Lifting chain of sufficient strength and length to permit safe removal of pump unit from sump.

2.12 DRIVERS

A. Horsepower:
1. As scheduled.
2. Listed driver horsepower is the minimum to be supplied:
a. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout.
b. When scheduled driver is a motor, increase motor horsepower if required to prevent operation in the service factor.
c. Make all structural, mechanical, and electrical changes required to accommodate increased horsepower.

B. Motors:
1. Revolutions per minute: As scheduled.
2. Enclosure: As scheduled.
3. Electrical characteristics: As scheduled.

C. Motor construction:
1. Squirrel cage induction motor, shell type design.
2. If explosion proof motor is scheduled, provide motor that is UL or FM listed for NEC Class I, Division 1, Groups C and D service, whether submerged or unsubmerged.
3. NEMA design type: B.
4. Motor insulation, either one:
a. Class F, moisture resistant, rated for 155 degrees Celsius.

b. Class H, moisture resistant, rated for 185 degrees Celsius.

5. The motor shall be designed for continuous duty handling pumped media of 40 degrees Celsius and capable of a minimum of 15 evenly spaced starts per hour.
6. The motor shall be capable of continuous operation under load with the motor submerged, partially submerged, or exposed, without derating the motor.
7. Motor cooling, one of the following:
   a. Motor cooled by the surrounding media.
   b. Cooling jacket:
      1) Non-clogging ports and channels that use pumped fluid as the cooling media.
      2) Functional with motor submerged, partially submerged, or exposed.
      3) Provide capability to relieve entrapped air from the system.
   c. Spray systems, air moving equipment or other secondary cooling systems are not acceptable.
8. Motor sealing: Design motor case and seals to withstand 65 feet of submergence.
9. Coordinate motors with the variable frequency drive manufacturer to ensure compatibility between the motor and variable frequency drive. Other drivers: As scheduled and as specified in sections listed in the Schedule.

D. Power and control cables:
   1. Submersible to same water depth as motor casing.
   2. Type SPC with Hypalon/Buna N or chloroprene rubber jacket.
   3. Insulation rated for 90 degrees Celsius.
   4. Non-wicking fillers.
   5. Length: Sufficient to connect to surface junction box (without the need of splices) as indicated on the Drawings or 30 feet, whichever is greater.
   6. All power and control conductors shall terminate at terminal blocks in the local control panel or junction box.
   7. Sized in accordance with NEC, ICEA, and CSA specifications.
   8. Provide stainless steel cable and stainless steel wire braid sleeve to support power cable from underside of wet well roof slab or access frame.

E. Cable entry/junction chamber:
   1. Cable entry seal design shall not require specific torque requirements to insure a watertight and submersible seal.
   2. Cable entry seal shall consist of a single cylindrical elastomer grommet, flanked by stainless steel washers.
   3. The entry body shall perform compression and strain relief that is separate from the sealing function.
   4. The cable entry junction chamber shall be separate from the motor chamber to prevent foreign material from gaining access to the motor interior through the top of the pump.

F. Control/protection module:
   1. Each pump shall be supplied with its own self-contained control/protection module to provide for the direct connection to all internal pump monitoring devices, including:
      a. Thermal protection: Provide automatic reset motor stator temperature detectors, 1 switch in each phase winding. If any detector is activated, the sensor shall activate an alarm and shut down the motor. The thermal

detectors shall activate when the stator temperature exceeds 125 degrees Celsius.

b. Moisture detection: one of the following:
   1) Provide capacitive type leakage sensor for the detection of water in the oil chamber or a moisture sensor in the lower motor chamber to detect any fluid in the motor. The sensor shall have an explosion proof rating.
   2) Provide a small float to detect the presence of water in the stator chamber.

c. The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump control panel.

2. The module shall signal an alarm condition if any of the internal monitoring devices is activated as described in the controls section.
3. Install module in the manufacturer supplied VCP.

2.13 CONTROLS

A. General:
   1. Provide a vendor control panel for control of the pumps, consisting of, but not limited to the following to provide a complete and operable system.

B. Vendor control panel:
   1. Construction and components as specified in Section 17710 and confirming to other requirements in Divisions 16 and 17.
   2. Enclosure:
      a. Type: NEMA 4X.
      b. Material: Type 316 stainless steel.
      c. Electrical components shall be UL approved for use in the enclosure. The control panel shall be UL approved and labeled.
      d. Provide a sunshade of same material as the enclosure.
   3. Power supply:
      a. As indicated in the Pump Schedule.
   4. Electrical components:
      a. Main circuit breaker:
         1) As specified in Section 16412.
         2) Flange-mounted operator:
            a) Pad-lockable in the off position.
         3) Disconnects all power to the panel.
         4) Defeatable interlock with the panel door.
      b. Motor starter for each pump:
         1) As specified in Section 16422.
         2) Motor circuit protector circuit breaker.
         3) Full voltage non-reversing magnetic starter.
         4) Thermal or electronic overloads.
      c. Control power transformer:
         1) Primary voltage: Match the power supply voltage to the VCP.
         2) Secondary voltage: 120 volt.
         3) Sized for all panel components plus 10 percent spare capacity.
         4) Primary and Secondary fuses.
      d. Receptacle:
         1) 120 volt duplex GFCI, inside control panel.

5. Control components:
    a. Pump protection module as specified in this Section.
    b. Terminal strips:
        1) Provide terminal strips for landing all external wiring.
    c. Relays, timers, and other components as required to provide the specified functionality and remote monitoring connections.
    d. Operator interface unit for adjustment of level setpoints and alarms.
    e. Level indicating controller capable of switching four setpoints (LSLL, LSL, LSH, LSHH).
    f. Submersible level transducer.
6. Front panel control devices:
    a. HAND/OFF/AUTO selector switch for each pump.
    b. LOCKOUT-STOP pushbutton for each pump.
    c. RESET pushbutton for each pump.
    d. LEAD/LAG selector switch.
        1) Required only for duplex sump pump systems.
7. Front panel indicators and alarms:
    a. RUNNING pilot light for each pump.
    b. FAULT pilot light for each fault condition for each pump:
        1) Pump fault is defined as motor overload, high temperature, or excessive moisture.
    c. Sump level indication.
    d. HIGH LEVEL ALARM pilot light.
    e. LOW-LOW LEVEL ALARM pilot light.
    f. Run time indication.
8. Indicators, alarms, and controls accessible through VCP operator interface unit:
    a. Control and alarm setpoints for level transmitter.
9. Remote monitoring:
    a. Provide dry relay contact outputs for the following:
        1) PUMP IN AUTOMATIC status for each pump.
        2) PUMP IN RUNNING status for each pump.
        3) PUMP FAULT for each pump.
        4) HIGH-HIGH LEVEL alarm.
        5) LOW-LOW LEVEL alarm.

C. Operation:
1. General:
    a. With the HAND/OFF/AUTO selector switch in the HAND position, the pump will run.
    b. With the HAND/OFF/AUTO selector switch in the OFF position, the pump is prevented from running.
    c. With the HAND/OFF/AUTO selector switch in the AUTO position, the pump will run based on sump level as determined by level indicating controller connected to a submersible pressure transducer in the wet well as specified below.
    d. RESET button will extinguish alarm lights and allow pumps to run upon removal of the associated alarm condition.
2. Interlocks: The following interlocks control pump operation as indicated whether the pump is in HAND or AUTO mode:
    a. A hardwired low-low-level interlock will prevent the pump(s) from operating at or below this level:

1) Activated by the low-low-level switch (LSLL).
2) Alarm is reset with rising fluid levels.

b. A motor high-temperature interlock will prevent the pump from running in all modes:
1) Alarm is latched until the RESET pushbutton is pressed.

c. A moisture detection interlock will prevent the pump from running in all modes:
1) Alarm is latched until the RESET pushbutton is pressed.

d. A motor overload interlock will prevent the pump from running in all modes:
1) Alarm is latched until the RESET pushbutton is pressed.

e. High-high level alarm is generated by the high-high level switch (LSHH):
1) Alarm is reset with decreasing fluid levels.

3. AUTO operation: Control operation as follows when the pump is in AUTO mode:
a. At low level, (LSL) stop both pumps.
b. At lead pump start level, (LSH), start the lead pump.
c. At lag pump start level, (LSHH), start the lag pump.
d. Both pumps continue to run until the low level (LSL) is reached.
e. Provide an alternator to switch lead-lag operation of the pumps after every pump down.

4. Initial Setpoints:
a. High-High level (LSHH): (Elev. 96.00).
b. High level (LSH): (Elev. 95.00).
c. Low level (LSL): (Elev. 75.00).
d. Low-Low level (LSLL): (Elev. 74.00).

D. Ancillary Instruments:
1. General: As part of the VCP provide level sensors as described below.
2. Type: Submersible pressure transducer as specified in Section 17407.
3. Provide panel meter capable:
a. Power 2-wire submersible pressure transducer.
b. Display wet well level.
c. Outputs:
1) Four Form C relays for pump control and monitoring.
2) One 4-20 mA output for PLC monitoring.

d. Manufacturer: The following or equal:
1) Red Lion PAX Series.

4. If explosion proof motor is scheduled, provide intrinsically safe level sensor system.

2.14 FINISHES

A. Pump manufacturer shall factory prime coat.

B. The Contractor shall coat pump/motor and discharge elbow as specified in Section 09960.

C. Contractor shall provide touch-up field coatings as specified in Section 09960.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be as indicated on the Drawings, in accordance with written instructions of the manufacturer, and as specified in Section 15050.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:

			Manufacturer Rep Onsite					
	Training Requirements		Installation Testing		Functional Testing		Process Operational Period	
Source Testing (Witnessed or Non-witnessed)	Maintenance (hrs per session)	Operation (hrs per session)	Trips	Days (each trip)	Trips	Days (each trip)	Trips	Days (each trip)
Non-witnessed	4	2	1	1	1	1	24 hour on-call	

C. Source Testing:
1. Pump:
   a. Test witnessing: As scheduled and as specified in Section 01756.
   b. Performance test: Test level as scheduled; test as specified in Section 15958.
   c. Vibration test: Test level as scheduled; test as specified in Section 15958.
   d. Noise test: Test level as scheduled; test as specified in Section 15958.
2. Pump casing: Hydrostatic pressure tests if specified in this Section.
3. Motor: Test as specified in Section 16222.

D. Functional Testing:
1. Pump assembly:
   a. Performance test: Test level as scheduled; test as specified in Section 15958.
   b. Vibration test: Not required for wet pit pump. Otherwise, Test level as scheduled; test as specified in Section 15958.
   c. Noise test: Not required for wet pit pump. Otherwise, Test level as scheduled; test as specified in Section 15958.
2. Motor: Test as specified in Section 16222.

3.03 FIELD QUALITY CONTROL

A. Witnessing: All field-testing shall be witnessed by the Engineer; provide advanced notice of field-testing as specified in Section 15958.

B. Inspection and checkout: As specified in Sections 15050 and 15958.

C. Equipment performance test: Test level as scheduled; test as specified in Section 15958.

D. Vibration test: None required.

E. Noise test: Test level as scheduled; test as specified in Section 15958.

F. Driver and motor tests: Test as specified in scheduled section.

G. Operational testing: As specified in Section 01756.

3.04 MANUFACTURER'S FIELD SERVICE

A. Start-up: Inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up.

B. Training: As specified in Section 01756.

3.05 PUMP SCHEDULE

Tag Numbers	**PMP-2655 PMP-2656**
General Characteristics	
Service	Scum (Secondary Clarifier No.5)
Quantity	2
Maximum Noise, dBA at 3 Feet	Not Required
Torsional Analysis	Not Required
Minimum Pumped Fluid Degrees Fahrenheit	35
Normal Pumped Fluid Degrees Fahrenheit	60
Maximum Pumped Fluid Degrees Fahrenheit	75
Installation Configuration	Wet Pit
Pump Characteristics	
Impeller Type	Non-Clog
Pass Minimum Sphere Size, Inch	3
Speed Control	Constant
Maximum Pump Speed, rpm	3,500
Minimum Pump Speed, rpm	N/A
Rated Design Point: (at Maximum rpm)	
Flow, gpm	250
Head, Feet	43
Minimum Overall Efficiency, Percent	47
Required Condition 2 (at Maximum rpm)	
Flow, gpm	150
Head, Feet	55-60
Minimum Overall Efficiency, Percent	38-42
Required Condition 3 (at Maximum rpm)	
Flow, gpm	320

Tag Numbers	PMP-2655 PMP-2656
Head, Feet	25-30
Minimum Overall Efficiency, Percent	40-45
Other Conditions	
Shut Off Head, Feet	87
Minimum NPSHa at Every Specified Flow, Feet	38
Minimum Suction Static Head, Feet	5
Minimum Discharge Size, Inches	3
Motor Characteristics	
Minimum Submergence	Exposed
Maximum Driver Speed, rpm	3,600
Motor Horsepower, Minimum	6.5
Voltage/Phases/Hertz	460/3/60
Service Factor	1.15
Starting Current, Amperes	147
Rated Current, Amperes	16
Motor Efficiency (At 100-Percent Load) Minimum	86
Enclosure Type	Submersible, Explosion Proof
NEMA Design Type	B
Vendor Control Panel	
Required	Yes
Operation	Duplex
Accessories	
Basin Cover	Not Required
Hoist	Not Required
Source Testing	
Test Witnessing	Not Required
Performance Test Level	2
Vibration Test Level	Not Required
Noise Test Level	Not Required
Functional Testing	
Performance Test Level	2
Vibration Test Level	Not Required
Noise Test Level	Not Required

END OF SECTION

PRE-NEGOTIATED PROPOSAL FROM SHAPE INCORPORATED

SECTION 11312K:

SUBMERSIBLE MEDIUM CAPACITY CENTRIFUGAL PUMPS

SHAPE INCORPORATED

QUOTATION

PLEASANTON

6600 Knoll Center Parkway, Ste. 220
Pleasanton, CA 94566
Phone (925) 485-9720
Fax (925) 485-6085

STOCKTON

119 Val Dervin Parkway #2
Stockton, CA 95206
Phone (209) 234--5909
Fax (209) 234-5913

John Mohr mobile # 209-324-8058

TO: **City of Turlock / Carollo Engineering**

DATE: **12/22/2016, 02/13/2017 revised as of 03/16/2017**

QUOTE #: **96742 FL (11312K)**

Page (1) of (2) - Quote based on 2017 Xylem/Flygt Prices and 90% Plans &

JOB: **City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project – Spec. Section: 11312K Sub. Medium Cap. Pumps – Scum Pmp**

Specifications dated January 2017

LOCATION: **Turlock, CA**

ATTN:

PHONE:
Fax:

WE ARE PLEASED TO QUOTE ON THE FOLLOWING EQUIPMENT

SUBJECT TO CONDITIONS PRINTED ON THE BACK HEREOF, THESE CONDITIONS MAY BE CHANGED ONLY BY A WRITTEN STATEMENT SIGNED BY AN OFFICER OF SHAPE, INCORPORATED.

☒ F.O.B.
☒ F.F.A. TO FIRST

QTY	ITEM	PRICE
	II) Specification Section 11312K Submersible Medium Capacity Pumps – Scum Pump Station – Secondary Clarifier # 5 – with local control and level sensors	
	245 GPM @ 42.4 TDH - Two (2) Units – Equipment Tag #: PMP-2655 & PMP-2656	
2	Flygt pump/motor unit: **3" NP3102.095-257SH, 6.5 HP, 3490 RPM**, 50 ft. power/sensor cord, 480- volt 3-phase, FLS, FM Explosion Proof Rated, FLS sensor / Moisture Intrusion and Thermal Overload monitoring system, **Hard Iron/High Chrome Impeller & Cutter/Wear Plate Factory Standard Paint /Finish**, 16 FLA @ 480 volts 3-phase, Pump/motor weight: 245 lbs.	
2	Factory Non-Witnessed Hydraulic Performance Testing	
2	3" Flygt Base Discharge elbow	
2	2" Upper Guide Rail Bracket, 316 stainless-steel	
2	2" x 6" Intermediate Guide Rail Bracket, 316 Stainless-steel	
1	Cable Holder, 316 stainless-steel	
1	**PLC based Local Control Panel with HMI screen and Level Sensors, 316SS – Duplex**	
2	pieces of Lifting Chain & Connectors, 1/4" x 35 ft. - 316 stainless-steel	
2	Flygt Mini-cas relays (moisture intrusion & motor thermal overload monitoring relay) The responsibility to install the mini-cas relay into the pump's control panel supplied by others	

SHAPE INC.

John Mohr

John Mohr cell ph: 209-324-8058 OR jmohr@shapecal.com

QUOTATION DOES NOT INCLUDE ANY SALES OR USE TAX PAYABLE UNDER ANY STATE OR FEDERAL STATURE. THIS QUOTATION PRICE IS FOR MATERIAL LISTED ABOVE. ANY ADDITIONS OR MODIFICATIONS THAT BECOME NECESSARY FOR APPROVED SUBMITTALS, UPON AWARDING OF THIS CONTRACT, MAY RESULT IN NECESSARY PRICE CHANGES.

NOTE: ITEMS NOT SPECIFIED ON THIS QUOTATION ARE NOT INCLUDED IN OUR PRICE AND ARE TO BE SUPPLIED BY OTHERS. PRICES ARE FOR IMMEDIATE ACCEPTANCE AND SUBJECT TO CHANGE WITHOUT NOTICE. Rev. 01/98
SALE SUBJECT TO MANUFACTURERS STANDARD TERMS AND CONDITIONS.

See attached page for Shape, Inc. terms and conditions

SHAPE INCORPORATED

QUOTATION

	Page (2) of (2), City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project, March 16, 2017 based on 90% project plans & specifications, dated January 2017 Continued: **II) Specification Section 11312K Submersible Medium Capacity Pumps – Scum Pump Station – Secondary Clarifier # 5 – with local control and level sensors** **245 GPM @ 42.4 TDH - Two (2) Units – Equipment Tag #: PMP-2655 & PMP-2656** and any material or labor cost incurred is not Shape Inc. responsibility	**11312K II) (2) Pumps - Net Delivered Price: $44,111.00 Not including sales tax**
1	O & M Manual	
1	Spare Parts Item – Basic Repair Kit which includes one (1) set of following: upper & lower Bearings, inner/outer mechanical seal assembly, and “O” ring kit	
1	Seismic Calculations	
1	Start-up Service & Training, (two (2) week notice required) Contractor responsibility to have pumps pulled and sitting at grade for physical inspection, correct rotation check and then re-installed at time of start-up	
1	Freight Charges to Jobsite, FOB Factory	
	Important Notes / Not Included: No special coatings/finishes on the pump/motor units or base discharge elbows interior or Exterior surface, only factory standard finishes is being supplied. No level sensors, electrical junction boxes, motor control center (MCC), Variable Frequency Drives (VFD) are being supplied except for where noted above Prices include freight charges to one destination, FOB Factory Prices do not include any sales or use taxes concrete wet well or valve vault, access-cover & frames, grating, any other Factory special testing, pipe support brackets, equipment unloading, guide rails - 2” schedule 40, 316 or 304 stainless-steel welded pipe, discharge pipe, fitting, and valves, anchor bolts & nuts, kellum / cable grips, special coatings or finishes, pressure or vacuum gauges, control panels, electrical junction boxes, local or remote control panels unless noted is the material to be supplied, any other item not specifically noted in the list of items being supplied Extra length of Power/ Sensor cable is available at an additional cost **Estimated Delivery Schedule:** Equipment submittals for pumping equipment and accessories is 4 weeks and after contract and credit approval Delivery of equipment to ship to address is 12 -14 weeks, based upon having an approved equipment submittal in hand Shape Inc. Terms & Conditions of sale apply	

SHAPE INC.

*John Mohr*_____

John Mohr cell ph: 209-324-8058 OR jmohr@shapecal.com

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SECTION 11312P

SUBMERSIBLE AXIAL FLOW PROPELLER PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: This section included the requirements for mixed liquor return (MLR) submersible horizontal axial flow pumps and appurtenances in the Aeration Basins 1-7.

B. Related section:
   1. Section 01140 - Work Restrictions.
   2. Section 01600 - Product Requirements.
   3. Section 01610 - Project Design Criteria.
   4. Section 01782 - Operation and Maintenance Data.
   5. Section 09960 - High Performance Coatings.
   6. Section 15050 - Common Work results for Mechanical Equipment.
   7. Section 15958 - Mechanical Equipment Testing.
   8. Section 16222 - Low Voltage Motors up to 500 Horsepower.
   9. Section 17100 - Control Strategies.

C. The Owner has pre-qualified and pre-negotiated with Xylem Flygt (this arrangement is referred to herein as “Supplier/Manufacturer”) a cost proposal for providing the Submersible Axial Flow Propeller Pumps. Unless stated otherwise, the cost proposal for the Submersible Axial Flow Propeller Pumps includes equipment and accessories as specified in this section. The pre-negotiated price quotation for the Submersible Axial Flow Propeller Pumps is $405,379. A copy of the cost proposal from the Supplier dated March 16, 2017, is for the Contractor’s informational use and reference only. The price quotation is valid until 120 days from Bid Opening. A copy is attached at the end of this Section. The Contractor shall purchase the equipment from the Supplier/Manufacturer and shall install the equipment as part of this Project. However, the Contractor is allowed, prior to opening bid, to negotiate with the Supplier/Manufacturer the cost, terms, and conditions for the purchase of the system and accessories to be furnished by the Contractor as part of this project to provide a complete working system.

D. Cost of Pre-negotiated Items:
   1. The Contractor shall carefully review the applicable pre-negotiated proposal to determine those items required by the Contract Documents which are not part of the proposal or specified Supplier/Manufacturer’s scope of supply. In addition to the cost indicated for the applicable bid item in the pre-negotiated proposal, the Contractor shall include in his bid the costs for the following:
      a. All items not specifically itemized in the Supplier/Manufacturer’s Scope of Supply provided as part of the pre-negotiated proposal, but required by the Contract Documents and/or necessary to provide a complete and operational system.
      b. All items specifically itemized in the Supplier/Manufacturer’s Scope of Supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by customer, provided by Owner, or any similar designation.

c. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.
d. Any additional cost required by the supplier due to any charges the Contractor may wish to make to the terms and/or conditions of the pre-negotiated proposal, including but not limited to payment terms, delivery schedule, scope or work, etc.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. American Society of Mechanical Engineers (ASME):
1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
2. B16.5 - Pipe Flanges and Flanged Fittings.

C. ASTM International (ASTM):
1. A 48 - Standard Specification for Gray Iron Castings.
2. A 108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
3. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
4. A 283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
5. A 532 - Standard Specification for Abrasion-Resistant Cast Irons.
6. A 536 - Standard Specification for Ductile Iron Castings.
7. A 576 - Standard Specification for Steel Bars, Carbon, Hot Wrought, Special Quality.
8. A 582 - Standard Specification for Free-Machining Stainless Steel Bars.
9. A 743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
10. B 505 - Standard Specification for Copper Alloy Continuous Castings.
11. B 584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
12. B 763 - Standard Specification for Seamless Copper Tube in Coils.
13. E 10 - Standard Test Method for Brinell Hardness of Metallic Materials.
14. F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
15. F 594 - Standard Specification for Stainless Steel Nuts.

D. American Water Works Association (AWWA):
1. C200 – Steel Water Pipe 6 Inch and Larger.

E. FM Global (FM).

F. Hydraulic Institute (HI):
1. 1.1-1.5 - Centrifugal Pumps - Nomenclature, Definitions, Application and Operation.
2. 1.6 - Centrifugal Pump Tests.
3. 9.1-9.5 - General Pump Standards For Types, Definitions, Application, and Sound Measurements.

G. National Electrical Code (NEC).

H. National Electrical Manufacturers Association (NEMA).

1.03 DEFINITIONS

A. Flow, head, efficiency, and motor horsepower specified in this Section are minimums unless stated otherwise.

B. NEMA Type TEFC enclosure in accordance with NEMA 250.

C. Pump head (Total Dynamic Head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.5, 1.6 and 9.1-9.5 and as modified in the Specifications.

D. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 SYSTEM DESCRIPTION

A. Submersible pumps and components:
   1. Submersible non-clog horizontal axial flow pump.
   2. Submersible electric motor.
   3. Motor drive.
   4. Bearings.
   5. Seals or packing.
   6. Couplings.
   7. Base plates.
   8. Pedestals.
   9. Guards.
   10. Supports.
   11. Anchor bolts.
   12. Gauges.
   13. Pump discharge pipe and supports.
   14. Submersible cable.
   15. Submersible cable support and protection.
   16. Necessary controls and instrumentation.
   17. Taps.
   18. Lifting eyes.
   19. Lifting cable.
   20. Similar type items as specified and as required for complete operational units ready for use as specified and installed as indicated on the Drawings.

B. Design requirements:
   1. Pump performance characteristics:
      a. As specified in the Pump Schedule.
      b. Continuously rising pump curve with no point of zero slope or slope reversal from shut-off head to the specified minimum head.
      c. Stable and free from excessive vibration, motor overloading, and cavitation from shutoff head through the specified operating range.

d. Performance tolerances shall be the same as the test tolerances specified in Section 15958.
e. Performance tolerances shall be the same as the test tolerances specified in Section 15958.

2. Motor characteristics: As specified in the Pump Schedule.

C. Pumps shall be suitable for pumping fluid as scheduled.

1.05 SYSTEM OPERATION

A. System operation as specified in Section 17100 Control Strategies.

1.06 SUBMITTALS

A. Submit as specified in Section 15050.

B. Product Data and Shop Drawings for Each Pump to Include:
1. Complete shop and installation drawings.
2. Literature and drawings describing the equipment in sufficient details, including parts list, dimensions, materials, and details of construction and installation.
3. Electrical schematic and wiring diagrams and other data as required for the complete system.
4. Certified dimensional data for components, including foundation and anchor bolts and details.
5. Equipment Data:
   a. Pump information (each pump):
      1) Manufacturer.
      2) Model.
      3) Impeller type, and size.
      4) Weight of pump and motor.
   b. Pump performance data (each pump):
      1) Pump speed.
      2) Pump curve.
      3) Power versus flow curve.
      4) Hydraulic efficiency curves.
   c. Motor data.
6. Descriptive brochures of each item of auxiliary equipment.
7. Calculation of rail wall thickness. (Not applicable, not load bearing).

C. Furnish motor submittals as specified in Section 16222.

D. Manufacturer’s Representatives qualifications as specified in this Section.

E. Provide vendor operation and maintenance manual as specified in Section 01782.

1.07 QUALITY ASSURANCE

A. As specified in Section 15050.

B. Provide pumps in this Section from same manufacturer.

C. Require pump manufacturer to furnish and coordinate pump, motor and pump components as specified and scheduled and to provide written installation and check out requirements.

D. Package Systems: Each pump station shall be provided as a complete package by one manufacturer or supplier, including pumps, motors, base elbow, guide rails, hoists, monitors, marine grade cables, and specified appurtenances.

E. Manufacturer qualifications: Manufacturer of pumps similar to specified pumps as evidenced by references to minimum 2 installations currently having operated the same model and drive configuration pump as proposed, operating under similar conditions of head, flow, and speed for minimum 5 years.

F. Pump Test: The pump manufacturer shall perform the following inspections and tests on each pump before shipment from the factory:
   1. Propeller(s), motor rating(s), and electrical connection(s) were checked for compliance to the purchase order.
   2. All pumps are vacuum (or pressure) tested to establish sealing integrity. All pumps are momentarily energized to determine correct rotation and current draw (prior to immersion).
   3. All pumps are run dry and/or immersed to determine correct shaft rotation, and power consumption.
   4. After immersion test(s), all pumps are inspected for lubricant seepage and/or water infiltration, insulation defect(s), and resistance (ohms).

G. Inspections and tests performed shall confirm the pump(s) listed have met all established quality assurance standards set for similar materials. All pumps shall be warranted against defects in design, workmanship, and material (with validation being the warranty card(s) shipped with the product(s)).

H. A written report stating the foregoing steps have been done and may be required with each pump at the time of shipment (upon prior notice to the fabrication of the pumps).

1.08 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050.

1.09 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 01610.

1.10 SEQUENCING AND SCHEDULING

A. Coordinate with restrictions as specified in Section 01140.

B. Coordinate work with Commissioning and Start-up as specified in Section 01756.

1.11 WARRANTY

A. As specified in Section 01783.

B. The equipment manufacturer shall warrant the OWNER against defects in workmanship and materials including parts and labor for a period of one year. The warranty period shall begin upon final acceptance of the project by the OWNER. The manufacturer further agrees to provide warranty service at the project site or at the manufacturer's facility at the sole discretion of the Owner without additional costs to the Owner. The provisions of this warranty shall not apply to any part or product which has been damaged through misuse, accident, negligence or failure to connect the protective devices specified herein.

1.12 MAINTENANCE

A. Maintenance and repair shall be performed by lifting the pump/motor unit out of the discharge pipe. It shall not be necessary for maintenance personnel to enter the aeration basin.

B. Special tools: Deliver 1 set for every furnished pump type and size needed to assemble and disassemble pump system. Spare parts: Provide 1 of the following for each size or type of pump; deliver as specified in Section 01600:
   1. Upper bearing set.
   2. Lower bearing set.
   3. Upper and lower mechanical seal set.
   4. Casing seal gaskets or O-rings.
   5. Power cable entry seal set.

PART 2 PRODUCTS

2.01 DESIGN

A. Furnish two submersible horizontal propeller pumps for each aeration basin.

B. Design Condition: As specified in Section 3.

C. Each pump shall be equipped with a minimum 10 (7.5) horsepower, submersible electric motor connected for operation on 480-volt, 3 phase, 60 hertz. All cables shall be neoprene or CPE jacketed. Each unit shall be fitted with 30 feet (minimum) of lifting cable of adequate strength to permit raising and lowering the pump.

D. Each pump will be run from a variable frequency drive.

2.02 MANUFACTURERS

A. Pump: By the following manufacturer, no equal:
   1. Xylem Flygt, PP series.

2.03 MATERIALS

A. General: When materials are referenced in this Section or on the pump schedule, the compositions shall be the UNS Alloys, Types or Grades in this article unless specified or scheduled otherwise.

B. Carbon steel: C 1035.

C. Cast Iron: ASTM A48, Class 35 B minimum.

D. Nickel cast iron: ASTM A48, Class 35 minimum with 3 percent nickel added.

E. Steel: ASTM A108, Grade or UNS Alloy as specified or scheduled.

F. Stainless steel: ASTM A276 or ASTM A582, Type or UNS Alloy as specified or scheduled.

G. Bronze: ASTM B505 or ASTM B584, UNS Alloy C83600.

H. Zincless bronze: ASTM B505 or ASTM B584, Leaded Tin Bronze, UNS Alloy C92700.

I. Aluminum bronze: ASTM B148, ASTM B505 or ASTM B584, UNS Alloy C95200.

J. Fasteners: Stainless Steel, ASTM F593 or ASTM F594, type or grade as specified.

2.04 COMPONENTS

A. Pump Design:
   1. The pumps shall be capable of handling raw, screened wastewater. The pumps shall be able to be raised and lowered, and shall be easily removed for inspection or service without the need for personnel to enter the Oxidation Ditch. The pump, with its appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 130 feet.

B. Pump Construction:
   1. Each pump shall be of the integral design, close coupled, submersible type. All components of the pump, including motor, shall be capable of continuous underwater operation. In addition, all components of the pump shall be capable of continuous operation completely unsubmerged, for two (2) hours.
   2. The pump shall be of ASTM 316 or 304 construction or epoxy coated cast iron. The lubricant housing cover plate shall be of corrosion resistant plastic. All exposed nuts and bolts shall be of stainless steel.

C. Motor:
   1. The multi-pole motor shall either be directly connected to the propeller or through a gearbox that locates the motor shaft in line with the propeller shaft. The pump motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. The stator winding shall be insulated with moisture resistant Class F insulation, which will resist a temperature of 180 degrees C (311 degrees F). The stator shall be dipped and baked three times in Class H varnish. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least thirty (30) evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum.
   2. The motor shall be submersible and non-explosion proof.

D. Elastomers: All mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber or Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific

torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease or other devices shall be used.

E. Propeller: The propeller shall be of 316 stainless steel, dynamically balanced, nonclogging backward curved design. Each blade shall be laser cut and welded to the hub and tested to ensure that the propeller is properly balanced. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in normal sewage applications. The propeller shall have three blades.

F. Cable Entry: The cable entry housing shall be an integral part of the backplate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of a cable entry seal failure. Single sealing systems will not be deemed acceptable. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak proof, torque-free seal at the cable entrance. The assembly shall bear against a shoulder in the stator casing opening, and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the pump top. Connection between the threaded compressed type binding posts is permanently affixed to the terminal board and, thus, perfectly leak proof. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

G. Bearings: All bearings shall have a minimum B-10 rated life of 100,000 hours. The outboard propeller bearing shall be an angular contact bearing. The motor shaft end shall be supported by two bearings. A roller bearing shall take up the radial loads, while an angular contact bearing shall take up the axial loads.

H. Thermal Sensors: Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three (3) thermal switches embedded in the end coils of the stator winding. These shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the pump protection relay.

I. Shroud Assembly: The pump assembly shall incorporate a bell shaped inlet shroud, 360 degrees around the propeller. Nuts on the shroud to the pumps shall be bolt pinned so the nuts do not back off.

J. Lubricant Housing: The lubricant housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate lubricant flow. In the event that the mixed media bypasses the outer seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of the simple process of gravity.

K. Mechanical Seals:
   1. Each pump shall be provided with two sets of lapped and face type mechanical seals running in lubricant reservoirs for cooling and lubrication. The mechanical seals shall contain both stationary and positively driven rotary tungsten carbide face rings, unless otherwise specified. In order to avoid seal failure from sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its

retaining clips shall be contained in the lubricant housing. All seal faces must be solid material capable of being relapped.

2. The seals shall require neither maintenance nor adjustment, but shall be easy to check and replace. Shaft seals without positively driven rotating members shall not be considered acceptable or equal.

L. Variable Frequency Drive (VFD): As specified in Section 16262.

M. Moisture Sensors: Each pump shall be equipped with moisture sensing devices with contacts for remote leak detection alarms.

N. Guide Rail and Pump Mounting:
   1. Provide a permanently installed guide rail assembly that allows for pump installation, operation, and retrieval without the need to enter the Oxidation Ditch. The guide rail assembly shall be supplied with factory welded mounting brackets at the top, bottom and intermediate levels as needed to provide support at a maximum of 10-foot intervals. A pump mounting system shall be provided by the pump manufacturer.
   2. A fabricated support frame shall support the weight of the pump at its horizontal center of gravity. Cantilevered designs, with the pump suspended on its own motor housing, will not be considered equal to a support frame design.

O. Hoist:
   1. A hoist system shall be used for lifting and lowering of the pump on the guide rail during installation and maintenance:
      a. Each pump shall have a dedicated hoist.
      b. The hoist shall be designed and mounted such that it is capable of removing two different pumps as shown on the drawings.
      c. The hoist system shall include a manual brake winch, and shall be adequately rated to lift the pump and support arm off the mast and directly onto the adjacent deck surface.
      d. The system shall be capable of 360 degree-rotation. Each hoist assembly shall be rated at a minimum of 500 pounds. All crane and receiving boxes shall be constructed of 316 stainless steel. The sleeves and the bearings in the receiving box shall be constructed of Nylon (PA).
      e. Where handrail is fitted to the deck, removable sections shall be provided such that the pump does not need to be lifted over the handrail.
      f. A lifting cable, permanently attached to each pump, shall be provided in sufficient length for attachment of the upper end to the winch cable reel when the davit assembly is installed.

P. Control/protection module:
   1. Each pump shall be supplied with its own self-contained control/protection module to provide for the direct connection to all internal pump monitoring devices, including:
      a. Thermal protection: Provide automatic reset motor stator temperature detectors, 1 switch in each phase winding. If any detector is activated, the sensor shall activate an alarm and shut down the motor. The thermal detectors shall activate when the stator temperature exceeds 125 degrees Celsius.
      b. Moisture detection: one of the following:

1) Provide capacitive type leakage sensor for the detection of water in the oil chamber or a moisture sensor in the lower motor chamber to detect any fluid in the motor. The sensor shall have an explosion proof rating.
2) Provide a small float to detect the presence of water in the stator chamber.

c. The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump control panel.

2. The module shall signal an alarm condition if any of the internal monitoring devices is activated as described in section 17101.
3. Install module in the pump control panel.

Q. Wall thimbles for each pump shall be provided by pump manufacturer and coordinated with the Contractor.
1. Wall thimbles shall be 304 SST, with minimum 1/4" thick walls and per Specification Section 11292A.
2. Provide transition reducers, if necessary, between the wall thimble and the pump.

2.05 FINISHES

A. Pump manufacturer to factory prime pump/motor as specified in Section 09960. Contractor to provide field coatings as specified in Section 09960.

2.06 CONTROLS

A. As specified in Section 17100 and 17101 as indicated on the Drawings.

B. Coordinate with variable frequency drive manufacturer/supplier.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be as indicated on the Drawings, in accordance with written instructions of the manufacturer, and as specified in Section 15050.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
a. Manufacturer shall provide qualified representative to verify proper installation and assist in pump start-up:

			Manufacturer Rep Onsite					
	Training Requirements		Installation Testing		Functional Testing		Process Operational Period	
Source Testing (Witnessed or Non-witnessed)	Maintenance (hrs per session)	Operation (hrs per session)	Trips	Days (each trip)	Trips	Days (each trip)	Trips	Days (each trip)
Non-Witnessed	4	2	1	1	1	1	24 hour on-call	

b. Start-up: Inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up.
c. Training:
   1) As specified in Section 01756.
   2) Manufacturer to provide at least 2 sessions of training, totaling 8 hours, per the requirements of Division 1.

C. Functional Testing:
   1. Pump assembly:
      a. Performance test: Test level as scheduled; test as specified in Section 15958.
      b. Vibration test: Not required.
      c. Noise test: Not required.

3.03 PUMP SCHEDULE

Tag Numbers	PMP - 2315, 2316, 2325, 2326, 2335, 2336	PMP - 2345, 2346, 2355, 2356, 2365, 2366, 2375, 2376
General Characteristics:		
Service	Mixed Liquor Aeration Basins Nos. 1 - 3	Mixed Liquor Aeration Basins Nos. 4 - 7
Quantity	6	8
Max. Noise, dBA at 3 Feet	85	85
Torsional Analysis	Not Required	Not Required
Minimum Pumped Fluid Degrees Fahrenheit	60	60
Normal Pumped Fluid Degrees Fahrenheit	70	70
Max. Pumped Fluid Degrees Fahrenheit	80	80
Installation Configuration	Wall Mounted	Wall Mounted
Pump Characteristics:		
Impeller Type	Axial	Axial
Impeller, Maximum Number Vanes	3	3
Pass Minimum Sphere Size, Inch	4	4
Speed Control	VFD	VFD
Maximum Pump Speed, rpm	580	860

Tag Numbers	PMP - 2315, 2316, 2325, 2326, 2335, 2336	PMP - 2345, 2346, 2355, 2356, 2365, 2366, 2375, 2376
Minimum Pump Speed, rpm	-	-
Rated Design Point: (at Maximum rpm)		
Flow, gpm	6,364	4,850
Head, Feet	2.6	1.71
Minimum Overall Efficiency, Percent	42	50
Rated Design Point: (at Reduced rpm)		
Flow, gpm	2,083	1,390
Head, Feet	0.30	0.15
Minimum Overall Efficiency, Percent	15	40
Pump Materials:		
Pump, Shroud, and Motor Casing	316 Stainless Steel	316 Stainless Steel
Shaft	316 Stainless Steel	316 Stainless Steel
Shaft Key	316 Stainless Steel	316 Stainless Steel
Motor Characteristics:		
Motor Drive	As specified in Section 16222	As specified in Section 16222
Maximum Driver Speed, rpm	580	860
Motor Horsepower, Minimum	8.3	4
Voltage/Phases/hertz	460/3/60	460/3/60
Service Factor	1.15	1.15
Full Load Current, Amperes	16	7.4
Locked Rotor Current, Amperes	53.9	27
Motor Efficiency (At 100 Percent Load)	75%	77%
Power Factor (At 100 Percent Load)	0.62	0.66
Enclosure Type	Submersible, Non-explosion Proof	Submersible, Non-explosion Proof
NEMA Design Type	B	B
Source Testing:		
Test Witnessing	Not Witnessed	Not Witnessed
Performance Test Level	3	3
Vibration Test Level	None	None
Noise Test Level	None	None
Functional Testing:		
Performance Test Level	1	1
Vibration Test Level	Not required.	Not required.
Noise Test Level	Not required.	Not required.

END OF SECTION

PRE-NEGOTIATED PROPOSAL FROM SHAPE INCORPORATED

SECTION 11312P:

SUBMERSIBLE AXIAL FLOW PROPELLER PUMPS

QUOTATION

PLEASANTON

6600 Knoll Center Parkway, Ste. 220
Pleasanton, CA 94566
Phone (925) 485-9720
Fax (925) 485-6085

STOCKTON

119 Val Dervin Parkway #2
Stockton, CA 95206
Phone (209) 234--5909
Fax (209) 234-5913

John Mohr mobile # 209-324-8058

TO: City of Turlock / Carollo Engineering

DATE: 12/22/2016, 02/13/2017 revised as of 03/16/2017

QUOTE #: 96742 FL (11312P)

Page (1) of (3) - Quote based on 2017 Xylem/Flygt Prices and 90% Plans &

Specifications dated January 2017

JOB: City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project – Spec. Section 11312P Submersible Axial Flow Propeller PMP.

LOCATION: Turlock, CA

ATTN:

PHONE:
Fax:

WE ARE PLEASED TO QUOTE ON THE FOLLOWING EQUIPMENT

SUBJECT TO CONDITIONS PRINTED ON THE BACK HEREOF, THESE CONDITIONS MAY BE CHANGED ONLY BY A WRITTEN STATEMENT SIGNED BY AN OFFICER OF SHAPE, INCORPORATED.

☒ F.O.B.
☒ F.F.A. TO FIRST

QTY	ITEM	PRICE
	III - A) Specification Section 11312P Submersible Axial Flow Propeller Pumps - 6 Units **Mixed Liquor Aeration Basins # 1, 2 and # 3 – 5,900 GPM @ 1.5 TDH** **Equipment Tag # PMP-2315, 2316, 2325, 2326, 2335, and PMP-2336**	
6	Flygt recirculation pumps PP4650.412-1258 3 degree (580 mm), 8.3 HP, 480 volts 3-phase, NON-EXP, 316 SS, 540 Lbs. each, 50 ft. power/sensor cord, 16 FLA, 580 RPM, FLS	
6	**24" x 54.5" long (Estimated Length)– WALL THIMBLE WITH ANNULAR RING, 304 STAINLESS- STEEL,** flange x flange,	
18	942056 Cable holders part # 834563	
6	24" ANSI Pipe Disc Flange Adapter	
6	PP4650 Upper Guide Rail Bracket, 316 SS	
6	Lifting Cable, 1/4" x 45 ft. long, 316 SS - Thern	
12	Plastic plugs for Guide rail pipes	
***	**Guide Rails by others, 2" schedule 40 welded 304 or 316 stainless-steel pipe**	
6	Flygt Mini-cas relays (moisture intrusion & motor thermal overload monitoring relay) The responsibility to install the mini-cas relay into the pump's control panel supplied by others and any material or labor cost incurred is not Shape Inc. responsibility	

SHAPE INC.

John Mohr

John Mohr cell ph: 209-324-8058 OR jmohr@shapecal.com

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NOTE: ITEMS NOT SPECIFIED ON THIS QUOTATION ARE NOT INCLUDED IN OUR PRICE AND ARE TO BE SUPPLIED BY OTHERS. PRICES ARE FOR IMMEDIATE ACCEPTANCE AND SUBJECT TO CHANGE WITHOUT NOTICE. Rev. 01/98
SALE SUBJECT TO MANUFACTURERS STANDARD TERMS AND CONDITIONS.

See attached page for Shape, Inc. terms and conditions

SHAPE INCORPORATED

QUOTATION

	Page (2) of (3), City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project, March 16, 2017 based on 90% project plans & specifications, dated January 2017 Continued: **III - A) Specification Section 11312P Submersible Axial Flow Propeller Pumps - 6 Units** **Mixed Liquor Aeration Basins # 1, 2 and # 3 – 5,900 GPM @ 1.5 TDH** **Equipment Tag # PMP-2315, 2316, 2325, 2326, 2335, and PMP-2336**	
6	Portable Davit Cranes & Winches – 316 stainless-steel	
6	Wall Mount Bases for the above davit cranes – 316 SS	
6	Lifting Cables Assembles, ¼" x 40 ft. long – 316 stainless-steel	
1	O & M manual for mixers and davit cranes	
1	Seismic Calculations for mixers & davit cranes	
1	Bearings, inner/outer mechanical seal assembly, and "O" ring kit	
2	Spare Parts Item –Power/Sensor Cable grommet	
1	Start-up Service & Training (two (2) week notice required) – the installing contractor has responsibility to remove and reinstall pumps into the wet well at the time the pumps are checked physically and correct rotation has been determined	
	III – B) Specification Section 11312P Submersible Axial Flow Propeller Pumps - 8 Units **Mixed Liquor Aeration Basins # 4, 5, 6 and # 7 – 4,500 GPM @ 1.5 TDH** **Equipment Tag # PMP-2345, 2346, 2355, 2356, 2365, 2366, 2375 and PMP-2376**	
8	Flygt recirculation pumps PP4640.412-837 - 13 degree (368 mm), 4 HP, 480 volts 3-phase, NON-EXP, 316 SS, 250 Lbs. each, 50 ft. power/sensor cord, 6.9 FLA, 860 RPM, FLS	
8	**16" to 20" x 54.5" long (Estimated Length)– WALL THIMBLE WITH ANNULAR RING, 304 STAINLESS-STEEL,** flange x flange,	
24	942056 Cable holders part # 834563	
8	16" ANSI Pipe Disc Flange Adapter	
8	PP4640 Upper Guide Rail Bracket, 316 SS	
8	Lifting Cable, 1/4" x 45 ft. long, 316 SS - Thern	
8	Plastic plugs for Guide rail pipes	
	Guide Rails by others, 2" schedule 40 welded 304 or 316 stainless-steel pipe	
8	Flygt Mini-cas relays (moisture intrusion & motor thermal overload monitoring relay) The responsibility to install the mini-cas relay into the pump's control panel supplied by others and any material or labor cost incurred is not Shape Inc. responsibility	
8	Portable Davit Cranes & Winches – 316 stainless-steel	
8	Wall Mount Bases for the above davit cranes – 316 SS	
8	Lifting Cables Assembles, ¼" x 40 ft. long – 316 stainless-steel	
1	O & M manual for mixers and davit cranes	
1	Seismic Calculations for mixers & davit cranes	
1	Spare Parts Item – Basic Repair Kit which includes one (1) set of following: upper & lower Bearings, inner/outer mechanical seal assembly, and "O" ring kit	

SHAPE INC.

*John Mohr*_____

John Mohr cell ph: 209-324-8058 OR jmohr@shapecal.com

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QUOTATION

	Page (3) of (3), City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project, March 16, 2017 based on 90% project plans & specifications, dated January 2017 Continued: **III – B) Specification Section 11312P Submersible Axial Flow Propeller Pumps - 8 Units** **Mixed Liquor Aeration Basins # 4, 5, 6 and # 7 – 4,500 GPM @ 1.5 TDH** **Equipment Tag # PMP-2345, 2346, 2355, 2356, 2365, 2366, 2375 and PMP-2376**	
2 1	Spare Parts Item –Power/Sensor Cable grommet Start-up Service & Training (two (2) week notice required) – the installing contractor has responsibility to remove and reinstall pumps into the wet well at the time the pumps are checked physically and correct rotation has been determined	
	Important Notes / Not Included: No special coatings/finishes on the pump/motor units or base discharge elbows interior or Exterior surface, only factory standard finishes is being supplied. No level sensors, electrical junction boxes, motor control center (MCC), Variable Frequency Drives (VFD) are being supplied except for where noted above Prices include freight charges to one destination, FOB Factory Prices do not include any sales or use taxes concrete wet well or valve vault, access-cover & frames, grating, any other Factory special testing, pipe support brackets, equipment unloading, guide rails - 2" schedule 40, 316 or 304 stainless-steel welded pipe, discharge pipe, fitting, and valves, anchor bolts & nuts, kellum / cable grips, special coatings or finishes, pressure or vacuum gauges, control panels, electrical junction boxes, local or remote control panels unless noted is the material to be supplied, any other item not specifically noted in the list of items being supplied Extra length of Power/ Sensor cable is available at an additional cost	**11312P III - A) and III - B) (14) Axial Flow Pumps (PP) Grand-total Net Delivered Price: $ 405,379.00 Not including sales tax**
	Estimated Delivery Schedule: Equipment submittals for pumping equipment and accessories is 4 weeks and after contract and credit approval Delivery of equipment to ship to address is 12 -14 weeks, based upon having an approved equipment submittal in hand Shape Inc. Terms & Conditions of sale apply	

SHAPE INC.

*John Mohr*_____

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SECTION 11317

SUBMERSIBLE MIXERS: HIGH-SPEED

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for providing submersible mixers and accessory items required for a complete and operable system.

B. Related sections:
   1. Section 01140 - Work Restrictions.
   2. Section 01756 - Commissioning and Process Start-Up.
   3. Section 09960 - High-Performance Coatings.
   4. Section 15050 - Common Work Results for Mechanical Equipment.
   5. Section 15958 - Mechanical Equipment Testing.

C. The Owner has pre-qualified and pre-negotiated with Xylem Flygt (this arrangement is referred to herein as “Supplier/Manufacturer”) a cost proposal for providing the Submersible Mixers: High-Speed. Unless stated otherwise, the cost proposal for the Submersible Mixers: High-Speed includes equipment and accessories as specified in this section. The pre-negotiated price quotation for the Submersible Mixers: High-Speed is $479,736. A copy of the cost proposal from the Supplier dated March 16, 2017, is for the Contractor’s informational use and reference only. The price quotation is valid until 120 days from Bid Opening. A copy is attached at the end of this Section. The Contractor shall purchase the equipment from the Supplier/Manufacturer and shall install the equipment as part of this Project. However, the Contractor is allowed, prior to opening bid, to negotiate with the Supplier/Manufacturer the cost, terms, and conditions for the purchase of the system and accessories to be furnished by the Contractor as part of this project to provide a complete working system.

D. Cost of Pre-negotiated Items:
   1. The Contractor shall carefully review the applicable pre-negotiated proposal to determine those items required by the Contract Documents which are not part of the proposal or specified Supplier/Manufacturer’s scope of supply. In addition to the cost indicated for the applicable bid item in the pre-negotiated proposal, the Contractor shall include in his bid the costs for the following:
      a. All items not specifically itemized in the Supplier/Manufacturer’s Scope of Supply provided as part of the pre-negotiated proposal, but required by the Contract Documents and/or necessary to provide a complete and operational system.
      b. All items specifically itemized in the Supplier/Manufacturer’s Scope of Supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by customer, provided by Owner, or any similar designation.
      c. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.

d. Any additional cost required by the supplier due to any charges the Contractor may wish to make to the terms and/or conditions of the pre-negotiated proposal, including but not limited to payment terms, delivery schedule, scope or work, etc.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. The mixers shall be capable of handling raw, screened sewage and mixture of primary effluent and activated sludge.
   2. The mixers shall be able to be raised and lowered and shall be easily removed for inspection or service without the need for personnel to enter mixing vessel.
   3. A sliding guide bracket shall be an integral part of the mixer unit. The entire weight of the mixer unit shall be guided by a single bracket which must be able to handle all thrust created by the mixer.
   4. The mixer, with its appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 130 feet.
   5. Each mixer shall be of the integral gear drive or direct drive, close-coupled, submersible type. All components of the mixer, including the motor and gearbox, shall provide continuous underwater operation while the mixer blades are completely submerged.
   6. Performance requirements:
      a. The mixers shall be selected and positioned by the mixer supplier to achieve a uniform concentration of mixed liquor suspended solids in the liquid under the specified operating conditions at all locations within the specified zones.
      b. Mixer supplier shall guarantee that the selected mixers will perform the specified duty when all mixers are operating and positioned according to the mixer suppliers requirements.
   7. Refer to the mixer schedule in Section 3 for additional design requirements.

1.03 SUBMITTALS

A. Submit as specified in Section 15050.

B. Design data: Sufficient to verify performance requirements including structural and vibration requirements, of these specifications:
   1. Structural calculations and details.
   2. Mechanical calculations and details including gear reducers.

C. Shop drawings.

D. Product data:
   1. Catalog data and manufacturers' specifications.
   2. Material specifications.

E. Closeout submittals:
   1. O&M Manual.

1.04 QUALITY ASSURANCE

A. General: As specified in Section 15050.

B. Provide pumps specified in this Section from same manufacturer.

C. Require manufacturer to furnish and coordinate mixer and components as scheduled and to provide written installation and checkout requirements.

D. Manufacturer's representative:
   1. The manufacturer shall provide the services of a qualified factory trained representative for the purpose of checkout, startup, testing, and instructing the operating personnel for a period of not less than 8 working hours. All associated costs shall be included in the bid.

E. The mixing equipment specified shall be the design and fabrication by a single manufacturer which shall have sole source responsibility for said equipment.

1.05 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions as specified in Section 01140.

1.06 WARRANTY

A. As specified in Section 15050.

1.07 MAINTENANCE

A. Spare parts: Provide 1 set of the following items for each type and size required by the units:
   1. O-rings.
   2. Bearings.
   3. Mechanical Seals.
   4. Power Cable Grommet.

PART 2 PRODUCT

2.01 MANUFACTURERS

A. By the following manufacturer, no equal:
   1. Xylem Flygt.

2.02 SUBMERSIBLE MIXERS

A. Each mixer shall be of the integral design, close coupled submersible type. All components of the mixer, including motor shall be capable of continuous underwater operation. In addition, all components of the mixer shall be capable of continuous operation completely unsubmerged, for 2 hours.

B. Major mixer components shall be of Type 316 stainless steel construction. The oil housing cover plate shall be of corrosion resistant composite. All exposed nuts and bolts shall be of Type 316 stainless steel.

C. Elastomers:
   1. All mating surfaces where watertight sealing is required shall be machined and fitted with a double set of Nitrile rubber or Viton O-rings.
   2. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces.
   3. This will result in controlled compression of the O-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease, or other devices shall be used.

D. Propeller:
   1. The propeller shall be of Type 316 stainless steel dynamically balanced, non-clogging backward curved design. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced. The propeller shall be capable of handling solids, fibrous materials, heavy sludge, and other matter found in normal sewage applications.
   2. The propeller shall have 3 vanes.
   3. The mixer shall be capable of providing the amount of thrust as required by the design requirements and as specified in Section 3.04.

E. Cable entry:
   1. The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of cable entry failure.
   2. Single sealing systems will not be deemed acceptable.
   3. The cable entry shall be comprised of 2 cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak proof seal at the cable entrance without the need for specific torque requirements.
   4. The assembly shall bear against the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion.
   5. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the mixer top.
   6. Connection between the threaded compressed type binding posts permanently affixed to the terminal board and thus perfectly leak proof.
   7. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

F. Bearings:
   1. All bearings shall have a minimum B-10 rated life of 100,000 hours.
   2. The outboard propeller bearing shall be an angular contact bearing.
   3. The motor shaft end shall be supported by 2 bearings:
      a. A roller and an angular contact bearing shall take up the axial and radial loads while an angular contact bearing shall take up the axial loads.
      b. The bearings shall be pre-loaded by a bearing loading nut located on the motor end of the shaft in order to reduce shaft deflection and increase bearing life and seal life.
      c. Mixers without pre-loaded bearings will not be considered acceptable or equal.

G. Thermal sensors:
   1. Thermal sensors shall be used to monitor stator temperatures.
   2. The stator shall be equipped with 3 thermal switches embedded in the end coils of the stator winding. These shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

H. Jet ring assembly:
   1. The mixer assembly shall incorporate a jet ring of full 360 degrees around the propeller.
   2. The jet ring shall be made from 316 Stainless Steel. Coating, mild steel, 304 material.
   3. A maximum clearance of 1-1/2 inches shall be maintained between the propeller tip and the shroud in order to maintain hydraulic efficiency and power consumption.

I. Oil housing:
   1. The oil housing shall contain 2 compartments consisting of an inner and an outer section with 4 ports to connect and facilitate oil flow. In the event that the mixed media bypasses the other seal, this design will allow the outer compartment to collect the heavier (denser) fluids by mean of a simple gravity process.

J. Mechanical seals:
   1. Each mixer shall be provided with 2 sets of lapped end face type mechanical seals running in oil reservoirs for cooling and lubrication:
      a. The mechanical seals shall contain positively driven rotary silicon carbide/tungsten carbide face rings.
      b. In order to avoid seal failure due to sticking, clogging, and misalignment from elements contain in the mixed media, only the seal faces of the outer assembly and its retaining clips shall be exposed to the mixed media.
      c. All other components shall be contained in the oil housing.
      d. All seal faces must also be capable of relapping.
   2. The seals shall require neither maintenance nor adjustment, but shall be easy to check and replace.
   3. Shaft seals without positively driven rotating members shall not be considered acceptable or equal.

K. Control/protection module:
   1. Each mixer shall be supplied with its own self-contained control/protection module to provide for the direct connection to all internal mixer monitoring devices, including:
      a. Thermal protection: Provide automatic reset motor stator temperature detectors, 1 switch in each phase winding. If any detector is activated, the sensor shall activate an alarm and shut down the motor. The thermal detectors shall activate when the stator temperature exceeds 125 degrees Celsius.
      b. Moisture detection: one of the following:
         1) Provide capacitive type leakage sensor for the detection of water in the oil chamber or a moisture sensor in the lower motor chamber to detect any fluid in the motor. The sensor shall have an explosion proof rating.

2) Provide a small float to detect the presence of water in the stator chamber.

c. The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump control panel.

2. The module shall signal an alarm condition if any of the internal monitoring devices is activated as described in section 17101.
3. Install module in the mixer control panel.

2.03 MOTOR

A. General:
1. The multi-pole motor shall be directly connected to the propeller to produce a propeller speed of not more than 860 revolutions per minute.
2. The mixer motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber.
3. The motor shall be non-explosion proof.
4. The stator winding shall be insulated with moisture resistant Class H insulation which will resist a temperature of 180 degrees Celsius (311 degrees Fahrenheit).
5. The stator shall be dipped and baked 3 times in Class F varnish.
6. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least 30 evenly spaced starts per hour.
7. The rotor bars and short circuit rings shall be made of aluminum.

B. Electric motor type:
1. Type: Submersible electric motors connected for operation on a 460 volt, 3 phase, 60 hertz, alternating current service.
2. Horsepower: As scheduled.
3. Conductors: Conductors of adequate length with #14AWG7 size submersible cable.
4. Cables: Shall be oil resistant chloroprene rubber jacketed. Each unit shall be fitted with lifting cable of adequate length and strength to permit raising and lowering the mixer.
5. The motor shall have three thermal switches, one in each phase, used in conjunction with and supplemental to external motor overload protections.

C. Motor efficiency and power factor:
1. Efficiency: At full load and 75 percent load shall not be less than 74.5 percent.
2. Power factor: At full load shall not be less than 73 percent.

2.04 MANUAL CRANE

A. The manual crane shall be supplied for each mixer and shall be capable of being removed from the mixer mounting location and used at a second mounting location when utilized in conjunction with the 2 inch system 4 mixer support cable.

B. The boom and winch shall be easily assembled and removed from the crane mast to better facilitate assembly and storage requirements, respectively.

C. The crane shall be capable of rotating a mixer 360 degrees.

D. The crane shall have a reach of 27 inches from the centerline of the crane mast to the centerline of the lifting cable.

E. Load capacity: The crane shall be capable of hoisting 650 pounds.

F. The winch shall be of marine grade construction.

G. The main body of the crane (excluding the winch) shall be of Type 316 stainless steel material of construction.

H. No less than 40 feet of Type 316 stainless steel cable (1/4 inch diameter) shall be supplied.

I. The entire manual crane assembly shall weigh no more than 70 pounds.

2.05 MIXER MOUNT ASSEMBLY

A. General:
   1. Stainless steel, mixer mount assembly kit shall be supplied by the mixer manufacturer for each mixer and used to mount the mixer during operation and to guide the unit during installation and removal from service.

B. Fabrication:
   1. Upper, lower, intermediate brackets, and structural spool support for intermediate brackets: Type 316 stainless steel.
   2. The upper bracket shall be fitted with a special receptacle that securely holds and supports the davit while the mixer is raised, lowered, installed or removed from the tank. The davit shall be sufficient to safely raise and lower the mixture.
   3. The mixer mount assembly shall include a field adjustable length of Type 316 stainless steel mixer support cable assembly of adequate length:
      a. A 2 inch by 2 inch by 1/4 inch mast shall securely interface with the mixer manufacturer's upper, lower, and intermediate brackets and integrate in such a way to securely support the mixer during operation.
      b. All support bracket assemblies shall be supplied by the mixer manufacturer only in order to ensure the integrity of the system under optional loads.
   4. The assembly shall also be provided with cable holders to secure the mixer electric power cable (1 every 5 feet). Their purpose shall be to prevent the electric cable from becoming entangled in the mixer propeller during operation:
      a. In addition, the mast shall be constructed with a positioning locking plate which will work in conjunction with a lock pin on the upper holder to positively lock the mast in place at various operating angles.

2.06 SOURCE QUALITY CONTROL

A. Mixer tests: The mixer manufacturer shall perform the following inspections and tests on each mixer before shipment form the factory:
   1. Propeller, motor rating, and electrical connections shall be checked for compliance to the specifications.
   2. All mixers shall be vacuum tested to establish sealing integrity. All mixers shall be momentarily energized to determine correct rotation and current draw (prior to immersion).

3. All mixers shall be run dry and/or immersed to determine correct shaft rotation, thrust direction, and power consumption.
4. After immersion test(s), all mixers shall be inspected for oil seepage and/or water infiltration, insulation defect(s), and motor resistance (Ohms).
5. The factory test shall use ISO21630 test for mixer thrust and ISO216 mixer efficiency standard to confirm satisfactory specification compliance.

B. Inspection and tests performed shall confirm the mixer(s) listed have met all established quality assurance standards set for similar materials. All mixers shall be warranted against defects in design, workmanship, and material.

C. A written report stating the foregoing steps have been completed shall be furnished.

D. The manufacturer shall test three mixers of each size at the factory for thrust in addition to the electrical inspections and tests.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as specified in Section 15050.

B. Field coating as specified in Section 09960.

3.02 FIELD QUALITY CONTROL

A. Field testing shall be completed by a third party provided by the Contractor. The third party tester shall be qualified to conduct field quality control tests to confirm proper operation and mixing in the basins.

B. Witnessing: All field-testing shall be witnessed by the Engineer; provide advanced notice of field-testing as specified in Section 15958.

C. Inspection and checkout: As specified in Sections 15050 and 15958.

D. Equipment performance test: Test level as scheduled; test as specified in Section 15958.

E. Vibration test: Test level as scheduled; test as specified in Section 15958.

F. Noise test: Test level as scheduled; test as specified in Section 15958.

G. Operational testing:
1. Clear Water Test:
    a. Operate mixers for a minimum of 24 hours with the basins full of water.
    b. Confirm that the masts and mounting bracket assemblies are free from vibration of any kind and that the mixers are maintained in their set positions at all times.
    c. After completion of 24-hour test, the equipment shall be removed from the tank and inspected by a factory-trained representative for leaks through

the seals. All leaks shall be documented and corrected at the Contractor's expense.

d. Demonstrate that the mixers are easily placed and removed without draining the tank and that the mixers easily move up and down the mast assembly without binding or crabbing.

H. Performance Testing:

1. General:
   a. Conduct either the Liquid Velocity Test or the Suspended Solids Concentration Test specified herein to demonstrate that each mixer has been positioned properly and achieves the performance criteria specified in the Performance Requirements.
   b. Failure to demonstrate compliance with one of these tests shall be cause for the equipment to be rejected. Upon rejection, all mixers shall be replaced with units of sufficient power and design to achieve the specified requirements. All costs associated with removal and replacement of mixing equipment to achieve the specified performance shall be borne by the Contractor.
2. Liquid Velocity Test:
   a. During the Clear Water Test, provide liquid stream current meters, boats, and sufficient personnel for sufficient time to demonstrate that each mixer has been positioned properly and achieves the minimum horizontal liquid velocities specified in the Performance Requirements.
3. Suspended Solids Concentration Test:
   a. Demonstrate that each mixer has been positioned properly and achieves a uniform concentration of mixed liquor suspended solids at all locations within the basins as specified in the Performance Requirements. Perform test after basin has been filled with mixed liquor and is in operation.
   b. Sample mixed liquor suspended solids at selected locations throughout the mixed basins in a vertical stack at various depths.
   c. A uniform concentration of mixed liquor suspended solids shall be defined as 75 percent of the samples being within plus or minus 10 percent of the arithmetic average of the suspended solids concentration for all samples taken during the test.

3.03 MANUFACTURER'S FIELD SERVICES

A. Require manufacturer to inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up as specified in this Section and in Sections 15050 and 15958.

B. Training:

1. A technical representative shall provide a total of 4 hours of onsite instruction to the Owner regarding operation and maintenance of the mixer systems.
2. As specified in Section 01756.

3.04 MIXER SCHEDULE

Tag numbers	MIX-2311, MIX-2312, MIX-2313, MIX-2321, MIX-2322, MIX- 2323, MIX-2331, MIX-2332, MIX-2333	MIX-2341, MIX-2342, MIX-2343, MIX-2351, MIX-2352, MIX-2353, MIX-2361, MIX-2362, MIX-2363 MIX-2371, MIX-2372, MIX-2373
Service	Mixed Liquor in Anoxic Zone (Aeration Basins Nos. 1 - 3)	Mixed Liquor in Anoxic Zone (Aeration Basins Nos. 4 - 7)
Mixing Basin Characteristics		
Length, ft each zone (1)	(See Note 1)	35
Width, ft each zone (1)	(See Note 1)	35
Side Water Depth, ft	13.5	13.5
Volume, gal each zone	160,000	120,000
Number of Basins	3	4
Number of Zones per Basin	3	3
Number of Mixers per Zone	1	1
Total Quantity of Mixers	9	12
Minimum Fluid Temperature Degrees Fahrenheit	40	40
Normal Fluid Temperature Degrees Fahrenheit	70	70
Max. Fluid Temperature Degrees Fahrenheit	90	90
Mixer Characteristics		
Model Number of First Named Manufacturer	Flygt 4650	Flygt 4640
Number of Blades	3	3
Propeller diameter, minimum inches	22.8	14.5
Jetring	Required	Required
Speed Control	Constant Speed	Constant Speed
Propeller Speed, maximum RPM	600	860
Max. Mixer Shaft Power, hp Mixer voltage/cycle/hertz Mixer nominal thrust, N	8 460/3/60 1,350	4 460/3/60 820

Tag numbers	MIX-2311, MIX-2312, MIX-2313, MIX-2321, MIX-2322, MIX- 2323, MIX-2331, MIX-2332, MIX-2333	MIX-2341, MIX-2342, MIX-2343, MIX-2351, MIX-2352, MIX-2353, MIX-2361, MIX-2362, MIX-2363 MIX-2371, MIX-2372, MIX-2373
Mixer power uptake, kW	4.67	3.21
Motor Enclosure	Submersible, Non-explosion Proof	Submersible, Non-explosion Proof

Source Quality Control Testing		
Test witnessing	Not Witnessed	Not Witnessed
Performance Test Level	As specified in Section 2.06	As specified in Section 2.06
Vibration Test Level	None	None
Noise Test Level	None	None
Functional Testing	1	1
Performance Test Level	1	1
Vibration Test Level	None	None
Noise Test Level	None	None
Notes: 1. Basins have side slopes. See drawings for basin geometry.		

END OF SECTION

PRE-NEGOTIATED PROPOSAL FROM SHAPE INCORPORATED

SECTION 11317:

SUBMERSIBLE MIXERS: HIGH SPEED

SHAPE INCORPORATED

QUOTATION

PLEASANTON

6600 Knoll Center Parkway, Ste. 220
Pleasanton, CA 94566
Phone (925) 485-9720
Fax (925) 485-6085

STOCKTON

119 Val Dervin Parkway #2
Stockton, CA 95206
Phone (209) 234--5909
Fax (209) 234-5913

John Mohr mobile # 209-324-8058

TO: **City of Turlock / Carollo Engineering**

DATE: **12/22/2016, 02/13/2017 revised as of 03/16/2017**

QUOTE #: **96742 FL (11317)**

Page (1) of (3) - Quote based on 2017 Xylem/Flygt Prices and 90% Plans & Specifications dated January 2017

JOB: **City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project – Spec. Section 11317 Submersible Mixers: High Speed**

LOCATION: **Turlock, CA**

ATTN:

PHONE:
Fax:

WE ARE PLEASED TO QUOTE ON THE FOLLOWING EQUIPMENT

SUBJECT TO CONDITIONS PRINTED ON THE BACK HEREOF, THESE CONDITIONS MAY BE CHANGED ONLY BY A WRITTEN STATEMENT SIGNED BY AN OFFICER OF SHAPE, INCORPORATED.

☒ F.O.B.
☒ F.F.A. TO FIRST

QTY	ITEM	PRICE
	IV - A) Specification Section 11317 Submersible Mixers: High Speed - 9 Mixer Units Mixed Liquor in Anoxic Zone (Aeration Basins # 1, 2 and # 3) Equipment Tag # MIX-2311, 2312, 2313, 2321, 2322, 2323, 2331, 2332, and MIX-2373	
9	Flygt mixers 4650.412-P35803SJ - 3 degree, 8.3 HP, 460 volts 3-phase, NON-EXP, 316 SS, 50 ft. power/sensor cord, FLS, 435 lbs. each,	
1	Factory Set-up fee for Mixer Thrust Test	
3	Factory Mixer Thrust Test, 2.2	
9	System 4 mast assembly w/o provisions for crane mounting, 316 SS, part # 14-589252	
1	Spare Parts Item – Basic Repair Kit which includes one (1) set of following: upper & lower Bearings, inner/outer mechanical seal assembly, and “O” ring kit	
2	Spare Parts Item –Power/Sensor Cable grommet	
180	Ft. of 4" x 4" x 3/16" wall thickness - 316 SS Square Guide Tube, each piece is 20 ft. lengths	
9	Flygt Mini-cas relay	
9	Portable Davit Cranes & Winches – 316 stainless-steel	
9	Wall Mount Bases for the above davit cranes – 316 SS	
9	Lifting Cables Assembles, ¼” x 40 ft. long – 316 stainless-steel	

SHAPE INC.

John Mohr

John Mohr cell ph: 209-324-8058 OR jmohr@shapecal.com

QUOTATION DOES NOT INCLUDE ANY SALES OR USE TAX PAYABLE UNDER ANY STATE OR FEDERAL STATURE. THIS QUOTATION PRICE IS FOR MATERIAL LISTED ABOVE. ANY ADDITIONS OR MODIFICATIONS THAT BECOME NECESSARY FOR APPROVED SUBMITTALS, UPON AWARDING OF THIS CONTRACT, MAY RESULT IN NECESSARY PRICE CHANGES.

NOTE: ITEMS NOT SPECIFIED ON THIS QUOTATION ARE NOT INCLUDED IN OUR PRICE AND ARE TO BE SUPPLIED BY OTHERS. PRICES ARE FOR IMMEDIATE ACCEPTANCE AND SUBJECT TO CHANGE WITHOUT NOTICE. Rev. 01/98
SALE SUBJECT TO MANUFACTURERS STANDARD TERMS AND CONDITIONS.

See attached page for Shape, Inc. terms and conditions

SHAPE INCORPORATED

QUOTATION

	Page (2) of (3), City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project, March 16, 2017 based on 90% project plans & specifications, dated January 2017	
	Continued: **IV – A) Specification Section 11317 Submersible Mixers: High Speed - 9 Mixer Units Mixed Liquor in Anoxic Zone (Aeration Basins # 1, 2 and # 3)** **Equipment Tag # MIX-2311, 2312, 2313, 2321, 2322, 2323, 2331, 2332, and MIX-2373**	
1	O & M manual for mixers and davit cranes	
1	Seismic Calculations for mixers and davit cranes	
1	Start-up Service & Training (two (2) week notice required) – the installing contractor has responsibility to remove and reinstall pumps into the wet well at the time the pumps are checked physically and correct rotation has been determined	
1	Freight Charges to Job Site, FOB Factory	
	IV - B) Specification Section 11317 Submersible Mixers: High-Speed - 12 Units in Mixed Liquor in Anoxic Zone (Aeration Basins # 4,5,6, and # 7) **Equipment Tag # MIX-2341, 2342, 2343, 2351, 2352, 2353, 2361, 2362, 2363, 2371, 2372 and MIX-2373**	
12	Flygt mixers 4640.412-083712SL - 12 degree, 4 HP, 460 volts 3-phase, NON-EXP, 316 SS, 50 ft. power/sensor cord, FLS, 220 lbs. each,	
1	Factory Set-up fee for Mixer Thrust Test	
3	Factory Mixer Thrust Test, 2.2	
12	System 4 mast assembly w/o provisions for crane mounting, 316 SS,	
1	Spare Parts Item – Basic Repair Kit which includes one (1) set of following: upper & lower Bearings, inner/outer mechanical seal assembly, and “O” ring kit	
2	Spare Parts Item –Power/Sensor Cable grommet	
240	Ft. of 2" x 2" x 3/16" wall thickness - 316 SS Square Guide Tube, each piece is 20 ft. lengths	
12	Flygt Mini-cas relay	
12	Portable Davit Cranes & Winches – 316 stainless-steel	
12	Wall Mount Bases for the above davit cranes – 316 SS	
12	Lifting Cables Assembles, ¼” x 40 ft. long – 316 stainless-steel	
1	O & M manual for mixers and davit cranes	
1	Seismic Calculations for mixers & davit cranes	
1	Start-up Service & Training (two (2) week notice required) – the installing contractor has responsibility to remove and reinstall pumps into the wet well at the time the pumps are checked physically and correct rotation has been determined	
1	Freight Charges to Job Site, FOB Factory	

SHAPE INC.

*John Mohr*_____

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SHAPE INCORPORATED

QUOTATION

	Page (3) of (3), City of Turlock – Secondary Clarifier No. # 5 and Denitrification Project, March 16, 2017 based on 90% project plans & specifications, dated January 2017 **Important Notes / Not Included:** No special coatings/finishes on the pump/motor units or base discharge elbows interior or Exterior surface, only factory standard finishes is being supplied. No level sensors, electrical junction boxes, motor control center (MCC), Variable Frequency Drives (VFD) are being supplied except for where noted above Prices include freight charges to one destination, FOB Factory Prices do not include any sales or use taxes concrete wet well or valve vault, access-cover & frames, grating, any other Factory special testing, pipe support brackets, equipment unloading, guide rails - 2" schedule 40, 316 or 304 stainless-steel welded pipe, discharge pipe, fitting, and valves, anchor bolts & nuts, kellum / cable grips, special coatings or finishes, pressure or vacuum gauges, control panels, electrical junction boxes, local or remote control panels unless noted is the material to be supplied, any other item not specifically noted in the list of items being supplied Extra length of Power/ Sensor cable is available at an additional cost **Estimated Delivery Schedule:** Equipment submittals for pumping equipment and accessories is 4 weeks and after contract and credit approval Delivery of equipment to ship to address is 12 -14 weeks, based upon having an approved equipment submittal in hand Shape Inc. Terms & Conditions of sale apply	**11317** **IV - A) and** **IV - B)** **(21) MIXERS** **Grand-total** **Net** **Delivered** **Price:** **$ 479,736.00** **Not including sales tax**

SHAPE INC.

*John Mohr*_____

John Mohr cell ph: 209-324-8058 OR jmohr@shapecal.com

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SECTION 11353B

CIRCULAR SECONDARY CLARIFIER EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Specification of equipment for installation in circular secondary clarifiers of center feed, peripheral overflow design.
   2. Clarifier accessories:
      a. Weir washer system.
      b. Density current baffle.
   3. Not all clarifier accessories described in this specification are necessarily supplied by the sludge collector mechanism manufacturer. The Contractor shall coordinate among the different manufacturers to ensure a compatible and complete installation as indicated on the Drawings.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01140 - Work Restrictions.
      b. Section 01410 - Regulatory Requirements.
      c. Section 01612 - Seismic Design Criteria.
      d. Section 01756 - Testing, Training, and Facility Startup.
      e. Section 05500 - Metal Fabrications.
      f. Section 06611 - Fiberglass Reinforced Plastic Fabrications.
      g. Section 09960 - High-Performance Coatings.
      h. Section 15061 - Pipe Supports.
      i. Section 16222 - Low Voltage Motors up to 500 Horsepower.
      j. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. American Gear Manufacturers Association (AGMA):
   1. 908 - Information Sheet - Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth.
   2. 915-1 - Inspection Practices - Part 1: Cylindrical Gears - Tangential Measurements.
   3. 915-2 - Inspection Practices - Part 2: Cylindrical Gears - Radial Measurements.
   4. 2001 - Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   5. 2004 - Gear Materials, Heat Treatment and Processing Manual.
   6. 2009 - Bevel Gear Classification, Tolerances and Measuring Methods.
   7. 2011 - Cylindrical Wormgearing Tolerance and Inspection Methods.
   8. 2015-1 - Accuracy Classification System - Tangential Measurements for Cylindrical Gears.
   9. 2015-2 - Accuracy Classification System - Radial Measurements for Cylindrical Gears.
   10. 6013 - Standard for Industrial Enclosed Gear Drives.
   11. 6022 - Design Manual for Cylindrical Wormgearing.
   12. 6034 - Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
   13. 9005 - Industrial Gear Lubrication.

C. American Institute of Steel Construction (AISC):
   1. 360 - Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design.

D. American Welding Society (AWS):
   1. D 1.1 - Structural Welding Code for Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

E. ASTM International (ASTM):
   1. A 36 - Standard Specifications for Structural Steel.
   2. A 48 - Standard Specification for Gray Iron Castings.
   3. A 148 - Standard Specification for Steel Castings, High Strength, for Structural Purposes.
   4. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   5. A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   6. A 536 - Standard Specification for Ductile Iron Castings.
   7. D 638 - Standard Test Method for Tensile Properties of Plastics.
   8. D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   9. D 2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

F. International Organization for Standardization (ISO):
   1. 53 - Cylindrical Gears for General and Heavy Engineering - Standard Basic Rack Tooth Profile.

G. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 volts maximum).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.
   2. Type 7 enclosure in accordance with NEMA 250

B. Continuous operation: 24 hour-per-day operation for design life of not less than 20 years, which equals 175,200 hours.

C. Intermittent operation: Periodic operation, including starts and stops, and prolonged periods of resting.

D. Subassemblies: Includes, but may not be limited to, complete center column, drive cage, drive assembly, truss arms, and scum skimming system.

E. Set: Equipment necessary to completely furnish 1 clarifier.

F. Continuous running torque:
   1. The 100 percent AGMA torque, assumed to be continuously applied, 24 hours a day, to the drive system.
   2. Bearing life, gear strength, gear durability, gear rating, mechanism structural design, and alarm and shutdown setpoints are specified as a percentage of the continuous running torque.

G. Momentary peak torque:
   1. The maximum torque for rating yield strength or ultimate strength of center drive mechanism components.
   2. The numerical value for momentary peak torque shall be 2.0 times continuous running torque.

H. Spiral scraper angle of attack: The angle between the clarifier radial line and the line tangent to the spiral scraper.

I. Manufacturer:
   1. Firm responsible for the design, operation, delivery, installation certification, and warranty of sludge collection equipment.
   2. Manufacturer shall also provide sludge collector drive mechanism.

J. Fabricator:
   1. Firm responsible for the fabrication of sludge collection equipment conforming to the manufacturer’s design.
   2. Manufacturer may also be the fabricator if fabrication of all components is self-performed.

1.04 SYSTEM DESCRIPTION

A. Nominal clarifier dimensions:
   1. Diameter: As indicated on the Drawings.
   2. Side water depth: As indicated on the Drawings.
   3. Bottom slope: As indicated on the Drawings.

B. Sludge collector mechanism:
   1. Supply as a complete and operational system by a single manufacturer.
   2. Equipment to include, but not be limited to, the following components:
      a. Walkways and access bridges with guardrail and grating.
      b. Center column.
      c. Influent well.
      d. Flocculating well.
      e. Center drive cage.
      f. Sludge collector truss arms.
      g. Scum skimming system.
      h. Tapered spiral scraper blades.
      i. Center drive mechanism.
      j. Drive motor.
      k. Electrical controls.
      l. Overload devices and alarms.
      m. Other components necessary to provide a complete system.
   3. Process description:
      a. Mixed liquor enters the clarifier through a center column and is discharged into the influent well through openings in the center column.
      b. The influent well dissipates the kinetic energy of the influent mixed liquor flow. Peripheral outlet ports in the influent well create a controlled discharge of the mixed liquor into the flocculating well to enhance flow distribution and flocculation.
      c. The flocculating well promotes flocculation of the mixed liquor suspended solids and allows for a gradual redirection of the flow velocity into the clarifier.
      d. A central drive mechanism mounted on a center column supports and rotates a center cage with 2 full radius truss arm assemblies, each supporting a tapered spiral scraper blade and 2 surface skimming arms. Central drive mechanism and center cage also rotates 2 partial radius truss arm assemblies with spiral scraper blades positioned perpendicular to the full radius truss arms.
      e. Clarifier connected to RAS pump wet well:
         1) Sludge is transported in a single revolution toward a center sludge hopper.
         2) Sludge removal is accomplished by the combined action of the continuously rotating sludge collection mechanism and the hydrostatic head difference between the clarifier water surface and a return activated sludge wet well water surface.
         3) The rate of sludge withdrawal is controlled by a modulating valve in the return activated sludge pipeline.
      f. The sludge accumulated in the clarifier is scraped to a center sludge hopper by tapered spiral scraper blades mounted on the truss arms for continuous removal.
      g. The scum skimming system consists of full radius skimming arms that collect secondary scum from the surface of the clarifier and deposits it into the scum collection hopper.
      h. The weir washer mechanism is attached to the scum skimming arm and cleans the effluent launders.
      i. The density current baffle extends along the periphery of the clarifier and keeps the rising density current from carrying solids over the weirs.

C. Design requirements:
1. Operating parameters:
a. Process flows:

Parameter (Per Clarifier)	Minimum	Average	Maximum	Peak
Effluent Flow, million gallons per day (mgd)	2.5	5.5	5.7	9.7
Return Activated Sludge (RAS) Flow, mgd	1.4	3.0	5.7	5.3
Total Mixed Liquor (ML) Flow, mgd	3.9	8.5	11.4	15.0

b. Maximum allowable headloss through the center column, the influent well, and the flocculating well at peak flow = 2 inches.
c. Mixed liquor suspended solids concentration range = 2,000 milligrams per liter to 4,000 milligrams per liter.
2. Mechanical design:
a. Design for a continuous running torque of 49,000 foot pounds.
b. Design collector mechanism to operate at a tip speed, measured at the ends of the rake arms, of approximately 8 feet per minute.
c. Use no chains, sprockets, bearings, or gears below the water surface for the sludge collector mechanism.
3. Structural design:
a. Design the sludge collector mechanism in accordance with AISC 360, except:
1) Provide a 3/16 inch minimum thickness for all members, except where specifically modified by this Section.
2) Include stresses in members caused by bending and twisting due to eccentricities of members at joints.
b. Slenderness ratio (Kl/r) using K Value of 1.0 shall not exceed the values specified below:
1) Tension members: Not greater than 240.
2) Compression members: Not greater than 200.
c. Base member weights used for design on final full member thickness.
d. Full member thicknesses may be used for performing deflection calculations.
e. Design the center cage and the truss arms as an integral structure. Design the center cage and the connections to the truss arms for the reactions from the truss arms.
f. Do not include live load where its inclusion results in lower stresses in a member under investigation.
g. Seismic loads: Seismic loads shall be as required by the Building Code specified in Section 01410, where load and resistance factor design (strength design) is used:
1) Hydrodynamic loads for load and resistance factor design (strength design):
a) Flocculating well: Total load of 53 kilopounds applied appropriately to the inside and outside surfaces.
b) Influent well: Total load of 18 kilopounds applied appropriately to the inside and outside surfaces.
c) Center column: Total load of 5 kilopounds applied appropriately to the outside surfaces.
d) All other elements: Hydrodynamic loads as determined using the seismic criteria specified in Section 01612.

2) Hydrodynamic loads for allowable stress design (alternate design method) shall be equal to the load and resistance factor design loads divided by 1.4.
3) Seismic loads due to weight of mechanism; as determined using the seismic criteria specified in Section 01612. Include the water inside the center column as part of the weight of the center column.

h. Load combinations: Design each structural member of the sludge collector mechanism for the most critical load combination resulting from the following load combinations:
1) Dead load plus live load plus continuous running torque.
2) Dead load plus live load plus continuous running torque plus seismic load:
a) Seismic load shall include seismic load from the water inside the clarifier acting on members of the clarifier mechanism.
b) For elements of the clarifier such as the center column, the influent well, and the flocculating well, impulsive and convective seismic loads from the water shall be applied appropriately on both the inside and outside surfaces.
c) These seismic loads shall be in addition to the seismic loads due to the dead loads of the elements.
3) Dead load plus live load plus torque due to screeding grout topping on slab using sludge collector mechanism.
4) Dead load plus live load plus torque due to cutout torque test.
5) Other load combinations selected by the manufacturer.
6) Truss arm load cases: Use the following load cases on the truss arms for load combinations:
a) Equal uniform horizontal load along the full length of both truss arms which results in a combined torque equal to the continuous running torque.
b) Uniform horizontal loads along the full length of both truss arms which results in 70 percent of the torque from 1 truss arm and 30 percent of the torque from the other truss arm for a combined torque equal to the continuous running torque.
c) Load on truss arms due to spreading grout topping on slab using sludge collector mechanism.
d) Load on truss arm**s** due to cutout torque load test.

i. Deflections:
1) The horizontal deflection of the truss arm, due to truss arm deflection plus rotational deflection of the center cage for load cases which contain continuous running torque, shall not exceed a deflection equal to the radius of the clarifier divided by 400 (L/400):
a) Not more than 60 percent of the total horizontal deflection shall be due to center cage rotation.
b) Horizontal deflection of the truss arm shall be measured at the end of the truss arm furthest from the center column.
2) The vertical deflection of the truss arm due to equipment dead load shall not exceed the length of the truss arm divided by 800 (L/800).

j. Seismic design criteria: As specified in Section 01612.

k. With sufficient strength to sweep in a 2-inch grout layer on the basin bottom under its own power.

1.05 SUBMITTALS

A. Submit product data and shop drawings, operation and maintenance manuals, and test reports.

B. Product data and shop drawings:
   1. Shop drawings shall consist of a cover sheet indicating the drawing number and specification page and number to which referenced, intended use and data summary, outline drawings, cut-away drawings, parts lists, material specification lists, and all information required to substantiate that the proposed equipment meets the specifications:
      a. Shop drawing submittals will not be considered complete if cut-away or assembly drawings with part and material specification lists are not included.
   2. General arrangement drawings showing the complete assembly, part numbers, and materials list.
   3. Detailed drawings:
      a. Sludge collector mechanism indicating dimensions, member sizes and thicknesses, welding, and connection details.
      b. Drive mechanism showing sizes, dimensions, and arrangement of each drive component.
      c. For gears, except those contained in the gearmotor speed reducer, detailed drawings with the following minimum data for each gear:
         1) Number of teeth.
         2) Net face width.
         3) Outside diameter of external gears.
         4) Inside diameter of internal gears.
         5) Normal diametral pitch or axial pitch for worm gears.
         6) Normal generating pressure angle.
         7) Lead angle (for worm gears).
         8) Operating center distance.
         9) Addendum modification coefficient.
         10) Tooth thickness or pin or span measurements.
         11) Quality numbers in accordance with AGMA 915-1, 915-2, 2009, 2011, 2015-1, and 2015-2.
         12) Material alloy.
         13) Type of heat treatment.
         14) Tooth surface hardness.
         15) Tooth core hardness.
         16) For case hardened gears, effective case depth to Rc 50.
         17) Lubricant type (mineral/synthetic/EP).
         18) Lubricant viscosity.
      d. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages. In addition to the manufacturer supplying installation instructions as specified, the manufacturer shall supply storage procedures for all equipment as required. Submit design calculations as shop drawings prior to the completion of all shop drawings.
   4. Certified motor data sheets.
   5. Shop primer and coating data.
   6. Control system data, schematics, and wiring diagrams.
   7. Spare parts list.

8. Qualifications and resume of installation engineer.
9. Training course outlines.
10. Manufacturer's experience and reference list as specified in Article Quality Assurance.

C. Manufacturer's installation instructions.

D. Calculations: Include, without necessarily being limited to:
   1. Structural calculations:
      a. Calculations shall be prepared and signed by a professional civil or structural engineer licensed in the state of California demonstrating compliance with structural criteria specified in this Section and seismic design criteria as specified in Section 01612.
      b. Submit design calculations with complete shop drawings.
      c. Submit Type 316 stainless steel anchor all thread rod mechanical property requirements.
   2. Mechanical and hydraulic calculations: Performed by a professional civil or mechanical engineer licensed in the state where the Project is located. Calculations are intended to:
      a. Substantiate continuous running torque loading and overload torque rating of each component of drive mechanism:
         1) Calculations shall be in accordance with AGMA 908.
         2) Calculations shall clearly specify all design parameters used in developing the ratings, including materials in accordance with AGMA 2004.
         3) All ratings in accordance with AGMA 2001 and AGMA 6034.
      b. Demonstrate that each bearing in drive mechanism complies with bearing life requirements of this Section.
      c. Verify that the tapered spiral scraper blade design, as proposed by the manufacturer, is capable of transporting settled sludge from the entire floor area of the clarifier to the withdrawal point under all specified flow and sludge loading conditions without resulting in excessive sludge accumulation. An excessive accumulation is defined as a depth of settled sludge which exceeds the spiral scraper blade depth:
         1) The manufacturer shall submit modeling results which incorporate both hydraulic and mechanical transport mechanisms for review.

E. Reference list: Include the following information as a minimum:
   1. Name and location of installation.
   2. Name and telephone number of the person in direct responsible charge of the equipment.
   3. Name and contact information for equipment fabricator.
   4. Name and contact information for manufacturer's engineer responsible for structural design.
   5. Month and year the equipment was placed in operation.
   6. Size of equipment.
   7. Number of units installed.
   8. Service.

F. Quality control submittals:
   1. Welder's certificates.

2. Submit Manufacturer's or designated contract fabrication facility's structural steel fabrication qualifications and information.
3. Engineer's qualifications to complete structural analysis and design.

G. Fabrication certification report:
1. Provide fabrication certification report prior to equipment delivery to project site.

H. Test reports:
1. Method of conducting cutout torque test and verification that method of testing will not impose stresses in any member which exceeds maximum allowable stresses specified in this Section.
2. Results of field torque tests on sludge collector mechanism.

I. Operation and Maintenance Manuals.

J. Certificates: Manufacturer's certification that equipment was installed in accordance with the manufacturer's instructions, inspected by the manufacturer, serviced with the proper initial lubricants, and equipped with applicable safety equipment and controls.

K. Technician's Qualifications Resume: Submit resume of technician to perform Manufacturers Field Service.

1.06 QUALITY ASSURANCE

A. Manufacturer qualifications:
1. Experience: Demonstrate minimum 5 years experience in the manufacture and fabrication of tapered spiral scraper sludge collectors which have been successfully utilized in domestic wastewater applications:
a. Experience of fabricator, if manufacturer does not self-perform fabrication, shall meet or exceed that required of manufacturer.
b. Submit substantial information as necessary to establish qualifications of fabricator, if manufacturer does not self-perform fabrication, including location (address), experience, qualifications, and certifications of all fabricator's staff to be utilized.
c. Manufacturer's engineer responsible for structural design shall also demonstrate minimum 5 years experience designing sludge collectors to withstand operational and seismic loads, including sloshing of tank contents on sludge collection mechanism.
2. References: Provide a reference list of at least 5 different installations in domestic wastewater treatment plants of not less than 5 million gallons per day in the continental United States, where the manufacturer has supplied equipment substantially similar in design and characteristics to that proposed in this Section:
a. The installations listed must:
1) Have been designed and fabricated by the manufacturer. If manufacturer does not self-perform fabrication, the installation list shall also include the experience of the Project equipment fabricator.
2) Be at least 140 feet in diameter.
3) Have been currently operating for last 5 years.

b. Provide the following information related to the installation:
    1) Owner name, address, and telephone number.
    2) Design flow of plant.
    3) Sludge collector dimensions.
    4) Time in operation.
    5) References for manufacturer's engineer responsible for the structural design.

B. Welding and welder qualifications:
    1. Perform welding and qualify and certify welders in accordance with AWS D1.1 and D1.6.
    2. Welds:
        a. Use shielded arc welding.
        b. Conform to requirements of design loads.
        c. Conform to information indicated on the Drawings.
        d. Use a minimum weld size of 3/16 inch.
        e. Field welding is permitted only for bridge splice (if required).
        f. Engineer may check materials, equipment, and qualifications of welders.
        g. Remove welders performing unsatisfactory Work, or require to requalify.
        h. Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
        i. Manufacturer shall bear costs of retests on defective welds.
        j. Manufacturer shall also bear costs in connection with qualifying welders.

C. Steel fabrication:
    1. Manufacturer's authorized representative shall be present during fabrication of equipment.
    2. Manufacturer's authorized representative shall provide a fabrication certification report complete with certified fabrication drawings, a journal of the fabrication work process, photo documentation of the shop assembly of all components required to be field erected, and a certification that the fabricated equipment is complete and ready for installation by the Contractor.

D. Equipment subassemblies:
    1. Each component subassembly requiring field erection shall be test assembled and documented at the manufacturer's fabrication facility.
    2. Digital photographic evidence of assembly shall be submitted as part of the fabrication certification report.
    3. Mark parts with erection matchmarks for ease of field erection.
    4. Lubricate moving parts before shipment.
    5. When necessary to disassemble parts for shipping, coat uncoated exposed machine surfaces with suitable, easily removable, rust-preventive compound before shipping.

1.07 PROJECT CONDITIONS

A. Environmental project conditions:
    1. Installation in a wastewater treatment plant.
    2. Moderate quantities of commercial and industrial waste.
    3. Exposure to industrial solvents and petroleum products.
    4. Operation at 100 feet above mean sea level.

5. Ambient air temperature:
    a. Maximum 115 degrees Fahrenheit.
    b. Minimum 20 degrees Fahrenheit.
6. Wastewater temperature:
    a. Maximum 80 degrees Fahrenheit.
    b. Minimum 60 degrees Fahrenheit.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Preparation for shipment:
    1. All materials shall be suitably packaged and braced to protect against damage during transit, handling, and unloading.
    2. Manufacturer shall package equipment, be responsible for, and make good, any and all damage until the equipment is delivered to the job site.
    3. Accessories shall be packaged separately in containers clearly marked “ACCESSORIES ONLY”.
    4. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.
    5. Provide written storage procedures for all equipment.

B. Delivery to job site:
    1. Manufacturer shall fabricate and deliver materials to the job site in conformance with the Contractor’s construction schedule to minimize handling and on-site storage of equipment.

C. Storage and protection:
    1. Protect the system components at the site and during installation prior to project completion.
    2. As a minimum, provide cover, ventilation, and proper stacking to prevent warping of any equipment stored on-site.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work with work sequence specified in Section 01140.

1.10 MAINTENANCE

A. Spare parts: Furnish the following spare parts suitably packaged and marked. Include a price list and name, address, and telephone number of local supplier:
    1. 2 sets of scum skimmer blade wear strips.
    2. 1 set of squeegees for each spiral scraper mechanism furnished.
    3. 4 sets of shear pins.
    4. 1 set of scum skimmer wipers.
    5. 1 set each of oil seals for the worm shaft and pinion shaft.
    6. 1 set of pier seals, as applicable.
    7. 1 set of spare nozzles for the weir washer system.
    8. 1 set of rotary joints for the weir washer system.

B. Special tools: Provide the following special tools:
    1. Tools required to assemble, disassemble, repair, and maintain equipment, and that have been specifically made for use on the equipment.

2. Necessary eyebolts, hooks, and rods for handling equipment parts.
3. List of tools with the maintenance and operation data describing the uses of the tools.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sludge collector mechanism:
   1. All equipment components of the sludge collector mechanism including the walkways and access bridges, center column, influent well, flocculating well, center drive cage, sludge collector truss arms, scum skimming system, tapered spiral scraper blades, center drive mechanism, drive motor, electrical controls, and overload devices and alarms, shall be furnished by the same manufacturer.
   2. Some equipment may require modification from the manufacturer's standard.
   3. Exercise care to assure that the electrical, mechanical, structural, and miscellaneous systems comply with the requirements specified or in other referenced sections.
   4. Manufacturers: One of the following or equal:
      a. Ovivo USA.
      b. Evoquo.Inc.
      c. WesTech, Inc.
      d. Kuesters Water.

B. Weir washer mechanism:
   1. Manufacturer:
      a. Weir Washer Automated Cleaning Systems, GillTrading.com, Inc.; Model WWR-FSE-14042.

C. Density current baffle:
   1. Manufacturer:
      a. Nefco, Inc.
      b. Warminster Fiberglass.

2.02 MATERIALS

A. For all components unless specified otherwise the materials of construction are specified below.

B. Structural steel:
   1. In accordance with ASTM A 36 for clarifier bridge construction, and for all other components, ASTM A 276, Type 304 Stainless Steel.

C. Stainless steel, ASTM A 276, Type 304:
   1. Components or structural shapes which are welded:
      a. Materials: Type 304L stainless steel.
      b. Manufacturer's shop welds, welding procedures, and welders:
         1) Qualified and certified in accordance with the requirements of AWS D1.6.

D. Anchor bolts: Type 316 stainless steel.

E. Weir plate: Fiberglass reinforced plastic as specified in Section 06611.

F. Scum baffles: Fiberglass reinforced plastic as specified in Section 06611.

G. Fasteners and washers: Type 304 stainless steel, except for bolts which will be removed during installation and any high strength bolts.

H. High strength bolts: In accordance with ASTM A 325 hot-dip galvanized high strength bolts in attaching truss arms to cage, and cage to center drive gear casting.

I. Do not use cadmium plated parts and fasteners.

J. Dissimilar metals: All aluminum components shall be isolated from steel components as specified in Section 05500, to prevent electrolysis.

2.03 SLUDGE COLLECTOR MECHANISM

A. Walkways and access bridges:
   1. Materials:
      a. Welded steel truss construction.
   2. Design:
      a. Composed of 2 main members laterally braced together.
      b. Minimum live load of 100 pounds per square foot.
      c. Maximum deflection not to exceed span length divided by 360 (L/360) for dead plus live loads.
      d. Support light standards and fixtures as indicated on the Drawings.
      e. Supported using:
         1) Center column at one end and the outer concrete clarifier wall at the other as indicated on the Drawings.
         2) Make allowance at outer concrete wall for expansion and contraction of walkway due to temperature changes:
            a) Use self-lubricating bearings.
            b) Do not use non-lubricated metal-to-metal slide plates or direct metal-to-concrete bearing.
            c) Prevent lateral movement of bridge at outer wall.
      f. Provide additional structural supports as required for piping and conduit on the bridge as indicated on the Drawings.
   3. Platform at the center turntable: Provide a minimum clearance of 2 feet 6 inches around all sides of drive mechanism and allow uninhibited access to all parts of the drive unit.
   4. Guardrail with kickplate:
      a. On both sides of walkway and all around center turntable platform.
      b. Guardrail and kickplate as specified in Section 05500 and matching other railing supplied for Project.
   5. Walking surface:
      a. Materials: Aluminum grating as specified in Section 05500.
      b. Location: Over entire bridge and center turntable platform.

B. Center column:
   1. Materials:
      a. Vertically mounted, cylindrical Type 304L stainless steel column:
         1) Inside diameter: As indicated on the Drawings.
         2) Wall thickness: 1/4-inch minimum.

2. Design:
    a. Support the entire sludge collector mechanism including inboard end of bridge.
    b. Size and anchor the center column to be capable of resisting design loads when the tank is empty or full.
3. Center column anchorage: Mount the center column over the influent port at the center of the clarifier floor. Connect the base flange of the center column to the concrete foundation using anchor bolts:
    a. Use a rigid steel template of minimum 1/4 inch thickness to accurately locate anchor bolts for the center column during concrete placement.
    b. Supplier shall coordinate with the Contractor to ensure proper anchor bolt location.
    c. Center column base anchor bolts:
        1) Not less than 24 in number.
        2) Not less than 15 bolt diameters of embedment length.
        3) Not less than 1-1/2 inches in diameter.
        4) Use a minimum edge distance for anchor bolts of the larger of 6 inches or 6 anchor bolt diameters, and as required to clear reinforcing bars located around opening.
    d. Center column base mounting flange:
        1) Size and reinforce using gussets or other stiffeners as necessary to adequately transfer loads from the sludge collector mechanism to clarifier structure.
        2) Bolt holes in flange to accommodate anchor bolts shall not exceed 1/8 inch plus bolt diameter.
4. Center column outlet ports: Provide outlet ports in the upper end of the center column to disperse influent flow into the influent well. Provide the following:
    a. A total of 4 ports.
    b. Appropriately reinforced port openings.
    c. Port dimensions: As indicated on the Drawings.
5. Flange and stiffen the top of the center column for supporting the sludge collector mechanism, the drive mechanism, and the access bridge:
    a. Attach the center column to the drive assembly using bolts.
6. Drain holes: Provide two 2-inch holes at bottom to allow column to drain into the tank.

C. Influent well:
1. Materials:
    a. Stainless steel Type 304L plate and members.
    b. Reinforced with steel stiffening angles where necessary.
2. Design:
    a. Closed-bottom tub concentric with the center column.
    b. Supported around the outside of the center drive cage.
    c. Diffuse influent flow into the clarifier tangentially, evenly, and efficiently without excessive disturbances.
    d. Influent well outlet ports:
        1) Shall direct and control flow into the clarifier.
        2) Dimensions: As indicated on the Drawings.
    e. Dimensions: As indicated on the Drawings.
    f. Provide four 3-inch orifices in the bottom to allow the well to drain as the clarifier is emptying.

D. Flocculating well:
   1. Materials:
      a. Stainless steel Type 304L plate and members.
      b. Reinforced with steel stiffening angles where necessary.
   2. Design:
      a. Dimensions: As indicated on the Drawings.
      b. Equip with a minimum of 4 baffled slots as indicated on the Drawings to allow for removal of floating material in the well.
      c. Support from center cage using rigid connection:
         1) Other methods of connection such as swinging supports or breakaway supports are not permitted.

E. Center drive cage:
   1. Materials:
      a. Structural steel members.
   2. Design:
      a. Box truss design.
      b. Design to carry load from the truss arms plus its own dead load.
      c. Fasten center drive cage to spur gear assembly using bolted connection.
      d. Design to support and rotate the truss arm assemblies with the tapered spiral scraper blades, and the surface skimming arms.

F. Sludge collector truss arms:
   1. Materials:
      a. Stainless steel Type 304L.
   2. Design:
      a. Truss design. Tie rods not permitted.
      b. Design with sufficient structural strength to screed in a layer of grout on the clarifier bottom under its own power.
      c. Maintain width of the truss arm the same as the width of center drive cage to ensure alignment and proper connection.
      d. Rigidly connect truss arm to the center drive cage.
      e. Use the truss arm to support the sludge collection tapered spiral scraper blades, and scum skimmer arms.

G. Tapered spiral scraper blades:
   1. General:
      a. Manufacturer shall be solely responsible for the design of the spiral scraper blades.
      b. Number and dimensions of blades shall be based upon sludge transport model results prepared by manufacturer and submitted for review.
      c. Spiral sludge blades indicated on the Drawings are for illustration purposes only, and shall not be construed as design intent.
      d. Additional blades to transport sludge away from center column to withdrawal point shall be provided, if required by manufacturer’s design configuration.
   2. Blades:
      a. Materials: Stainless steel Type 304L.
      b. Thickness and stiffeners as required to limit blade deflection:
         1) Taper blades as required to match floor slope.
         2) Top of blade shall be horizontal.

3. Squeegees:
    a. Materials: Stainless steel, spring type, not less than 26 gauge thickness.
    b. Attach squeegees to blades utilizing stainless steel hardware. Squeegees shall be designed to allow 2 inches of vertical adjustment.

H. Scum skimming system: Consisting of a scum skimmer assembly that pushes floating scum to a scum trough for removal. Basic components of skimmer assembly include scum deflector blades and skimmer device:
    1. Scum deflector blades:
        a. Material: Structural Stainless steel Type 304L.
        b. Designed to collect and push floating scum radially outward toward the circumferential scum baffle.
        c. Extends from the flocculating well to the scum skimmer device.
        d. A central drive mechanism mounted on a center column support and rotates a center cage with 2 truss arm assemblies, including tapered spiral scraper blades and 2 surface skimming arms.
        e. Attach inner end of deflector blade tangentially to the flocculating well where practicable. Otherwise, provide maximum angle of approach of scum deflector blade to the scum in order to drift the scum to circumferential baffle.
    2. Scum skimmer device:
        a. Materials: Structural steel plate and members.
        b. Attach to outer end of the scum deflector blade to trap scum for discharge into scum trough.
        c. Size: Full length of the scum trough.
        d. Design:
            1) Maintain continuous contact and proper alignment with scum baffle and inclined scum ramp to positively rake scum to the scum trough.
            2) Use a hinged blade to move entrapped scum up the scum beach to the scum trough.
            3) Provide a replaceable wear block on the outer edge of each scum skimmer device.
        e. Hinged blade:
            1) Adjustable vertically to control the dewatering of scum as it travels up the inclined ramp to the scum trough.
            2) Adjustable vertically over the length to ensure contact with the scum trough even though the trough may not be level.
            3) Capable of being raised and locked out above the water level or held horizontally against the circumferential scum baffle when skimming is not required.
            4) Equipped with replaceable scum skimmer wipers on the bottom inner and outer edges to seal the entrapped scum and water when moving up the inclined approach ramp to the scum trough.
        f. Scum skimmer wipers: Oil resistant neoprene.
        g. Wear block:
            1) Material: Polyvinyl chloride.
            2) Wear block constantly forced against circumferential scum baffle to keep baffle clean using a coiled spring arrangement.
            3) Force between baffle and wear block adjustable between 1 to 5 pounds.
        h. Wear block coiled springs:
            1) Material: Type 18-8 stainless steel.

2) Enclosed to protect them from the weather.
3) Spring enclosures:
a) Material: Welded steel or cast iron housing.
b) Bronze bushed and grease lubricated for easy movement of hinged blades.

3. Scum trough and scum beach:
a. Fabricated from 3/16 inch minimum thickness Type 304L stainless steel plate.
b. Supported from clarifier wall by Stainless steel Type 304L members.
c. Scum trough:
1) Width: As indicated on the Drawings.
2) No internal stiffeners or structural members which obstruct scum flow.
3) Standard pipe flanged connection for scum discharge pipe. Size as indicated on the Drawings.
d. Scum beach (inclined approach ramp):
1) Length: As indicated on the Drawings.
2) Shaped to contain scum as it is moved up the incline to the trough by the scum skimmer.

4. Skimmer assembly supports:
a. Material: Stainless steel Type 304L members.
b. Attached to the sludge collector truss arms. Do not support scum skimmer assembly from the scum baffle.
c. Space supports, brought up from the truss arm, at not greater than 10 feet on center.

5. Equipment manufacturer shall size and locate counterweights to be installed by the Contractor.

6. Scum skimmer assembly, supports, and sludge collection rake arm designed to operate with either at weir washer system or a launder cleaning brush mechanism supported by the arm, and to withstand forces imposed by brush mechanism.

7. Threaded fasteners: Type 18-8 stainless steel.

I. Center drive mechanism: Provide a center drive mechanism consisting of a primary speed reducer driven by electric motor, through a roller chain using an intermediate gearset consisting of a cylindrical-worm and helical-wormgear, and a low speed gearset consisting of a spur pinion and internal spur gear supported within a cast iron housing by a circular main bearing featuring replaceable bearing race inserts. Center drive mechanisms utilizing housings and internal spur gears featuring integral gothic arch style bearing races are not acceptable:

1. Gear motor speed reducer:
a. Type:
1) Cylindrical-worm or helical-wormgear motor.
2) Planetary gear units will not be acceptable.
b. Speed reducer in accordance with AGMA 6013 and 6034.
c. Service factors: Minimum speed reducer service factor of 2.0 minimum based on continuous running torque.
d. Connect speed reducer output shaft to drive sprocket of chain drive.
e. Speed reducer overhung load rating:
1) Exceed the chain pull (based on continuous running torque) by 1.50 minimum.
f. Oil bath lubrication:

1) Lubricant in accordance with AGMA 9005.
2) Provide oil fill, drain, and oil level indicator devices.
3) Oil bath protection seal: Felt.

g. All gears supported by anti-friction bearings.
h. Lubricant: In accordance with AGMA 9005.

2. Intermediate gearset:
   a. Type: Cylindrical-worm and wormgear.
   b. Materials:
      1) Worm: Alloy steel, hardened, ground, and polished.
      2) Wormgear: Centrifugally cast bronze.
      3) Washers: Hardened steel to prevent embedding of bolt head or nut.
      4) Bushings: Bronze.
      5) Housing: Cast iron in accordance with ASTM A 48, Class 30 minimum.
   c. Load capacity: Rated in accordance with AGMA 6034.
   d. Service factor: Minimum of 1.25 based on continuous running torque.
   e. Wormgear shaft:
      1) Drives pinion of low-speed gearset.
      2) Support shaft by anti-friction bearings or combination of anti-friction bearings and bushing.
   f. Wormgear: In accordance with AGMA 6022.
   g. Worm shaft: Support by anti-friction bearings. If the wormgear is bolted to a drive hub, it shall be piloted for concentricity.
   h. Worm and wormgear shaft: Anti-friction bearings shall have ABMA 9, L-10 life of 180,000 hours minimum based upon continuous running torque.
   i. Provide oil bath lubrication:
      1) Lubricant in accordance with AGMA 9005.
      2) Provide oil fill, drain, and oil level indicator devices.
3. Low-speed gearset:
   a. Provide low-speed gearset using spur pinion and internal spur gear.
   b. Spur pinion shall be:
      1) Integral with its shaft or keyed to a shaft:
         a) If keys are used, the pinion shall be secured to the shaft with a shrink fit.
         b) Set screws will not be acceptable.
      2) Welded spur pinion and shafts will not be acceptable.
      3) Keyed spur pinions shall have a wall thickness above the keyway equal to 1 tooth whole depth minimum:
         a) Keyway and keyseat shall have 0.02-inch minimum inside radii.
         b) Keys shall have 0.04 inch minimum chamfer on all edges.
      4) Manufactured to have a minimum AGMA Quality Class 8 in accordance with AGMA915-1, 915-2, 2015-1, and 2015-2.
   c. Provide full depth teeth in accordance with ISO 53:
      1) Stub pitch gear teeth will not be accepted.
      2) Undercut gear teeth will not be accepted.
   d. Load capacity rated in accordance with AGMA 2001.
   e. Power rating based on continuous service and the lower of the:
      1) Pitting resistance for the pinion and gear.
      2) Bending strength for the pinion and gear.

f. Minimum service factor of 1.25 based on continuous running torque.
g. Overload torque capacity (based on yielding of the pinion or gear teeth) exceeding the momentary peak torque by 1.8 minimum.
h. Internal spur gear:
    1) Material: Ductile (nodular) iron in accordance with ASTM A 536 or cast steel in accordance with ASTM A 148, or heat-treated alloy steel.
    2) Minimum AGMA Quality Class 6 in accordance with AGMA 915-1, 915-2, 2015-1, and 2015-.
    3) Internal spur gear bolted to the center drive cage.
i. Turntable base:
    1) Material:
        a) Ductile (nodular) iron in accordance with ASTM A 536 or cast iron in accordance with ASTM A 48, Class 40 minimum.
        b) Fabricated steel bases will not be accepted.
    2) Bolted to the center column to provide support for the internal spur gear, entire rotating collector mechanism, and one end of the access bridge.
j. Raceways, ball bearings, and oil bath:
    1) Raceways and ball bearings:
        a) Raceways: Heat-treated alloy steel.
        b) Ball bearings: Heat-treated alloy steel.
    2) Provide replaceable annular raceways to support vertical and horizontal forces transmitted by ball bearings on turntable base and internal spur gear:
        a) Raceway 65 inches minimum in diameter.
        b) Size the raceways using the following equation:

$$q = 59{,}466 \left(\frac{P}{N * D^2} \right)^{1/3}$$

Where:
q = Contact stress, pounds per square inch (maximum = 300,000 pounds per square inch)
P = Total rotating (hung) load, pounds, including truss arms, center cage, internal spur gear, influent well, flocculating well, skimmers, tapered spiral scraper blades, counterweights, and any other rotating weight.
N = Number of balls.
D = Ball diameter, inches.

        c) Design raceway and ball bearings for ABMA 9, L-10 life of 200,000 hours minimum.
    3) Provide oil bath for turntable base and internal spur gear:
        a) Include felt seal and dust shield protection.
        b) Provide oil fill, oil drain, and oil level indicator devices in readily accessible locations.
        c) Lubricant in accordance with AGMA 9005.

4. Chain drive:
    a. Material:
        1) Sprockets: Steel.
    b. Type: Standard roller chain in accordance with ASME B 29.1M connecting drive sprocket of the gear motor speed reducer to the driven sprocket.
    c. Drive sprocket: Minimum of 12 teeth.

d. Chain and sprockets enclosure: Enclose roller chain and sprockets in weatherproof fabricated steel guard with service openings.
e. Chain:
1) Minimum tensile strength greater than 4 times chain pull based on momentary peak torque.
2) Power rating exceeding the transmitted power (based on continuous running torque) by 1.50 minimum.

5. Drive motor:
a. Type: Drive motor shall be a squirrel-cage induction type.
b. As specified in Section 16222.
c. Motor characteristics:
1) Minimum continuous horsepower not less than 1 hp.
2) Voltage: 480-volts.
3) Phase: 3.
4) Frequency: 60-hertz.
5) Insulation: Class B, moisture resistant.
6) Service factor: 1.15.
7) Maximum ambient temperature: 40-degrees Celsius.
8) Enclosure: TEFC.
9) Synchronous speed: 1,800 revolutions per minute.
d. Nameplate information: Include all information listed under subparagraph "Motor Characteristics" above.

J. Electrical controls:
1. Local control panel:
a. Enclosure: NEMA Type 4X.
b. Mount local control panel near drive mechanism on guardrail as indicated on the Drawings.
2. Electrical wiring as specified in Section 17710.
3. Overload device and alarms:
a. Torque overload device: Incorporate into drive assembly:
1) Mechanical overload device shall be actuated by torque from the rotation of the wormgear.
2) Torque indicator:
a) Provide a visual torque indicator oriented so that it may be read from the walkway at all times during operation.
b) Calibrate torque indicator from 0 to 160 percent of the continuous running torque.
3) Include with the overload device, 2 independently adjustable switches as follows:
a) Alarm switch: An alarm switch that shall be adjusted to activate an alarm when load reaches 90 percent of the continuous running torque.
b) Cutout switch: A cutout switch that shall be adjusted to shut off the motor when load reaches 100 percent of the continuous running torque.
c) Alarm circuit to sound an alarm horn and illuminate a red lamp, both mounted at the local control panel.
d) Alarm contacts of the maintained type rated at 10 amps continuous pilot duty.
e) Overload device indicating meter enclosure: Weather proof steel, NEMA Type 4X.

4) Provide electrical supply to overload device as indicated on the Drawings. Include:
a) Electrical components of overload device compatible with alarm devices.
b) Other electrical requirements as indicated on the Drawings.

b. Additional protection:
1) Provide shear pins in the drive assembly for additional protection above the shut-off torque rating:
a) This additional protection device shall function at approximately 125 percent of continuous running torque.
b) Shear pins: Corrosion resistant material.
2) Provide limit switch that indicates breakage of the shear pin due to any circumstance. Shear pin limit switch shall be interlocked with motor controls to prevent mechanism from operating with a broken shear pin:
a) Materials: Corrosion resistant.
b) Electrical enclosure: NEMA Type 4X.

c. Alarm horn:
1) Suitable for outdoor installation.
2) Manufacturers: The following or equal:
a) Federal Horn, Catalog Number 350W.

d. Alarm lamp: Provide vapor-tight red alarm lamp suitable for outdoor installation.

e. Equipment identification plates: Provide 16-gauge stainless steel identification plate, securely mounted on equipment in readily visible location, bearing equipment identification tag number.

4. Scum Beach Spray Valve:
a. Provide electrically actuated ball valve for scum beach spray valve EDR-2651.
b. Voltage: 120VAC.
c. Operation: Open/Close.
d. 1/2" NPT conduit entry.
e. Visual status indication.
f. Rating: NEMA 4X.
g. Opening duration not longer than 15 seconds.
h. See section 15111 for additional ball valve requirements.
i. Manufacturers: The following or equal:
1) Apollo Valves AE Series.
2) Triac WE Series.
3) Remote Control RCEL Series.

2.04 CLARIFIER ACCESSORIES

A. Weir washer mechanism:
1. Fixed spray assembly:
a. The fixed spray assembly shall provide a means of attaching the automatic algae cleaning system to the skimmer arm of the tank mechanism in a manner that does not interfere with the normal operation of the skimmer arm.
b. The fixed spray assembly shall be constructed of heavy duty copper and custom designed for compatibility with the tank mechanism provided.

c. The fixed spray assembly requires no contact with the surfaces being cleaned. The fixed spray assembly will allow surface irregularities and/or radial variance of within 6 inches or more if required.
d. Obstructions, support bars, bolts, and framing will all be cleaned.

2. Piping:
   a. The piping of the mechanism shall be designed to attach to the fixed spray assembly.
   b. The piping shall attach to the skimmer arm as specified in Section 15061.
3. Center unit:
   a. Center unit shall be constructed of Type 304 stainless steel and polyethylene thermo plastics and custom designed and installed.
   b. The center unit will be installed on the center column and set for permanent operation with minimum controlled leakage to allow for proper pressure out at the fixed spray attachment.
   c. Center unit will be driven by Type 304 stainless steel chain separate from the piping, so that the piping in no way will ever bind and fail.
   d. Center unit shall have flexible piping between the skimmer blade piping and the outlet feed piping from the center column.
4. Nozzles:
   a. The nozzles shall be constructed with brass to withstand continuous exposure to sunlight, seasonal temperature changes and the corrosive elements found in wastewater.

B. Density current baffle:
1. The baffle system shall consist of a series of baffle panels which are attached to the inboard launder and form an inclined, shelf-like surface around the entire inner periphery of the tank as indicated on the Drawings.
2. Construct panels of corrosion-resistant, UV-treated fiberglass-reinforced plastic:
   a. For the resin, use an isophthalic polyester with corrosion-resistant properties, 33-402 resin or equivalent, which is typically used in submerged wastewater treatment applications.
   b. Do not use any fillers in the resin except as required for viscosity control, for which, up to 5 percent by weight of a thixotropic agent may be added.
   c. Treat the resin to provide ultraviolet suppression.
3. Glass reinforcement to consist of chemically bonded surfacing mat and copped strand roving, with the glass contents of the finished laminate to be not less than 30 percent by weight.
4. The nominal thickness of each baffle panel shall be 3/16 inches minimum.
5. Attach the panels to the inboard launder at a reinforced mounting flange and support them at the proper angle with a triangular shaped bracket:
   a. The brackets may be molded as an integral part of each panel, or separate brackets may be supplied.
   b. If separate brackets are supplied, the brackets shall be fabricated of Type 316 stainless steel.
   c. Design the baffle to withstand a buoyant force load equal to the weight of the water displaced from the volume beneath the baffle.
   d. In addition, design the baffle to withstand common wind and snow loads where applicable.
   e. Provide sufficient pitch and width of the angle’s working surface of the baffle to divert the flow and create a self-cleaning action of the baffle.

6. Include provisions to vent gases which may form beneath the baffle through the installation of vents located in the panel.
7. Manufacturer shall furnish certified test reports of the physical and mechanical properties of the product. Each panel shall have the following minimum physical properties:

Tensile Strength	5,000 psi per ASTM D 638
Flexural Strength	16,000 psi per ASTM D 790
Hardness	Barcol 60 per ASTM D 2583

8. Manufacturer shall also furnish certified design calculations and drawings showing details of installation.
9. Install the baffle as indicated on the Drawings and in accordance with the manufacturer's recommendations:
    a. For attachment of the baffle panels, use concrete expansion anchors with neoprene-backed fender washers, lock washers and hex nuts.
    b. Use Type 316 stainless steel for all the installation fasteners.

2.05 FINISHES

A. Shop finishing:
    1. Center drive mechanisms: Prime and finish paint before shipping to project site.

B. Field finishing:
    1. Sludge collector mechanisms: For all metal surfaces, except stainless steel or aluminum components, perform surface preparation and coating as specified in Section 09960.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install sludge collector mechanism and clarifier accessories as indicated on the Drawings and in accordance with the manufacturer's installation instructions and recommendations.

B. Field welding:
    1. Field welding is permitted only for the bridge splice.
    2. Use shielded arc welding and conform to requirements of design loads.

C. Guardrail with kickplate: Install on both sides of walkway and around center turntable as specified in Section 05500.

D. Scum skimming system: Install counterweights designed and located by the manufacturer if required.

E. Center column: Mount center column vertically over influent port at center of basin floor.

3.02 FIELD QUALITY CONTROL

A. Testing, training, and start-up: As specified in Section 01756 and the following requirements below.

B. Tests:
   1. General: Conduct tests in presence of the Engineer.
   2. Working under direction of manufacturer's engineer, perform field tests on each mechanism as follows:
      a. Cutout torque test:
         1) Perform cutout torque test prior to placement of grout topping on concrete slab.
         2) The manufacturer shall propose a method of conducting this test and shall verify that the method of testing will not impose stresses in members that exceed allowable stresses.
      b. Adjustments and settings to overload device:
         1) Adjustments and settings: Perform necessary adjustments and settings to overload device to ensure that sludge collector mechanism will sound an alarm and shutdown the drive motor when specified overload conditions occur in clarifier.
         2) Test run: Perform test run following completion of adjustments and settings of overload device to confirm effectiveness of overload device.
      c. Dry test run of equipment:
         1) Special attention: Give attention during dry test run of equipment to operation of scum skimming device.
         2) Settings of skimmer boom to scum box lip and rubber wiping and sealing strips: Set as required to ensure that adequate volume of scum is discharged under normal operating conditions.
      d. Weir washer leakage test:
         1) Center unit shall have minimal leakage to provide adequate spray pressure at the fixed spray attachment nozzles.
         2) All piping joints will be inspected and verified leak free at the time of the test.
         3) Each weir washer mechanism shall be operated continuously pressurized at its maximum speed for a period of not less than 48 hours. During this time, each system shall be momentarily un-pressurized and then pressurized. At no time during the operating test shall the equipment fail on torque overload or exhibit indications of binding or uneven operation.

C. Required results:
   1. Sludge collector mechanism:
      a. In event mechanism fails to meet field quality control test requirements of this Section, make necessary changes and retest mechanism.
      b. If mechanism remains unable to meet test requirements to satisfaction of the Engineer, remove and replace such mechanism with satisfactory mechanism at no additional cost to the Owner.

D. Manufacturer's field service:
   1. Contractor to coordinate field service work with the manufacturer's service representative, Owner, and Engineer prior to initiating such work.

2. Manufacturer's service representative:
    a. Manufacturer is to furnish services of representative experienced in erection and operation of the sludge collector mechanism.
    b. Period of services: The manufacturer shall include in his bid a minimum of three 8-hour days and three trips. The specified durations are the minimum required time on the job site and do not include travel time.
    c. Services are to include the following:
        1) Installation consultation and advice.
        2) Checking and supervision of the collector installation.
        3) Inspection and certification that unit is ready to sweep in grout prior to grouting operation.
        4) Final inspection and adjustments prior to testing.
        5) Supervision of testing.
        6) Instruction of personnel on operation and maintenance of equipment as specified in Section 01756.

END OF SECTION

SECTION 11378A

FINE BUBBLE DIFFUSED AERATION SYSTEM - DISK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Specification of a membrane disk fine bubble diffused aeration system for installation in activated sludge aeration basins.
   2. Includes, but not limited to:
      a. Air distribution piping (including droplegs, manifolds, and laterals).
      b. Piping supports.
      c. Air diffuser assembly (including membrane diffuser element, baseplate, diffuser holder, retainer ring, and airflow control orifice).
      d. Moisture blowoff system.
      e. Fasteners and hardware.

B. Related sections:
   1. Section 01140 - Work Restrictions.
   2. Section 01330 - Submittal Procedures.
   3. Section 01610 - Project Design Requirements.
   4. Section 01612 - Seismic Design Criteria.
   5. Section 01756 - Commissioning and Process Start-Up.
   6. Section 01782 - Operation and Maintenance Data.
   7. Section 15050 - Common Work Results for Mechanical Equipment.
   8. Section 15286 - Stainless Steel Pipe.

C. The Owner has pre-qualified and pre-negotiated with Xylem Sanitaire (this arrangement is referred to herein as “Supplier/Manufacturer”) a cost proposal for providing the Fine Bubble Diffused Aeration System - Disk. Unless stated otherwise, the cost proposal for the Fine Bubble Diffused Aeration System - Disk includes equipment and accessories as specified in this section. The pre-negotiated price quotation for the Fine Bubble Diffused Aeration System - Disk is $594,900. A copy of the cost proposal from the Supplier dated April 17, 2017, is for the Contractor’s informational use and reference only. The price quotation is valid until 120 days from Bid Opening. A copy is attached at the end of this Section. The Contractor shall purchase the equipment from the Supplier/Manufacturer and shall install the equipment as part of this Project. However, the Contractor is allowed, prior to opening bid, to negotiate with the Supplier/Manufacturer the cost, terms, and conditions for the purchase of the system and accessories to be furnished by the Contractor as part of this project to provide a complete working system.

D. Cost of Pre-negotiated Items:
   1. The Contractor shall carefully review the applicable pre-negotiated proposal to determine those items required by the Contract Documents which are not part of the proposal or specified Supplier/Manufacturer’s scope of supply. In

addition to the cost indicated for the applicable bid item in the pre-negotiated proposal, the Contractor shall include in his bid the costs for the following:

a. All items not specifically itemized in the Supplier/Manufacturer's Scope of Supply provided as part of the pre-negotiated proposal, but required by the Contract Documents and/or necessary to provide a complete and operational system.
b. All items specifically itemized in the Supplier/Manufacturer's Scope of Supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by customer, provided by Owner, or any similar designation.
c. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.
d. Any additional cost required by the supplier due to any charges the Contractor may wish to make to the terms and/or conditions of the pre-negotiated proposal, including but not limited to payment terms, delivery schedule, scope or work, etc.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 2-91 - Measurement of Oxygen Transfer in Clean Water.
   2. Standard Guidelines for In-Process Oxygen Transfer Testing.

B. ASTM International (ASTM):
   1. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Application.
   2. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   3. A480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   4. A530 - Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.
   5. A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
   6. A774 - Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
   7. A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
   8. D395 - Standard Test methods for Rubber Property - Compression Set.
   9. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   10. D573 - Standard Test Method for Rubber - Deterioration in an Air Oven.
   11. D1171 - Standard Test Method for Rubber Deterioration - Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens).
   12. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   13. D2240 - Standard Test Method for Rubber Property - Durometer Hardness.
   14. D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure - Rated Pipe (SDR Series).

15. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
16. D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
17. D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) PVC Sewer Pipe and Fittings.

1.03 DEFINITIONS

A. SOTR: Standard Oxygen Transfer Rate, expressed as pounds of oxygen per day; the rate of transfer of oxygen from air into tap water at standard conditions of temperature (20 degrees Celsius) and pressure (1 atmosphere), with zero dissolved oxygen concentration.

B. SOTE: Standard Oxygen Transfer Efficiency, expressed as a percentage; the efficiency of oxygen transfer under standard conditions (20 degrees Celsius, 1 atmosphere and 36% relative humidity), determined as the fraction of oxygen in an injected gas stream dissolved under standard conditions.

C. DO: Dissolved Oxygen concentration in the mixed liquor, in milligrams per liter (mg/L).

D. MLSS: Mixed liquor suspended solids concentration, in mg/L.

E. Zone: Section or compartment of each aeration basin that contains at least 1 individual diffuser grid and aeration air dropleg, as indicated on the Drawings.

F. Swing zone: A zone that is equipped with both diffusers and mixers and can therefore be utilized as either aerated or unaerated.

1.04 SYSTEM DESCRIPTION

A. System configuration:
1. Seven existing aeration basins with layout and dimensions as indicated on the Drawings and as specified.
2. Each aeration basin contains 6 or 7 zones. Nominal dimensions, including side water depths in units of feet of water for each zone at different operating conditions, are indicated below:

Zone	Flat Floor Length (ft)	Flat Floor Width(ft)	Side Water Depth (ft)		
			Minimum	Average	Peak
Aeration Basins No. 1 - 3[(1)]					
Zone 3 - Swing Zone	36.50	27.92	13.3	13.5	13.6
Zone 4 - Aerobic	29.75	27.92	13.2	13.4	13.5
Zone 5 - Aerobic	42.50	41.08	13.2	13.4	13.5
Zone 6 - Aerobic	36.50	41.08	13.2	13.4	13.5
Zone 7 - Aerobic	42.50	41.08	13.2	13.4	13.5
Aeration Basins No. 4 - 7[(2)]					

Zone	Flat Floor Length (ft)	Flat Floor Width(ft)	Side Water Depth (ft)		
			Minimum	Average	Peak
Zone 3 - Swing Zone	32.67	35.00	13.6	13.8	13.9
Zone 4 - Aerobic	64.83	35.00	13.5	13.7	13.8
Zone 5 - Aerobic	84.83	35.00	13.5	13.7	13.8
Zone 6 - Aerobic	84.83	35.00	13.5	13.7	13.8

Notes:

(1) Aeration Basins No. 1 - 3 sides are sloped at 2.5 horizontal to 1 vertical. Indicated nominal length and width values are for flat floor area. Basin nominal side water depth is at edge of side slope. Basin is deeper at drainage inlet. See Drawings.

(2) Aeration Basins No. 4 - 7 side-walls are vertical. Basin nominal side water depth is average depth of flat floor area sloped for drainage at 2 percent +/-. See Drawings.

B. Design requirements:
   1. General:
      a. The fine bubble diffused aeration system furnished under this Section is designed to supply the aeration required to maintain a DO concentration of 2.0 mg/L in each aeration basin, and to maintain suspension of a mixed liquor with a MLSS concentration ranging from 1000 mg/L to 4,000 mg/L.
      b. The airflow to the fine bubble diffused aeration system will be supplied by centrifugal blower and the airflow rate varied independently to maintain the desired DO concentration in the mixed liquor.
   2. Mechanical:
      a. The fine bubble diffused aeration system includes the air distribution piping (droplegs, manifolds, and laterals), piping supports, the air diffuser assemblies (diffuser disks, baseplates, diffuser holders, retainer rings, and flow control orifices), the moisture blowoff system, fasteners, hardware, and all accessories required for a complete installation and as required by the performance requirements in this Section.
      b. The aeration system shall be compatible with hydrochloric acid, formic acid, and hydrogen chloride gas.
      c. Joints in the aeration system piping which are factory solvent welded shall conform to the standard practice described in accordance with ASTM D2855.
      d. PVC solvent cement shall conform to all requirements in accordance with ASTM D2564.
   3. Operating parameters:
      a. Process airflows: Process airflows, in units of standard cubic feet per minute (scfm), for each zone at different operating conditions are indicated below:

Zone	Operating Condition		
	Minimum	Average	Peak
Aeration Basins No. 1 - 3			
Zone 3 Swing Zone	492	1029	1,400
Zone 4 Aerobic	585	758	1,370
Zone 5 Aerobic	411	921	1,330
Zone 6 Aerobic	250	526	770
Zone 7 Aerobic	271	543	760
Aeration Basins No. 4 - 7			
Zone 3 Swing Zone	315	600	910
Zone 4 Aerobic	489	750	1,250
Zone 5 Aerobic	333	624	1,060
Zone 6 Aerobic	258	464	750
Notes:			

b. Maximum allowable pressure in the air piping at the dropleg connection for any of the specified conditions shall not exceed:
   1) 6.5 pounds per square inch gauge.
c. System to be designed to withstand the maximum allowable pressure plus a surge factor of 1.25.
d. Air temperature at dropleg during operation: ambient to 200 degrees Fahrenheit.

4. Diffuser layout:
   a. Provide manifolds, laterals, and diffusers as required by the performance requirements in this Section.
   b. Provide diffuser quantities as required to meet performance requirements specified.
      1) Provide additional diffusers for mixing in Aeration Basin Nos. 1-3 as indicated on the Drawings.
   c. The diffuser layout shall be subject to the approval of the Engineer. The Engineer shall determine compliance with the stated requirements.
      1) The Engineer recognizes that due to the minimum active diffuser requirements specified in this section for Aeration Basin Nos. 1 - 3, Zones 3 and 4 and Aeration Basin Nos. 4 - 7, Zone 3, the requirements for minimum clearances specified below may not be achievable for those specific zones. Where the specified minimum clearances cannot be met, the diffuser supplier shall lay out the diffuser system in other manners to provide adequate access to the diffusers for installation, cleaning, membrane replacement and all other necessary activities. The diffuser system supplier's diffuser layout drawings shall identify where the specified design layout requirements cannot be bet due to high diffuser density requirements and describe how access to diffusers for installation, cleaning, and other activities can be accomplished.

2) All other aerated zones shall meet all the layout requirements specified below.

d. Design the diffuser grid layout to satisfy the following minimum requirements:
   1) Minimum clearance of 12 inches from any wall to edge of diffuser.
   2) Maximum clearance of 36 inches from any wall to edge of diffuser.
   3) A minimum clear spacing of 2 inches between adjacent diffusers (including blank diffusers) on the same lateral.
   4) A maximum clear spacing of 48 inches between adjacent diffusers (including blank diffusers) on the same lateral.
   5) A minimum clear spacing of 6 inches between diffusers (including blank diffusers) on adjacent laterals.
   6) A maximum clear spacing of 48 inches between diffusers (including blank diffusers) on adjacent laterals.
   7) Make provisions for ladder placement to allow entry into each zone from the top of the basin.
   8) Access-ways shall be provided between groups of laterals and have a minimum clear spacing of 24 inches (edge-to-edge) between diffusers. Sufficient clearance shall be provided to move from one access-way to another.
   9) It shall not be necessary for a person to reach across more than 1 diffuser lateral to access any diffuser from an access-way; therefore, no more than 4 laterals may be placed in a group between access-ways and no more than 2 laterals between a wall and the first access way.
   10) Contractor shall coordinate with diffuser manufacturer and mixer supplier to provide diffuser system layout that is compatible with the provided mixer installation:
      a) Make provisions for access around each mixer and guide rail.
      b) Do not install diffusers directly below mixer or within a minimum horizontally projected distance of 3 feet from mixer. Increase horizontal diffuser-free distance if required by mixer manufacturer.
      c) Provide additional diffuser supports as required to accommodate the fluid forces developed by mixers and process pipe inlets/outlets.
   11) For Aeration Basins Nos. 1 through 3, provide additional diffuser supports as required to accommodate the fluid forces developed by the side slopes in the basins:
      a) Design for minimum velocity of 1.0 ft/sec at base of aeration basin side slopes.
   12) The final aerobic zone in each basin (Zone 7 in Aerations Basins Nos. 1 through 3, Zone 6 in Aeration Basins Nos. 4 through 7) shall not have diffusers installed within 5 horizontal feet of the MLR pumps.

e. Droplegs:
   1) A fixed number of droplegs on the main air header piping have been provided and additional droplegs are not available.
   2) The location of these droplegs is fixed and changes in dropleg location are not allowed unless approved in writing by the Engineer.

3) The diffuser manufacturer shall refer to the grid layout and dropleg locations indicated on the Drawings during design of the diffuser system.

f. Cooling:

1) Include additional submerged stainless steel piping as part of the diffuser layout as required to provide cooling of air and to prevent exceeding maximum recommended diffuser membrane and piping system operating temperatures at all specified side water depths:

a) Maximum temperature of 130 degree F at the connection to the header.

b) Diffuser manufacturer shall submit heat dissipation calculations to confirm and provide required length of additional aeration air piping to dissipate heat.

c) Length, fittings, supports, and layout of piping shall be by the diffuser manufacturer and coordinated with the engineer during submittal review.

C. Performance requirements:

1. System performance requirements (minimum) are as follows:

Zone	SOTR, lbs/day	SOTE, % (Note 1)	Airflow Rate, scfm	Minimum Active Diffuser Count (Note 2)	Number of Blank Diffusers, %
Aeration Basins Nos. 1 - 3					
Zone 3 Swing Zone	5,980	22.9	1029	600	0
Zone 4 Aerobic	4,396	23.2	758	550	0
Zone 5 Aerobic	5,326	23.1	921	722	0
Zone 6 Aerobic	3,018	22.9	526	420	10
Zone 7 Aerobic	2,952	21.7	543	396	10
Aeration Basins Nos. 4 - 7					
Zone 3 Swing Zone	4,414	29.1	600	522	0
Zone 4 Aerobic	5,422	28.6	750	624	10
Zone 5 Aerobic	4,185	26.5	624	522	10
Zone 6 Aerobic	2,876	24.5	464	396	10

Notes:

1) Listed SOTE value for Aeration Basins Nos 1 - 3 reflect a 15% reduction to account for basin side slope configuration.

2) Listed minimum active diffuser count represents diffusers required for system process requirements. Provide additional diffusers for mixing purposes on ledges located in the Aeration Basin Nos. 1-3 as indicated on the Drawings.

2. Demonstrate compliance with the minimum SOTE requirements specified above through a Factory Standard Oxygen Transfer Test for each Aeration Basin configuration:

a. The Tests shall be based on the following test zone configuration:

1) Aeration Basins Nos. 1 - 3: Zone 5 as specified above.
2) Aeration Basins Nos. 4 - 7: Zone 4 as specified above.

b. Additional diffuser requirements for the remaining zones shall be determined by proration of the Test Zone results based on the estimated active diffusers specified for each zone:
1) The estimated active diffuser counts specified in the preceding table are included solely for the purposes of this proration.
2) Actual active diffuser requirements may be higher depending on the results of the Factory Test.

c. If the Factory Test determines that the specified minimum SOTE for the Test Zone can only be achieved by using more diffusers than estimated above for the Test Zone, then the active diffuser count in each of the other zones shall be proportionately increased over their respective estimated active diffuser counts.

d. Conversely, if the Factory Test of the Test Zone configuration demonstrates that the specified minimum SOTE can be achieved using less active diffusers than estimated above, then the active diffuser count in each of the other zones may be proportionally decreased below their respective estimated active diffuser counts with approval by the Engineer.

3. Provide a minimum number of blank diffuser assemblies as indicated in the table above. The number of blank diffusers assemblies required is specified as a percentage of the active diffuser assemblies.
4. Size dropleg, manifolds, and lateral piping as required to provide air distribution uniformity values in each zone as follows:
a. 98 percent at average conditions.
b. 95 percent at peak conditions.

1.05 SUBMITTALS

A. Submit product data and shop drawings, operation and maintenance manuals, and test reports to the Engineer for review as specified in Section 01330 and as detailed in this Section.

B. Product data and shop drawings: Include the following as part of the Product Data and Shop Drawing Submittals:
1. Descriptive literature and dimensional drawings for all equipment proposed, including views of the air manifold and diffuser assemblies indicating materials of construction, material product specification for all components, and number, location, and spacing of diffusers, and size and layout of air piping:
a. Include weights, center of gravity, and lifting diagrams, as required.
2. Pipe support layout describing methods for supporting and preventing uncontrolled movement of the air manifold and diffuser lateral grid pipe resulting from flotation dynamic forces, thermal expansion, fluid forces developed by mixers and flow from process pipe inlets/outlets forces, and other external forces.
3. Methods for compensating for thermal expansion and construction and design criteria employed.
4. Methods for draining the air distribution systems.
5. Air diffuser assemblies:
a. Number of diffuser elements.
b. Complete materials list, material specifications, dimensions, and tolerances of all parts of the diffuser assemblies.

c. Curve showing head loss versus airflow rate for the flow control orifice and diffuser element.
d. Testing and sampling plans for Source Quality Control of the diffuser elements.
e. A full-size, completely assembled, representative sample of the proposed diffuser assembly, mounted on 4-inch PVC pipe, including diffuser, gaskets, element holder, retaining ring, pipe supports, and expansion joint on 1 end, and all appurtenances for the particular diffuser system.

6. Diffuser grid piping:
   a. Complete materials list and specifications, dimensions, critical tolerances of piping, fittings, expansion joints, and accessories.
   b. Layout of grid piping, diffuser holders, expansion joints, and pipe supports.
   c. Identification of the installed location of the solvent welded pipe.
   d. Indicate diffuser-free areas required by the submersible mixer.
7. Manifold piping:
   a. Complete material list, material specifications, dimensions, thickness of piping, fittings, expansion joints, and accessories.
   b. Layout of air manifolds.
8. Pipe supports:
   a. Complete design criteria, material list, material specifications, and dimensions of all parts of the pipe supports and extensions.
   b. Include drawings showing proposed support design including anchor locations and details.
   c. Include calculations for supports for thermal expansion in air from 30 degrees Fahrenheit to 95 degrees Fahrenheit.
9. Moisture blow-off systems:
   a. Complete materials list, material specifications, and dimensions of all parts of the system.
   b. Location of the system and layout of the piping, including joints, pipe supports, and valves.
   c. Specifications for the ball valve.
10. Chemical cleaning systems:
    a. Complete process description, layout drawings, and bill of materials.
    b. Acid usage chart.
11. Storage and protection of material:
    a. Certification that special shipping and storage containers shall be utilized to protect the material from sun deterioration, handling damage, and heat warpage.
    b. Packing, shipping, and storage procedures.
12. Certified efficiency curve:
    a. Curve of SOTE versus air flux rate (defined as airflow in scfm per active diffuser area) at the design submergence, prepared, sealed, and signed by a registered professional engineer.
13. Air manifold piping factory leak test certification:
    a. Certification that air manifold piping has successfully passed the leak test specified in air manifold piping testing.
    b. Submit this certification prior to shipment.
14. Design calculations:
    a. Design calculations documenting air head loss from the top of the dropleg to the farthest diffuser for all conditions specified in System Description.

b. Design calculations verifying uniform air distribution through the manifold header and diffusers under all conditions specified in System Description.
c. Design calculations showing loading conditions on piping and support components. Include fluid forces developed by mixers and flow from process pipe inlets/outlets.
d. Design calculations showing mechanical strength capabilities of diffuser mounting system.
e. Design calculations showing normal buoyancy uplift forces and structural calculations to meet the requirements of piping supports. Note, in Aeration Basins Nos. 1 through 3, piping support must be able to withstand forces due to recirculation patterns caused by side slopes in the basins.
f. Design calculations for piping supports for thermal expansion in air from 30 degrees Fahrenheit to 95 degrees Fahrenheit.
g. Seismic calculations.
h. Calculations demonstrating adequacy of submerged stainless steel cooling piping to provide necessary cooling of airflow to diffusers.

15. Spare parts list.
16. Qualifications and resume of installation engineer.
17. Training course outlines.
18. Manufacturer's experience and reference list as specified in Quality Assurance.
19. Provide membrane longevity test reports:
    a. Longevity of the proposed membrane diffusers shall have been demonstrated in at least 3 full-scale municipal installations operating continuously for a minimum of 3 years.
    b. Test reports, prepared by an independent testing agency, shall confirm membrane longevity through compliance with the following maximum allowed percent (within) change in each membrane property:
        1) Tests conducted in-house by the Supplier shall not be acceptable.
    c. Data for a minimum of 3 diffusers from each installation shall be provided.

Property	Maximum Percent Change
Durometer	5 percent
Weight	5 percent
Permanent Set	0.5 percent

C. Operation and Maintenance Manuals: Furnish copies of operation and maintenance manuals as specified in Sections 01782 and 15050.

D. Factory Standard Oxygen Transfer Testing:
1. Test project installation:
    a. A minimum of 60 days prior to the factory tests, a description of the proposed test protocol and test tank layout, for review and approval.
    b. Submit shop drawings for the actual proposed diffuser grid layout, so that the test tank layout may be compared with the actual proposed layout.
    c. Following approval of test protocol and test tank layout, and a minimum of 30 days prior to the factory tests, a time schedule and location for the tests.
    d. A maximum of 30 days after the completion of the factory tests, 5 copies of the test report, signed and stamped by a licensed professional engineer documenting the results of the Factory Standard Oxygen Transfer Test in

full accordance with the referenced ASCE Standard Guidelines for In-Process Oxygen Transfer Testing. The report shall specifically include:

1) A reference to the latest ASCE Standard Guidelines for In-Process Oxygen Transfer Testing.
2) Test basin dimensions and modified dimensions.
3) Diffuser layout and DO probe type and location.
4) Volume of liquid in the test basin and diffuser submergence.
5) Type, quantity, and source of chemicals used between all reaeration test runs.
6) Documentation of calibration of all measurement instruments.
7) All raw test data placed in an Appendix.
8) Standard Oxygen Transfer Test procedure.
9) Data analysis procedure.

E. As-built set of diffuser drawings:
   1. A maximum of 30 days following the successful completion of the field 7-day test, provide an as-built set of diffuser drawings showing the installed diffuser configuration with all pertinent details including:
      a. Installed number and location of diffusers and droplegs.
      b. Installed configuration of the air distribution piping including valves and fittings, the location of the access ways.
      c. Location of the moisture blowoff piping.

1.06 QUALITY ASSURANCE

A. Experience: Demonstrate minimum 10 years experience in the manufacture of fine bubble diffused aeration systems which have been successfully utilized in domestic wastewater applications.

B. Reference information: Provide the following:
   1. List of at least 10 installations in domestic wastewater treatment plants located in the Continental United States of not less than 10 million gallons per day (mgd) and with aeration equipment utilizing a quantity of diffusers equal to or greater than the number of diffusers proposed for this installation, with at least 5 years of successful continual operation, where the manufacturer has supplied equipment similar in design and characteristics to that proposed here. Include names, addresses, and telephone numbers of the Owners.
   2. Name, address, and telephone number of contact person at each referenced installation.
   3. Location of manufacturer’s diffuser production facility.
   4. Location and description of manufacturer’s oxygen transfer testing facility and equipment.

1.07 PROJECT CONDITIONS

A. Environmental project conditions:
   1. As specified in Section 01610.
   2. Exposure to industrial solvents and petroleum products.
   3. Intermittently submerged and exposed to atmosphere.
   4. Wastewater temperatures:
      a. Maximum: 90 degrees Fahrenheit.
      b. Minimum: 50 degrees Fahrenheit.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Preparation for shipment:
   1. All materials shall be suitably packaged and braced to protect against damage during transit, handling, and unloading.
   2. Manufacturer shall package equipment, be responsible for, and make good, any and all damage until the equipment is delivered to the job site.
   3. Accessories shall be packaged separately in containers clearly marked, “ACCESSORIES ONLY.”
   4. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.
   5. Provide written storage procedures for all equipment.

B. Delivery to job site:
   1. Manufacturer shall fabricate and deliver materials to the job site in conformance with the Contractor's construction schedule, to minimize handling and on-site storage of equipment.
   2. Materials shall be unloaded and stored at a location on-site and covered in accordance with the manufacturer's recommendations. Covering system shall protect the materials from UV radiation.

C. Storage and protection: Protect the system components at the site and during installation prior to project completion. As a minimum, provide cover, ventilation, and proper stacking to prevent warping of all aeration system piping stored on-site.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate work with restrictions specified in Section 01140.

1.10 WARRANTY

A. The manufacturer shall provide a 3-year extended warranty on all parts and materials. The extended warranty shall provide for replacement of all membranes which physically fail, tear, or pull out of mounting systems in the first 3 years of operation.

B. Owner shall receive an executed copy of the written warranty prior to final payment to the Contractor.

C. This warranty shall commence upon final acceptance of the aeration system by the Owner.

1.11 MAINTENANCE

A. Spare equipment:
   1. 2 percent of the total diffuser membranes utilized on the project.
   2. 2 percent of the total diffuser plugs for blank diffusers.
   3. 1 percent of the total retainer rings and baseplates utilized on the project.
   4. 2 percent of each of the different supports utilized on the project.
   5. 2 spare moisture blowoff systems complete with fittings and fasteners.
   6. A minimum of 3 spanner wrenches for mounting of diffusers.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Furnish complete fine bubble aeration system by following manufacturer, no equal:
   1. Sanitaire manufactured by Xylem Water Solutions, Inc.

B. The complete fine bubble aeration system shall be furnished by a single manufacturer who is fully experienced in the design and manufacture of such equipment.

C. Use identical diffusers of the same model, type, and manufacturer, throughout the installation.

2.02 MATERIALS

A. General: For all components except where specifically modified in Equipment, use the materials of construction specified below:
   1. Stainless steel:
      a. Fabricate all welded parts and assemblies from sheets and plates of Type 304L stainless steel in accordance with ASTM A240 with a No. 2D finish in accordance with ASTM A480. Welds in accordance with ASTM A774.
      b. Fabricate all non-welded parts and assemblies from sheets and plates of Type 304 stainless steel in accordance with ASTM A240, with a No. 2D finish in accordance with ASTM A480.
      c. Use Type 304L stainless steel in accordance with ASTM A240 in the fabrication of all stainless steel pipe. In accordance with ASTM A530, ASTM A554, and ASTM A778 in the fabrication of all stainless steel pipe.
      d. Use Type 304L stainless steel in accordance with ASTM A240 in the fabrication of all stainless steel pipefittings. In accordance with ASTM A774 in the fabrication of all stainless steel pipefittings.
      e. Use Type 304 stainless steel in accordance with ASTM A240 in the fabrication of all stainless steel bolts, nuts, and washers.
      f. Pickle all stainless steel assemblies and parts after welding, fabrication, and wire brushing by complete immersion in an acid solution in accordance with ASTM A380:
         1) Corrosion protection techniques not employing full immersion methods shall not be acceptable.
      g. Do not field weld any stainless steel pipe, fittings, fabrications or assemblies.
   2. PVC:
      a. Fabricate all PVC moldings and extrusions from PVC compound in accordance with ASTM D1784, cell classification 12454-B.
      b. Fabricate all PVC droplegs, manifolds, piping from PVC material in accordance with ASTM D2241, with a hydrostatic design stress of 2,000 pounds per square inch.
      c. Use PVC pipefittings in accordance with ASTM D3034.
      d. Add a minimum of 2 percent titanium dioxide to all PVC compounds.
      e. Shop fabricate all solvent welded PVC joints in accordance with ASTM D2855.
   3. Membranes:
      a. Manufacture all membranes of EPDM synthetic rubber compound with precision die formed slits.
      b. Do not use thermoplastic materials such as plasticized PVC or polyurethane.

c. The EPDM rubber compound shall be tested by a certified laboratory and have the following characteristics:

Parameter	Standard	Value/Unit
Base Compound		**EPDM w/ Carbon Black for UV Protection**
Tensile Strength (Unperforated)	ASTM D412	1,200 psi
Elongation at Break	ASTM D412	350 percent
Hardness (Durometer)	ASTM D2240	58 within 5, Shore A
Accelerated Aging:		
Compression Set	ASTM D395	
@ 23 degree Celsius, 22 hours		20 percent
@ 70 degree Celsius, 22 hours		40 percent
Elongation (percent retained)	ASTM D573	
@ 100 degree Celsius, 70 hours		75 percent
Ozone Resistance	ASTM D1171	Pass
Modulus of Elongation @ 300 percent	ASTM D412	500 psi
Material Thickness		0.08 inches

2.03 EQUIPMENT

A. General:
1. Supply products that are units of the manufacturer's standard production, modified as necessary to satisfy the requirements of the Contract Documents, and specially fabricated for this project. Do not use products manufactured for another project.
2. The manufacturer shall supply a complete fine bubble diffuser system, ready for installation by the Contractor. No field modification of headers or field drilling or threading of headers shall be required.
3. Contractor shall provide all valves, air main piping, wall sleeves with seals, wall pipes, and concrete pedestals as necessary to complete the system as shown on the plans.
4. All equipment and appurtenances shall comply with the requirements as specified in Section 01612:
   a. Design mechanical equipment and piping and their supports to prevent sliding or overturning.
   b. Provide brackets and anchors of ductile material capable of absorbing energy and continuing to carry load.
   c. Submit seismic calculations as specified in Section 01330.

B. Air distribution piping:
1. General:
   a. The air distribution piping includes the droplegs into the aeration basin, the manifolds that supply air from the dropleg to the laterals, and the laterals on which the diffusers are mounted.
   b. Use only stainless steel or PVC for all air distribution piping as specified.
   c. Account for stresses due to temperature variation and provide suitable systems to permit non-destructive relief of piping stresses.
   d. Install piping plumb with walls and make up all changes in direction using standard fittings.
   e. Fabricate all piping assemblies to be field installed using flange-type joints or positive fixed threaded union joints:

1) Push on, bell in spigot, or expansion type joints will not be acceptable.

f. Field welding of pipe sections, fittings, or flanges is not acceptable.

2. Joints:
   a. Threaded union joints shall consist of a spigot section solvent welded to 1 end of the pipe, a threaded socket section solvent welded to the mating pipe, an O-ring gasket, and a threaded screw on a retainer ring.
   b. Positive fixed threaded union joints shall also have a spline and groove feature that will prevent rotation of adjacent header sections.
   c. Flange joints shall have standard 125 pound drilling.
   d. Band couplings shall not be considered a fixed joint.
3. Droplegs:
   a. Provide at least 1 independent dropleg for each Zone as indicated on the Drawings.
   b. Provide Schedule 10 seamless Type 304L stainless steel dropleg pipes as specified in Section 15286, and as indicated on the Drawings.
   c. Provide a 125-pound drilled flange connection at top of the dropleg.
   d. Extend dropleg to approximately 2 feet above manifold.
   e. Provide plain end at lower end of the dropleg.
   f. Connect dropleg to manifold with a Type 304 stainless steel flexible transition coupling.
   g. Install piping plumb with walls and make up all changes in direction with standard pipefittings.
4. Manifolds:
   a. Provide Schedule 80 PVC manifolds with PVC compound cell classification as specified in Materials.
   b. Shop fabricate the manifolds in sections of 20 feet or less to conform with the accepted layout for the equipment supplied.
   c. Maintain a constant bottom elevation of the manifolds throughout the basin.
   d. Provide removable blind flanges or threaded end caps at the ends of all manifolds to allow purging of debris prior to system start-up.
5. Laterals:
   a. Lateral grid piping includes all submerged piping other than the droplegs, manifolds, and the moisture blowoff piping.
   b. Provide lateral grid piping in accordance with ASTM D2241 and sized for SDR 33.5 or thicker. All fittings shall have pressure ratings not less than the attached piping and shall in accordance with ASTM D3034 with a maximum SDR of 33.5.
   c. Shop fabricate the laterals in sections of 20 feet or less.
   d. Field join lateral sections using flanged joints with gaskets. Connections shall permit rotation of each section independent of adjacent sections.

C. Piping supports:
   1. General:
      a. Provide supports of both guide and fixed type to allow for expansion of the system:
         1) Submit proposed pipe support layout and design for Engineer's review and acceptance prior to manufacture.
         2) Include all details outlined in Submittals.

b. For the welded parts of the pipe supports, use Type 304L stainless steel in accordance with ASTM A240 with a No. 2D finish and a maximum carbon content of 0.030 percent.
c. For the non-welded parts of the supports, such as concrete anchors, nuts, and washers, use Type 304 stainless steel in accordance with ASTM A240.
d. Fabricate the supports using flat stock of at least 18-gauge by 1-1/2 inches and rods of at least 5/16-inch diameter.
e. Supports shall be adjustable to allow movement of pipe and to compensate for a minimum variation in tank floor elevation of approximately 3 inches:
    1) All adjusting devices shall lock in place after piping has been installed and leveled.
f. Attach supports to the tank floor using expansion type concrete anchors designed for embedment in 3,000 pounds per square inch concrete:
    1) Size anchors for pullout strength against calculated buoyant forces, based on a design safety factor of 5 or more.
g. Design supports to allow for complete removal from the tank (less anchors) to facilitate cleaning and maintenance of tank bottom.

2. Dropleg supports:
    a. Provide a mounting support at the midpoint of each dropleg.
    b. Design the support to restrain horizontal movement of drop:
        1) Weight of the dropleg shall be supported by top connection.
3. Manifold supports:
    a. Provide a minimum of 2 supports with a maximum spacing between supports of 7.5 feet.
    b. Design support system to resist thrust generated by expansion or contraction of pipe.
    c. Design the manifold supports to include a manifold hold-down, guide straps, anchor bolts, and supporting structure. Use minimum 2-inch wide guide straps. Provide supports with a mechanism allowing for within 1.5 inches adjustment for alignment of the manifold in the field.
4. Lateral supports:
    a. Provide supports with a mechanism allowing for within 1.5 inches vertical adjustment for alignment of the laterals in the field.
    b. Adjusting and aligning mechanism shall be infinitely adjustable within its limits to allow precise leveling of the laterals and diffuser assemblies to within 1/4 inch of a common horizontal plane without removing the lateral from the support.

D. Diffuser assembly:
1. General:
    a. With each complete air diffuser assembly, include a membrane diffuser element with matching baseplate, diffuser holder, threaded retainer ring, and an airflow control orifice. Use Sanitaire Model 2300 diffuser holder.
    b. Diffusers elements utilizing ceramic or plastic type diffusion media elements or ones that require a center bolt to limit membrane deflection will not be acceptable.
    c. With each blank diffuser assembly, include a baseplate, threaded retainer ring, and an airflow control orifice.
    d. Design, manufacture, and install the entire system in such a manner that all the diffuser elements are within 1/4 inch of a common horizontal plane.

e. Air distribution shall be uniform throughout the entire system as specified in performance requirements.

2. Membrane diffuser element:
   a. Type: Membrane disk.
   b. Size: 9-inch diameter.
   c. Material: Provide membrane material specifications as outlined in Materials.
   d. Manufacture the membrane as a seamless, single extrusion or molding without defects or repairs and integral sealing ring on periphery of diffuser element:
      1) Surface of the membrane shall be smooth to prevent attachment of biological growth.
   e. Design the membrane diffuser element to collapse and seal on the supporting baseplate to prevent backflow of mixed liquor into the air piping when aeration air is turned off.
   f. Design for the membranes to be replaceable in the field without needing to remove the diffuser assembly from the basin.
3. Baseplate:
   a. Provide PVC baseplate to completely support membrane diffuser element and prevent reverse flexing.
   b. Baseplate shall include air release port centered in the baseplate.
4. Diffuser holder:
   a. Each diffuser shall incorporate a diffuser holder integrally bonded to the piping system and designed to provide complete peripheral edge support for the membrane element.
   b. Diffuser holders attached via mechanical fasteners, such as rivets, shall not be acceptable.
   c. Solvent weld each diffuser holder to the lateral grid piping in the factory such that the flat surface of all diffuser holders lie in the same plane along the length of the lateral grid piping; warping of this planar surface shall not be permitted:
      1) Diffuser elements shall be located directly above the centerline of the lateral pipes.
      2) Elements that are offset or cantilevered shall not be allowed.
   d. Secure the membrane diffuser element to the diffuser holder using a PVC retainer ring screwed on to the diffuser holder with the outer edge of the membrane diffuser element located in the groove provided:
      1) Use a hold-down ring of sufficient length to allow engaging a minimum of 1 full thread before compression of the membrane outer edge begins.
      2) Strictly adhere to manufacturer's recommendations during installation and tightening of the hold-down ring.
      3) Take precautions to avoid overtightening of the hold-down rings.
5. Airflow control orifice:
   a. Each diffuser assembly shall incorporate a flow control orifice sized to provide equal air distribution throughout the grid. Should a diffuser element break, the flow control orifice shall be capable of maintaining uniform distribution of air throughout the system.
   b. Design the airflow control orifice to be capable of being completely sealed.
   c. Factory drill the flow control orifices under controlled shop conditions prior to shipment of the diffuser assemblies to the job site.
   d. No field drilling of flow control orifices is allowed.

e. Provide removable orifice plugs for specified blank air diffuser assemblies:
    1) Design plugs to be capable of preventing any airflow leakage throughout the specified range of flows.
    2) Design plugs to allow removal using pliers.

E. Moisture blowoff system:
1. Provide a minimum of 1 moisture blowoff system per grid including all required pipe, fittings, valves, and accessories.
2. Design the moisture blowoff system to be capable of effectively removing any liquid that has entered the piping system:
    a. Include a sump in the piping at the location of the purge pipe to allow the purge pipe to extend below the invert of the manifold and completely remove moisture from the manifold.
    b. This fitting shall be a cross or a tee with a factory-solvent welded cap installed on the downward facing branch.
    c. Locate the sump at the side of the grid opposite the dropleg to allow accumulated moisture to migrate with the airflow towards the sump.
3. Provide Schedule 80 PVC for all moisture blowoff piping, except for a short length of flexible, reinforced EPDM hose from the header/lateral purge pipe connection to the rigid blower piping mounted on the tank wall:
    a. The use of lengths of EPDM hose greater than 4 feet or extending to the surface of the basin is not acceptable.
    b. All hose and fittings to have a pressure rating of no less than the attached pipe, except that the cross fitting used for the sump may be Schedule 40 PVC.
4. Solvent welds may be used to join fittings to PVC pipe:
    a. A union shall be required in each blowoff line.
    b. Properly support the systems and allow for expansion and contraction of the piping over a temperature range of 160 degrees Fahrenheit with no stress buildup in the piping.
    c. Provide stainless steel hose clamps at each end of the flexible hose.
5. Attach moisture blowoff piping to wall of basin with Type 304 stainless steel clips:
    a. The use of hose clamps or plastic ties to support blowoff piping from dropleg piping (or other piping) is not acceptable.
6. Locate the valves in the blowoff piping in an easily accessible location above the water surface adjacent to the wall and just above the grid system:
    a. The valve shall be a socket end type, PVC ball valve.

F. Fasteners and hardware:
1. Provide all bolts, nuts, and washers of Type 304 stainless steel.

2.04 SOURCE QUALITY CONTROL

A. Diffuser physical performance testing:
1. General:
    a. The fine bubble aeration equipment shall be shop tested as specified:
        1) No corrections shall be made to the measured values of any parameter for possible errors due to instrument calibration, method of measurements, data observation, reduction of data, or measurement accuracy.

b. Perform oven age testing on the membranes as part of the quality control testing:
    1) Results of the Accelerated Aging Test shall meet the criteria specified in Materials.
c. Sample and test the membrane diffuser elements for air distribution uniformity, dynamic wet pressure (DWP), and dimensional tolerance as specified.
d. Submit a testing and sampling plan designed to insure consistently good quality of the diffuser assemblies from each membrane lot.
e. All tests shall be witnessed by a representative of an independent, certified testing laboratory engaged by the Contractor and approved by the Owner, and may be observed by the Engineer and Owner.
f. All costs for inspection and testing, exclusive of the costs for the presence of witnesses from the Engineer and Owner, shall be borne by the Contractor.
g. Notify the Engineer at least 30 days prior to the scheduled testing dates, and confirm the testing schedule at least 3 days prior to the testing date, to allow the Owner to witness the sampling and testing procedure for the diffusers.

2. Uniformity:
    a. Test diffusers in a plan to show that 95 percent of the diffusers within a given lot meet the uniformity requirement. Uniformity is defined as a substantially even distribution of air bubbles across the diffuser surface when the diffuser is operating submerged in water.
    b. The uniformity testing apparatus shall consist of a container for testing the elements individually and calibrated instruments for the measurement of all variables:
        1) Provide a container or test box with suitable clamping devices for holding the membrane element in position and completely sealing the element against the passage of air except through the exposed face:
            a) The holding device shall be such that the air is distributed uniformly across the surface of the element.
        2) Use a nonpulsating air supply.
        3) If necessary, use a reservoir to dampen pulsation in the blower discharge piping.
    c. Membrane elements to be tested for uniformity:
        1) Saturate with tap water, clamped in position, and submerged in a depth of 2 inches of tap water.
        2) Air shall then be diffused through the element at a rate of 12 standard cubic feet per minute per square foot of effective surface area for 1 minute.
        3) The airflow rate shall then be reduced to 1.0 standard cubic feet per minute per square foot of effective surface area, and the uniformity of diffusion observed and recorded as satisfactory or rejected.
    d. All diffusers not satisfying the uniformity requirement shall be rejected.
    e. If the uniformity tests do not show substantial uniformity, additional tests shall be made as necessary to assure that elements with uniform permeability are being obtained:
        1) The cost of any additional tests shall be borne by the Contractor.
3. Dynamic wet pressure (DWP):
    a. Test diffusers in a plan to show that 95 percent of the diffusers within a given lot fall within 10 percent of the average DWP. DWP is defined as the

pressure to operate at the specified conditions minus diffuser submergence and flow control losses.

b. Test diffusers in a room maintained at 70 degrees Fahrenheit within 5 degrees Fahrenheit and 10 to 50 percent humidity.

c. Use the same apparatus for the DWP test as was used for the uniformity test:

1) Provide a means of measuring the pressure under the diffuser element.

2) Submerge the diffusers at least 2 inches of water and operate at an airflow rate of 3.5 scfm per square foot of active diffuser area within 10 percent.

3) The DWP is the pressure head under the diffuser in inches of water minus the submergence depth in inches.

d. All measured DWP values shall be within 10 percent of the average DWP.

e. All diffusers tested and found outside the acceptable range shall be rejected:

1) If the lot is found to have a greater variability than specified, all elements of the lot shall be tested and only individual diffusers which meet the variability requirement shall be accepted.

2) The cost of any additional tests shall be borne by the Contractor.

4. Dimensional tolerances:

a. Test diffuser elements and baseplates for dimensions and trueness of surfaces.

b. All elements with appreciable warping of surfaces shall be rejected. Appreciable warp is defined as irregularities greater than within 0.03 inch.

c. Maintain the following tolerances:

1) Membrane thickness: 0.08 inch within 0.01 inch.

2) Membrane disk diameter: 9 inch within 0.10 inch (9-inch diameter disk).

d. The criteria used to determine the acceptance of the dimensional tolerances shall be the same as for uniformity and DWP.

B. Air manifold piping testing:

1. Factory assemble and test the air manifold piping for leaks to a pressure of 10 pounds per square inch, or 1.25 times the maximum allowable pressure, whichever is higher, prior to shipment.

2. Provide written certification per requirements of product data and shop drawings.

2.05 FACTORY STANDARD OXYGEN TRANSFER TEST

A. Perform the test on a mockup of the project installation:

1. Conduct a factory standard oxygen transfer performance test to demonstrate the capacity of the supplied equipment to meet the specified performance requirements of design requirements.

2. Tests shall be conducted at the manufacturer's facility by an independent testing firm subject to acceptance by the Engineer:

a. Tests may be observed by the Engineer and Owner.

b. All costs for inspection and testing, exclusive of the costs for the presence of witnesses from the Engineer and Owner, shall be borne by the Contractor.

3. Conduct testing at a location within the continental United States.

4. Perform all testing in accordance with the referenced ASCE 2-91:
    a. The test procedure shall include analysis of the tap water in the test tank for total dissolved solids by a certified testing laboratory, both before and after the test.
5. Run all tests using diffusers of identical size and type to those supplied for the project.
6. Conduct at least 3 test runs at the airflow rate specified in design requirements, to establish an average clean water SOTE for the specified testing zone.
7. Conduct testing in a tank having a surface area larger than 200 square feet to eliminate the potential of wall effects:
    a. Further, conduct testing at submergence depths and diffuser densities equivalent to the actual project configuration of the specified testing zone.
8. The diffuser layout in the test tank shall be subject to the approval of the Engineer:
    a. As far as practicable, the diffuser layout in the test tank shall represent the actual full-scale layout, as shown in the diffuser grid shop drawings approved by the Engineer.
    b. The test tank diffuser layout shall include representative access-ways, header groupings, and diffuser spacing.
    c. If exact diffuser arrangements cannot be practically achieved during testing, the manufacturer shall perform 2 sets of tests, 1 set at a higher density, and 1 set at a lower density.
    d. Mathematical interpolation calculations shall be provided to demonstrate compliance at the specified floor coverage.
9. The Contractor shall provide shop drawings of the proposed diffuser grid layout for each zone for approval, in accordance with the requirements described in Submittals.
10. The Owner's witness for the diffuser test shall be given access to inspect all test apparatus prior to, during and following the test.
11. The test schedule shall allow for the Owner's witness to inspect the tank prior to filling with tap water, and to witness filling of the tank with tap water.
12. Any retesting, including costs for the presence of witnesses from the Engineer and Owner during retesting, shall be performed and provided for at no additional cost to the Owner.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage and conformance to the specifications.

3.02 INSTALLATION

A. Contractor shall remove all existing diffusers in the existing Aeration Basin and dispose of as directed by the Owner.

B. Contractor shall install the specified fine bubble diffused aeration system in accordance with the equipment manufacturer's instructions and recommendations furnished with the equipment, approved shop drawings, and as indicated on the Drawings and Specifications.

C. Contractor shall furnish and install all piping, valves, fittings, anchors, interconnections, and accessories as required to make the system complete and functional:
   1. Include in the bid all labor, materials, and equipment required to install the diffuser system and to make the complete system operate satisfactorily.

D. Install all diffusers at an identical elevation within 0.25 inches of a common horizontal plane.

3.03 FIELD QUALITY CONTROL

A. Cleaning of air piping:
   1. After installation of the new aeration piping, air from the low-pressure air system shall be discharged at the maximum rate possible for not less than 2 hours:
      a. This procedure shall be repeated.
      b. These operations shall be coordinated with the needs of plant operations through the Engineer.
   2. Do not install the diffuser elements until all cleaning operations are complete.
   3. Thoroughly clean all new air piping immediately prior to installation.
   4. Swab each unassembled piece of grid piping prior to installation.
   5. After installation, protect all surfaces from contamination by dust, dirt, construction debris, and moisture, including atmospheric moisture, in a manner satisfactory to the Engineer.
   6. Whether or not the pipe upstream has been cleaned, all openings in partially completed work shall be temporarily sealed off except where installation is actively in progress:
      a. Seal off openings where installation is in progress at the end of each day's work, or whenever the work is temporarily stopped for any reason.
   7. Suspend work whenever inclement weather is imminent.
   8. Thoroughly clean any surfaces which become contaminated prior to acceptance to the satisfaction of the Engineer.

B. Inspection and checkout:
   1. After installation, test the fine bubble diffusion equipment for mounting, levelness, air uniformity, and leakage:
      a. Notify the Engineer at least 1 week prior to the scheduled testing date, and confirm the testing schedule at least 2 days prior to the testing date, to allow the Engineer or his representatives to witness the field-testing.
      b. Replace all items found to be defective.
   2. Prior to initiating any field-testing, inspect all piping for proper joints, supports and tie-downs, plugs, and moisture blowoff valves.
   3. Provide a field service engineer to monitor the installation, leveling, and testing of the aeration equipment.
   4. Flood the aeration tank with water to the top of the diffusers:
      a. Check the level of the diffusers to insure that they are at the same elevation within 0.25 inch of a common horizontal plane.

C. Field performance tests:
   1. Notify the Engineer at least 1 week prior to the scheduled testing date, and confirm the testing schedule at least 2 days prior to the testing date.

2. Introduce water into the aeration basins until the water level just reaches the top of the diffusers:
    a. The level of the diffusers shall then be checked to insure that they are at the same elevation, within the limits specified.
3. After completion of the leveling test, add water to the aeration basins to cover the diffusers with about 3 inches of water.
4. Pass air through the diffusers, and check operation of the diffusers.
5. Visually inspect the surface of the water above the diffusers to ensure that airflow is uniformly distributed across the tank, as well as uniformly distributed across the surface of each diffuser.
6. All diffusers, which in the opinion of the Engineer do not produce a uniformly distributed flow pattern, or do not produce a flow pattern consistent with the majority of the diffusers, shall be replaced.
7. Check all air manifold, moisture blow-off, and drop piping above the water surface for leaks with soapsuds after covering the diffusers with water:
    a. All leaks shall be repaired and testing shall continue until the systems show no visual signs of leakage.
8. The Contractor is responsible for filling and emptying aeration basins with water as required for his testing activities:
    a. Water used shall be from the Owner's plant effluent water system.
    b. Contractor shall be responsible for conveying water between the plant effluent water system and the aeration basins.
    c. Provide written notification to the Engineer a minimum of 5 days in advance of any such use of the plant effluent water.

D. 3-day test:
1. Conduct the 3-day test following successful completion of the field performance tests.
2. Fill the aeration basins with plant water to normal operating levels.
3. Operate at normal airflow rates for a minimum of 3 days.
4. If any diffuser system failures occur during this period, drain the basin(s), make repairs/modifications, and then re-run the 3-day test.
5. Owner will provide a source of water and electrical energy.
6. Contractor shall pay for all costs of testing other than the cost of water and energy at their sources.
7. At the end of the test or retest, leave the basins full of plant water.

E. 7-day test:
1. Following successful completion of the 3-day test, coordinate with the plant operations personnel in placing the basins in operation.
2. Provide a minimum of 1 week for the Owner to establish operational conditions in the aeration basins.
3. Upon notice that the aeration basins have achieved operational conditions, begin the 7-day test.
4. Submit a written procedure for approval prior to beginning the 7-day test:
    a. Correct any deficiencies found during the 7-day test and at the Owner's option, run the 7-day test again at no additional cost.

3.04 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's factory-trained field service engineer, specifically trained in the installation and testing of the specific equipment. The field service engineer shall provide the following services:
   1. Supervising equipment installation.
   2. Providing start-up and testing assistance and making adjustments, repairs, and corrections.
   3. Training plant operating personnel.

B. Include a minimum of seven (7) 8-hour days of the field engineer's time on the site:
   1. Training shall count for 1 day of the total required time.
   2. Include a minimum of 3 trips.

C. Schedule in advance with the Owner, training for the fine bubble diffused aeration system operation and maintenance:
   1. Submit a training schedule based upon the projected installation schedule.

D. Furnish a certificate stating that the equipment has been tested, is correctly installed, properly aligned, and ready to be placed in regular operation.

E. A maximum of 30 days following the successful completion of the field 7-day test, provide as-built drawings of the diffuser installation including all information outlined in Factory Standard Oxygen Transfer Testing Data.

F. Refer to Section 01756 for additional training requirements.

END OF SECTION

PRE-NEGOTIATED PROPOSAL FROM SANITAIRE

SECTION 11378A:

FINE BUBBLE DIFFUSED AERATION SYSTEM - DISK

Xylem Water Solutions USA, Inc.
9333 N. 49th Street, Brown Deer, WI 53223
Tel 414.365.2200 Fax 414.365.2210

SANITAIRE
a xylem brand

DATE: **April 17, 2017**

TO: **Bidding Contractors**

RE: **City of Turlock**
Secondary Clarifier No. 5 & Denitrification Project
Sanitaire #16-27253s
Proposal Rev. 01

Engineer: **Carollo Engineers**

We propose to furnish the following Aeration Equipment subject to the terms and conditions set forth herein:

Section 11378 Fine Bubble Diffused Aeration System - Disk

A. EQUIPMENT AND SERVICE

The Xylem Water Solutions USA scope of supply for this project includes the following equipment and services:

1. **Fine Bubble Aeration:** SANITAIRE® Disc Fine Bubble Aeration System for installation in the following tanks:

Tank	Zone	Quantity of Grids	Manifold Dia., Inches	Installed Diffusers / Grid (including blanks)	Active Diffusers / Grid
Aeration Basins 1, 2, 3	3	3 (One per basin)	10	600	600
Aeration Basins 1, 2, 3	4	3 (One per basin)	10	550	550
Aeration Basins 1, 2, 3	5	3 (One per basin)	10	722	722
Aeration Basins 1, 2, 3	6	3 (One per basin)	8	465	420
Aeration Basins 1, 2, 3	7	3 (One per basin)	8	442	396

(Aeration Basins 1, 2, and 3 are identical)

Tank	Zone	Quantity of Grids	Manifold Dia., Inches	Installed Diffusers / Grid (including blanks)	Active Diffusers / Grid
Aeration Basins 4, 5, 6, 7	3	4 (One per basin)	8	522	522
Aeration Basins 4, 5, 6, 7	4	4 (One per basin)	8	686	624
Aeration Basins 4, 5, 6, 7	5	4 (One per basin)	8	576	522
Aeration Basins 4, 5, 6, 7	6	4 (One per basin)	8	441	396

(Aeration Basins 4, 5, 6, 7 are identical)

Equipment for each grid will include:

- One SCH 80 PVC manifold with connections for each 4 inch diameter air distributor.
- Stainless steel manifold supports with hold-clamps and cradle.
- Four-inch diameter, SDR 33.5 PVC air distribution headers including:
  - Fixed anti-rotational joint connection to the air manifold.
  - Factory installed diffuser holders.
  - Positive locking fixed anti-rotational joint connections.
- Stainless steel air distribution header support stands with header hold down clamp and locating plate.
- SANITAIRE® Fine Bubble Diffuser Elements with gaskets and retainer rings.
  - Sanitaire model 2300 holders will be factory installed.
  - Membranes and Retainer rings will be supplied for active diffusers
  - Diffuser plugs will be supplied for blank diffusers
- One diffuser plug tool (for installing plugs into blank diffusers) will be supplied per grid (only for grids that include blank diffusers)
- Flanges, bolts, nuts and neoprene gaskets necessary to assemble the system.
- One purge system with eductor piping and isolation valve.
- Stainless steel anchor bolts for the manifold and header supports.

NOTE: **Anchor bolts are designed for installation in 4000 PSI Concrete Per ACI Committee 350 ("Concrete Sanitary Engineering Structures").**

Sanitaire is supplying fine bubble aeration grids starting at the manifold. Existing droplegs will be used for all basins. Any new droplegs, if required (including supports), will be supplied by the contractor.

2. **Perimeter Aeration (Aeration Basins 1-3):** Nine (9) total grids will be provided for installation around the perimeters of aeration basin 1-3. There will be two distinct grid types, and each grid will consisted of one header with ~70 diffusers (refer to attached drawings for grid details). Equipment for each grid will include:

- Four-inch diameter, SDR 33.5 PVC air distribution header including:
  - Fixed anti-rotational joint connection to the air manifold.
  - Factory installed diffuser holders.
  - Positive locking fixed anti-rotational joint connections.
- Stainless steel air distribution header support stands with header hold down clamp and locating plate.
- SANITAIRE® Fine Bubble Diffuser Elements with gaskets and retainer rings.
  - Sanitaire model 2300 holders will be factory installed.
  - Membranes and Retainer rings will be supplied for active diffusers
- Flanges, bolts, nuts and neoprene gaskets necessary to assemble the system.
- One purge system with eductor piping and isolation valve.
- Stainless steel anchor bolts for the manifold and header supports.

NOTE: **Anchor bolts are designed for installation in 4000 PSI Concrete Per ACI Committee 350 ("Concrete Sanitary Engineering Structures").**

Existing droplegs will be used for perimeter aeration grids. Any new droplegs, if required, (including supports) required will be supplied by the contractor.

3. **Seismic Calculations:** Included for each grid type.

4. **Spare parts:** Included as specified:

- 2% total diffuser membranes
- 2% total diffuser plugs (for blank diffusers)
- 1% retainer rings
- 2% each different supports
- 2 spare moisture blow-off systems
- 3 spanner wrenches

5. **Engineering Drawings:** Required sets of engineering drawings.

6. **O & M Manuals:** Required sets of O & M Manuals.

7. **Field Installation Supervision and Start-Up Services:**

The following services will be provided as specified.

Installation Supervision, Startup Assistance.....Two (2) Trips, Ten (10) Days

Process Training/Follow-up ..... One (1) Trip, One (1) Day

Additional field service is available at a cost of $1,000.00 per day PLUS travel and living expenses.

B. EXCLUSIONS

The following are specifically excluded from our proposal:

1. All valves, air main piping and accessories.
2. All air drop piping
3. Additional submerged stainless steel piping for cooling legs, if required.
4. All bolts, gaskets and connectors for attaching drop pipe to upper air main piping.
5. All Chemical & Chemical storage
6. Installation of equipment furnished by Xylem-Sanitaire.
7. All costs associated with video-taping services.
8. All field testing (anchor bolt strength testing, leakage, level, uniformity, mixing and pressure testing, oxygen transfer)
9. Any and all items and services not specifically included

C. OXYGEN TRANSFER EFFICIENCY SHOP TEST

Sanitaire will perform an oxygen transfer shop test in complete accordance with the ASCE Standard for the Measurement of Oxygen Transfer in Clean Water at its Milwaukee, Wisconsin Performance Test Center. Sanitaire will run two (2) tests (2 grid types, 1 aeration condition) of the owner/engineer's choosing (from the proposed grid type and associated aeration conditions). Each Test includes:

- Use of Aeration Test Tank and Blowers.
- All water and chemicals
- Test probes, pressure and air gauges.
- Oxygen transfer testing
- Written test report

NOTE: Owner/Engineer and other witnesses' expenses (i.e. plane fare to Milwaukee, etc.) are **NOT** included.

D. ESTIMATED SUBMITTALS AND DELIVERIES

The submittal schedule begins after acceptance of purchase order by Sanitaire. Delivery schedule begins after receipt of approved drawings; Assume two week turnaround of submittals by the review engineer.

Certified engineered equipment drawings:	6 – 8 weeks
Equipment Shipment (after release for fabrication):	10 – 12 weeks

E. PRICING

Pricing for the equipment and field services outlined in this proposal, DAP Jobsite per Incoterms 2010, Full freight allowed to destination (Turlock, CA):

$ 594,900

F. PRICE NOTES

1. Taxes are not included. Purchaser to pay directly all applicable taxes separate from purchase order to Xylem Water Solutions USA.

2. All prices quoted shall be valid for 90 days from the date of bidding.

3. The prices are based on the equipment being released for shipment by the 4th Quarter, 2017.

4. Prices on orders received after the above deadline or specifying later shipping dates shall be subject to review and possible adjustment in line with the then existing economic conditions.

5. Terms of Payment: 10% Net 30 days due upon submission of shop drawings to Purchaser.
   85% Net 30 days after shipment
   5% After Start Up and Substantial use or final acceptance, Not To Exceed 120 days after shipment.

6. An interest charge of 1 1/2% per month will be added to past due accounts.

7. Other conditions of sale shall apply as noted in the attached Terms & Conditions.

G. WARRANTY

Xylem Water Solutions USA warrants all parts to be free from defective material and workmanship for a period of three (3) years after startup or forty-two (42) months after shipment – whichever occurs first - and to furnish to the Owner replacements for any such items found to be defective within that period.

H. PATENTS

Equipment offered in this proposal is covered by the following U.S. Patent owned by Xylem: 5,714,062. No person or firm other than Xylem is licensed to sell or install equipment under this patent. Xylem hereby agrees that any purchaser who purchases listed equipment from Xylem shall, in consideration of such purchase and without payment other than the agreed upon purchase price for the equipment, be licensed to install such equipment, and such equipment may be used by the installer or any subsequent owner of the equipment throughout its useful life free of any claim of patent infringement by Xylem, its successors and assigns.

Thank you for considering our proposal for this equipment.

Sincerely,

Bijan Baghernejad
Senior Sales Engineer - Sanitaire

cc: **Sanitaire Representative:** **David C. Frost**
Coombs-Hopkins Company
dcf@chcwater.com

TERMS AND CONDITIONS OF SALE – NORTH AMERICA

1. Agreement, Integration and Conflict of Terms. These terms and conditions, together with any special conditions expressly incorporated thereto in the quotation or sales form, are to govern any sale between the Seller and Buyer. The Seller shall mean the applicable affiliate of Xylem Inc. that is party to the Agreement ("Seller"). The Buyer shall mean the entity that is party to the Agreement with Seller. This writing is an offer or counteroffer by Seller to sell the goods and/or services set forth on the quotation or sales form subject to these terms and conditions and is expressly made conditional on Buyer's assent to these terms and conditions. Acceptance by Buyer is expressly limited to these terms and conditions. Any additional or different terms and conditions contained in Buyer's purchase order or other communication shall not be effective or binding upon Seller unless specifically agreed to in writing by Seller; Seller hereby objects to any such conditions, and the failure of Seller to object to specific provisions contained in any purchase order or other communication from Buyer shall not be construed as a waiver of these terms and conditions nor an acceptance of any such provisions. Neither Seller's commencement of performance nor delivery shall be deemed or construed as acceptance of Buyer's additional or different terms and conditions. Buyer agrees that these terms and conditions, together with any accompanying quotation and any special conditions or limited process guarantees or documents referred to or included within the quotation and expressly made a part of this agreement, (e.g., drawings, illustrations, specifications, or diagrams), is the complete and final agreement between Buyer and the Seller ("Agreement"). This Agreement supersedes all prior negotiations, representations, or agreements, either written or oral, between the parties and, further, can only be altered, modified or amended with the express written consent of Seller.

2. Quotation, Withdrawal, Expiration. Quotes are valid for thirty (30) calendar days from the date of issuance unless otherwise provided therein. Seller reserves the right to cancel or withdraw the quotation at any time with or without notice or cause prior to acceptance by Buyer. There is no Agreement if any conditions specified within the quotation ***or*** sales form are not completed by Buyer to Seller's satisfaction within thirty (30) calendar days of Seller's acknowledgement in writing of an order. Seller nevertheless reserves its right to accept any contractual documents received from Buyer after this 30-day period.

3. Prices. Prices apply to the specific quantities stated on the quotation or sales form. Unless otherwise agreed to in writing by Seller, all prices are DAP; Jobsite (as defined in accordance with the latest version of Incoterms), and do not include transportation costs or charges relating to transportation unless otherwise specified. Prices include standard packing according to Seller's specifications for delivery. All costs and taxes for special packing requested by Buyer, including packing for exports, shall be paid by Buyer as an additional charge. Prices are subject to change without notice.

4. Taxes. The price for the goods does not include any applicable sales, use, excise, GST, VAT, or similar tax, duties or levies. Buyer shall have the responsibility for the payment of such taxes if applicable.

5. Payment Terms. Seller reserves the right to require payment in advance or C.O.D. and otherwise modify credit terms should Buyer's credit standing not meet Seller's acceptance. Unless different payment terms are expressly set forth in the quotation or sales form or order acknowledgment or Sales Policy Manual, goods will be invoiced upon shipment. Payment shall be made in U.S. Dollars. Payment in full is due within thirty (30) days from the invoice date. In the event payment is not made when due, Buyer agrees to pay Seller a service or finance charge of the lesser of (i) one and one-half percent (1.5%) per month (18% per annum), or (ii) the highest rate permitted by applicable law, on the unpaid balance of the invoice from and after the invoice due date. Buyer is responsible for all costs and expenses associated with any checks returned due to insufficient funds. All credit sales are subject to prior approval of Seller's credit department. Export shipments will require payment prior to shipment or an appropriate Letter of Credit. If, during the performance of the contract with Buyer, the financial responsibility or condition of Buyer is such that Seller in good faith deems itself insecure, or if Buyer becomes insolvent, or if a material change in the ownership of Buyer occurs, or if Buyer fails to make any payments in accordance with the terms of its contract with Seller, then, in any such event, Seller is not obligated to continue performance under the contract and may stop goods in transit and defer or decline to make delivery of goods, except upon receipt of satisfactory security or cash payments in advance, or Seller may terminate the order upon written notice to Buyer without further obligation to Buyer whatsoever. If Buyer fails to make payments or fails to furnish security satisfactory to Seller, then Seller shall also have the right to enforce payment to the full contract price of the work completed and in process. Upon default by Buyer in payment when due, Buyer shall immediately pay to Seller the entire unpaid amounts for any and all shipments made to Buyer irrespective of the terms of said shipment and whether said shipments are made pursuant to this Agreement or any other contract of sale between Seller and Buyer, and Seller may withhold all subsequent shipments until the full amount is settled. Acceptance by Seller of less than full payment shall not be a waiver of any of its rights hereunder. Buyer shall not assign or transfer this Agreement or any interest in it, or monies payable under it, without the written consent of Seller and any assignment made without such consent shall be null and void.

6. Delivery, Risk of Loss. Delivery dates are estimates, and time is not of the essence. All shipments will be made DAP; Jobsite, unless otherwise specified. Seller shall not be responsible to Buyer for any loss, whether direct, indirect, incidental or consequential in nature, including without limitation loss of profits, arising out of or relating to any failure of the goods to be delivered by the specified delivery date. In the absence of specific instructions, Seller will select the carrier. Upon delivery to the common carrier, title and the risk of loss for the material shall pass to Buyer. Buyer shall reimburse Seller for the additional cost of its performance resulting from inaccurate or lack of delivery instructions, or by any act or omission on Buyer's part. Any such additional cost may include, but is not limited to, storage, insurance, protection, re-inspection and delivery expenses. Buyer further agrees that any payment due on delivery shall be made on delivery into storage as though goods had been delivered in accordance with the order.

Buyer grants to Seller a continuing security interest in and a lien upon the products and the proceeds thereof (including insurance proceeds), as security for the payment of all such amounts and the performance by Buyer of all of its obligations to Seller pursuant to the order and all such other sales, and Buyer shall have no right to sell, encumber or dispose of the products. Buyer shall execute any and all financing statements and other documents and instruments and do and perform any and all other acts and things which Seller may consider necessary, desirable or appropriate to establish, perfect or protect Seller's title, security interest and lien. In addition, Buyer authorizes Seller and its agents and employees to execute any and all such documents and instruments and do and perform any and all such acts and things, at Buyer's expense, in Buyer's name and on its behalf. Such documents and instruments may also be filed without the signature of Buyer to the extent permitted by law.

7. Warranty. For goods sold by Seller to Buyer that are used by Buyer for personal, family or household purposes, Seller warrants the goods to Buyer on

the terms of Seller's limited warranty available on Seller's website. For goods sold by Seller to Buyer for any other purpose, Seller warrants that the goods sold to Buyer hereunder (with the exception of membranes, seals, gaskets, elastomer materials, coatings and other "wear parts" or consumables all of which are not warranted except as otherwise provided in the quotation or sales form) will be (i) be built in accordance with the specifications referred to in the quotation or sales form, if such specifications are expressly made a part of this Agreement, and (ii) free from defects in material and workmanship for a period of one (1) year from the date of installation or eighteen (18) months from the date of shipment (which date of shipment shall not be greater than thirty (30) days after receipt of notice that the goods are ready to ship), whichever shall occur first, unless an alternate period of time is provided by law or is specified in the product documentation from Xylem (the "Warranty").

Except as otherwise provided by law, Seller shall, at its option and at no cost to Buyer, either repair or replace any product which fails to conform with the Warranty; provided, however, that under either option, Seller shall not be obligated to remove the defective product or install the replaced or repaired product and Buyer shall be responsible for all other costs, including, but not limited to, service costs, shipping fees and expenses. Seller shall have complete discretion as to the method or means of repair or replacement. Buyer's failure to comply with Seller's repair or replacement directions shall constitute a waiver of its rights and render all warranties void. Any parts repaired or replaced under the Warranty are warranted only for the balance of the warranty period on the parts that were repaired or replaced. The Warranty is conditioned on Buyer giving written notice to Seller of any defects in material or workmanship of warranted goods within ten (10) days of the date when any defects are first manifest. Seller shall have no warranty obligations to Buyer with respect to any product or parts of a product that: (a) have been repaired by third parties other than Seller or without Seller's written approval; (b) have been subject to misuse, misapplication, neglect, alteration, accident, or physical damage; (c) have been used in a manner contrary to Seller's instructions for installation, operation and maintenance; (d) have been damaged from ordinary wear and tear, corrosion, or chemical attack; (e) have been damaged due to abnormal conditions, vibration, failure to properly prime, or operation without flow; (f) have been damaged due to a defective power supply or improper electrical protection; or (g) have been damaged resulting from the use of accessory equipment not sold by Seller or not approved by Seller in connection with products supplied by Seller hereunder. In any case of products not manufactured by Seller, there is no warranty from Seller; however, Seller will extend to Buyer any warranty received from Seller's supplier of such products.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ANY AND ALL OTHER EXPRESS OR IMPLIED WARRANTIES, GUARANTEES, CONDITIONS OR TERMS OF WHATEVER NATURE RELATING TO THE GOODS PROVIDED HEREUNDER, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY EXPRESSLY DISCLAIMED AND EXCLUDED. EXCEPT AS OTHERWISE PROVIDED BY LAW, BUYER'S EXCLUSIVE REMEDY AND SELLER'S AGGREGATE LIABILITY FOR BREACH OF ANY OF THE FOREGOING WARRANTIES ARE LIMITED TO REPAIRING OR REPLACING THE PRODUCT AND SHALL IN ALL CASES BE LIMITED TO THE AMOUNT PAID BY THE BUYER HEREUNDER. IN NO EVENT IS SELLER LIABLE FOR ANY OTHER FORM OF DAMAGES, WHETHER DIRECT, INDIRECT, LIQUIDATED, INCIDENTAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY OR SPECIAL DAMAGES, INCLUDING BUT NOT LIMITED TO LOSS OF PROFIT, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY OR LOSS OF REPUTATION.

8. Inspection. Buyer shall have the right to inspect the goods upon their receipt. When delivery is to Buyer's site or to a project site ("Site"), Buyer shall notify Seller in writing of any nonconformity of the goods with this Agreement within three (3) days from receipt by Buyer. For all other deliveries, Buyer shall notify Seller in writing of any nonconformity with this Agreement within fourteen (14) days from receipt by Buyer. Failure to give such applicable notice shall constitute a waiver of Buyer's right to inspect and/or reject the goods for nonconformity and shall be equivalent to an irrevocable acceptance of the goods by Buyer. Claims for loss of or damage to goods in transit must be made to the carrier, and not to Seller.

9. Seller's Limitation of Liability. EXCEPT AS OTHERWISE PROVIDED BY LAW, IN NO EVENT SHALL SELLER'S LIABILITY UNDER THIS AGREEMENT EXCEED THE AMOUNT PAID BY BUYER UNDER THIS AGREEMENT. SELLER SHALL HAVE NO LIABILITY FOR LOSS OF PROFIT, LOSS OF ANTICIPATED SAVINGS OR REVENUE, LOSS OF INCOME, LOSS OF BUSINESS, LOSS OF PRODUCTION, LOSS OF OPPORTUNITY, LOSS OF REPUTATION, INDIRECT, CONSEQUENTIAL, INCIDENTAL, PUNITIVE OR EXEMPLARY DAMAGES.

10. Force Majeure. Seller may cancel or suspend this Agreement and Seller shall have no liability for any failure to deliver or perform, or for any delay in delivering or performing any obligations, due to acts or omissions of Buyer and/or its contractors, or due to circumstances beyond Seller's reasonable control, including but not limited to acts of God, fire, flood or other natural disasters, war and civil disturbance, riot, acts of governments, terrorism, disease, currency restrictions, labor shortages or disputes, unavailability of materials, fuel, power, energy or transportation facilities, failures of suppliers or subcontractors to effect deliveries, in which case the time for performance shall be extended in an amount equal to the excused period, provided that Seller shall have, as soon as reasonably practicable after it has actual knowledge of the beginning of any excusable delay, notified Buyer of such delay, of the reason therefor and of the probable duration and consequence thereof. Seller shall use its best efforts to eliminate the cause of the delay, interruption or cessation and to resume performance of its obligations hereunder with the least possible delay.

11. Cancellation. Except as otherwise provided in this Agreement, no order may be cancelled on special or made-to-order goods or unless otherwise requested in writing by either party and accepted in writing by the other. In the event of a cancellation by Buyer, Buyer shall, within thirty (30) days of such cancellation, pay Seller a cancellation fee, which shall include all costs and expenses incurred by Seller prior to the receipt of the request for cancellation including, but not limited to, all commitments to its suppliers, subcontractors and others, all fully burdened labor and overhead expended by Seller, plus a reasonable profit charge." Return of goods shall be in accordance with Seller's most current Return Materials Authorization and subject to a minimum fifteen percent (15%) restocking fee.

Notwithstanding anything to the contrary herein, in the event of the commencement by or against Buyer of any voluntary or involuntary proceedings in bankruptcy or insolvency, or in the event Buyer shall be adjusted bankrupt, make a general assignment for the benefit of its creditors, or if a receiver shall be appointed on account of Buyer's insolvency, or if Buyer fails to make payment when due under this Agreement, or in the event Buyer does not correct or, if immediate correction is not possible, commence and diligently continue action to correct any default of Buyer to comply with any of the provisions or requirements of this Agreement within ten (10) calendar days after being notified in writing of such default by Seller, Seller may, by written notice to Buyer, without prejudice to

any other rights or remedies which Seller may have, terminate its further performance of this Agreement. In the event of such termination, Seller shall be entitled to receive payment as if Buyer has cancelled the Agreement as per the preceding paragraph. Seller may nevertheless elect to complete its performance of this Agreement by any means it chooses. Buyer agrees to be responsible for any additional costs incurred by Seller in so doing. Upon termination of this Agreement, the rights, obligations and liabilities of the parties which shall have arisen or been incurred under this Agreement prior to its termination shall survive such termination.

12. Drawings. All drawings are the property of Seller. Seller does not supply detailed or shop working drawings of the goods; however, Seller will supply necessary installation drawings. The drawings and bulletin illustrations submitted with Seller's quotation show general type, arrangement and approximate dimensions of the goods to be furnished for Buyer's information only and Seller makes no representation or warranty regarding their accuracy. Unless expressly stated to the contrary within the quotation or sales form, all drawings, illustrations, specifications or diagrams form no part of this Agreement. Seller reserves the right to alter such details in design or arrangement of its goods which, in its judgment, constitute an improvement in construction, application or operation. All engineering information necessary for installation of the goods shall be forwarded by Seller to Buyer to upon Buyer's acceptance of this Agreement. After Buyer's acceptance of this Agreement, any changes in the type of goods, the arrangement of the goods, or application of the goods requested by Buyer will be made at Buyer's expense. Instructions necessary for installation, operating and maintenance will be supplied when the goods are shipped.

13. Proprietary Information, Injunction. Seller's designs, illustrations, drawings, specifications, technical data, catalogues, "know-how", economic or other business or manufacturing information (collectively "Proprietary Information") disclosed to Buyer shall be deemed proprietary and confidential to Seller. Buyer agrees not to disclose, use, or reproduce any Proprietary Information without first having obtained Seller's express written consent. Buyer's agreement to refrain from disclosing, using or reproducing Proprietary Information shall survive completion of the work under this Agreement. Buyer acknowledges that its improper disclosure of Proprietary Information to any third party will result in Seller's suffering irreparable harm. Seller may seek injunctive or equitable relief to prevent Buyer's unauthorized disclosure.

14. Installation and Start-up. Unless otherwise agreed to in writing by Seller, installation shall be the sole responsibility of Buyer. Where start-up service is required with respect to the goods purchased hereunder, it must be performed by Seller's authorized personnel or agents; otherwise, the Warranty is void. In the event Buyer has engaged Seller to provide an engineer for start-up supervision, such engineer will function in a supervisory capacity only and Seller shall have no responsibility for the quality of workmanship of the installation. In any event, Buyer understands and agrees that it shall furnish, at Buyer's expense, all necessary foundations, supplies, labor and facilities that might be required to install and operate the goods.

15. Specifications. Changes in specifications requested by Buyer are subject to approval in writing by Seller. In the event such changes are approved, the price for the goods and the delivery schedule shall be changed to reflect such changes.

16. Buyer Warranty. Buyer warrants the accuracy of any and all information relating to the details of its operating conditions, including temperatures, pressures, and where applicable, the nature of all hazardous materials. Seller can justifiably rely upon the accuracy of Buyer's information in its performance. Should Buyer's information prove inaccurate, Buyer agrees to reimburse Seller for any losses, liabilities, damages and expenses that Seller may have incurred as a result of any inaccurate information provided by Buyer to Seller.

17. Minimum Order. Seller reserves the right to refuse to process any order that does not meet quantity requirements that Seller may establish for any given product or group of products.

18. Quality Levels. Prices are based on quality levels commensurate with normal processing. If a different quality level is required, Buyer must specify its requirements, as approved in writing by Seller, and pay any additional costs that may be applicable.

19. Product Recalls. In cases where Buyer purchases for resale, Buyer shall take all reasonable steps (including, without limitation, those measures prescribed by the seller): (a) to ensure that all customers of the Buyer and authorised repairers who own or use affected products are advised of every applicable recall campaign of which the Buyer is notified by the Seller; (b) to ensure that modifications notified to Buyer by Seller by means of service campaigns, recall campaigns, service programmes or otherwise are made with respect to any products sold or serviced by Buyer to its customers or authorized repairers. The reimbursement of Buyer for parts and labor used in making those modifications shall be as set forth in the campaign or program instructions. Without the prior consent of the Seller, the Buyer shall not disclose to any third party the information contained in service campaign, recall campaign or service programme literature. Should Buyer fail to perform any of the actions required under this section, Seller shall have the right to obtain names and address of the Buyer's customers and shall be entitled to get into direct contact which such customers.

19. GOVERNING LAW. THE TERMS OF THIS AGREEMENT AND ALL RIGHTS AND OBLIGATIONS HEREUNDER SHALL BE GOVERNED BY THE LAWS OF THE STATE OF SELLER'S OFFICE TO WHICH THIS ORDER HAS BEEN SUBMITTED (WITHOUT REFERENCE TO PRINCIPLES OF CONFLICTS OF LAWS). THE RIGHTS AND OBLIGATIONS OF THE PARTIES HEREUNDER SHALL NOT BE GOVERNED BY THE 1980 U.N. CONVENTION ON CONTRACTS FOR THE INTERNATIONAL SALE OF GOODS.

20. Titles. The section titles are for reference only, and shall not limit or restrict the interpretation or construction of this Agreement.

21. Waiver. Seller's failure to insist, in any one or more instances, upon Buyer's performance of this Agreement, or to exercise any rights conferred, shall not constitute a waiver or relinquishment of any such right or right to insist upon Buyer's performance in any other regard.

22. Severability. The partial or complete invalidity of any one or more provisions of this Agreement shall not affect the validity or continuing force and effect of any other provision.

SECTION 11510

SAFETY EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: The following safety equipment:
   1. Safety rope.
   2. Life preserver.

1.02 REFERENCES

A. California Occupational Safety and Health Administration (Cal-OSHA).

B. National Institute for Occupational Safety and Health (NIOSH):
   1. Schedule 13F - Self-Contained Breathing Apparatus (SCBA).

C. Occupational Safety and Health Administration (OSHA).

D. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Shop drawings.

B. Product data:
   1. Submit manufacturer's product literature information for products specified.
   2. Manufacturer's installation instructions.

C. Operation and maintenance data.

D. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Show evidence that the firm has been engaged in producing such materials and products for at least 5 years and that the product submitted has a satisfactory performance record of at least 5 years.

B. Installer qualifications: Installer shall have 3 years experience in installing these materials for similar projects and shall be approved by the manufacturer prior to bidding of the project.

C. Regulatory requirements: As applicable, equipment of this Section shall comply with requirements of public agencies of the state where the project is located including Cal-OSHA and U.S. Coast Guard.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver to the job site in manufacturer's original containers.

B. Delivery: After wet operations in building are completed.

C. Storage and protection: Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

D. Keep materials dry until ready for use.

E. Keep packages of material off the ground, under cover, and away from sweating walls and other damp surfaces.

F. Protect finished surfaces from soiling and damage during handling and installation. Keep covered with a protective covering.

PART 2 PRODUCTS

2.01 SAFETY ROPE

A. Manufacturers: One of the following or equal:
   1. Mine Safety Appliances Company.
   2. California Safety.

B. Characteristics:
   1. Diameter: 9/16 inch.
   2. Length: 50 feet.
   3. Accessories: Snap hook on one end.

2.02 LIFE PRESERVER

A. Type: Doughnut-shaped, 30 inches diameter, with mounting brackets; U.S. Coast Guard approved.

B. Provide life preserver cabinet for 30 inch diameter buoy with mounting accessories necessary to hung and mount the equipment on the wall. The cabinet shall be removable from the pre-installed hook. Furnish the cabinet with clear polycarbonate door.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturers' recommendations.

B. Install fixed equipment in accordance with manufacturer's instructions.

C. Replace any equipment found defective with new.

END OF SECTION

SECTION 13443

ELECTRO-HYDRAULIC ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Electro-hydraulic actuators for modulating control valves.

B. Related sections:
   1. Section 01756 - Commissioning and Process Start-Up.
   2. Section 05190 - Mechanical Anchoring And Fastening To Concrete And Masonry.
   3. Section 15050 - Common Work Results for Mechanical Equipment.
   4. Section 15116 - Plug Valves.
   5. Section 15958 - Mechanical Equipment Testing.

1.02 REFERENCE

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA Type 4X enclosure in accordance with NEMA 250.

1.04 SUPPLIER'S SCOPE OF SUPPLY AND PRICE (NOT USED)

1.05 SUBMITTALS

A. Provide the following information, and technical data for all equipment specified in this Section:
   1. Manufacturer's certifications and other data confirming conformance to design and material requirements.
   2. Testing procedures and forms.
   3. Shipping, storage, and handling instructions.
   4. Operations and maintenance manual.
   5. Actuator sizing calculations based on corresponding valve torque requirements.

1.06 WARRANTY

A. The warranty shall be 5 years from the date of install, provided installation within 6 months of shipment from actuator OEM. Warranty shall cover any product related defects. The warranty does not cover non-product related failure, such as misuse of equipment, damage to the actuator by factors not related to operational use or mishandling by third parties. Warranty will be in place directly between the actuator OEM and the end-user, without a third party involved in between each entity.

B. As specified in Section 15050.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Rexa Inc., West Bridgewater, Massachusetts.

B. No other manufacturer accepted.

2.02 ELECTRO-HYDRAULIC ACTUATORS

A. General:
   1. Furnish an electro-hydraulic actuators for modulating control plug valves as indicated in the schedule:
      a. Coordinate actuators with plug valve manufacturer's requirements. See section 15116 for valve specification.
   2. Design the actuators to include a programmable actuator specifically sized for 100 percent continuous duty modulating control.
   3. Include the hydraulic actuator, hydraulic power module, motor power cable, feedback cable and a dedicated microprocess controller.
   4. Operate valve actuators at variable speed in response to a 4-20-milliampere signal:
      a. Provide with speed adjustable from the microprocess controller.
   5. Provide actuator that will fail in the last position if the control signal alone is lost.
   6. Provide operators with handwheel type manual overrides.
   7. Provide electrical surge protection for the actuator.
   8. Provide a 4-20-milliampere output signal for position indication.

B. Hydraulic actuator:
   1. Design the actuator as quarter turn rack and pinion cylinder rated for 3,000-pounds per square inch hydraulic pressure.
   2. Construct actuator by combining the quarter turn rack and pinion cylinder and the required power modules.
   3. Hydraulically seal actuator and purge of all air.

C. Hydraulic power module:
   1. Provide hydraulic power unit with hydraulic pump, drive motor, and flow match valves, mounted in a hydraulic manifold.
   2. Furnish a positive displacement gear pump to pump hydraulic fluid.
   3. The motor is to lose synchronization when the required load exceeds the output capacity of the actuator causing the pump to fail. The actuator controller will attempt to correct the over-torque condition, but failure to correct the condition shall stop the actuator and initiate an alarm.
   4. Provide drive motor with a stepping motor with double-ended shaft.
   5. Provide flow match valves that are modified pilot operated check valves designed to dissipate accumulated energy in the hydraulic oil from 2,000 pounds per square inch to atmospheric in a stable and controlled manner through an internal port:
      a. Each module will have 2 valves acting as a check valve in 1 direction and a throttling valve for the hydraulic pump in the opposite direction. The valve acts to direct hydraulic flow from the pump causing the actuator to move in the direction indicated by the controller.

6. Provide expansion chamber integral to the hydraulic manifold with an indicator button to show oil:
    a. Provide expansion chamber with a heater and thermostat to maintain oil temperature during cold weather.

D. Controller:
1. Provide position control processor, motor drive, internal power supply, and termination with controller mounted in a NEMA Type 4X stainless steel enclosure.
2. Include a 3-button keypad and 5-character LED display in the position control processor:
    a. Store the program in a socketed EPROM with the setup parameters stored in a non-volatile memory.
3. Provide controller with a dedicated microprocessor with 3 modes of operation: Automatic, Local and Setup:
    a. Provide with external control option with external pushbuttons with viewing window on enclosure with the following devices.
    b. Lockout ability with local-off-remote hand switch.
    c. Open and close pilot devices.
    d. Position indicator.
4. Automatic mode: To be used for modulating operation:
    a. Provide controller that will accept an external 4-20-milliampere input control signal for open/close and modulating control. Actual position is an available output through the position transmitter.
    b. Input signal with feedback signal for positioning is to be from a PLC external to the controller and not a part of the actuator package.
5. Local mode: Provide ability to stroke from the position control processor keypad pushbutton switches, while displaying the current control signal and the last encountered error:
    a. The 2 pushbuttons are normally open, push to operate switches. One will rotate the valve clockwise and the other will rotate it counter-clockwise. Motion will only continue as long as either button is depressed.
    b. When in local mode, the alarm relay will change state to indicate that the actuator is no longer following remote control signals.
6. Setup mode: Calibrate the controller in the setup mode:
    a. Use the 3-button keypad to provide user control over actuator operating parameters.
    b. Adjust speed of operation, stroke, deadband, and control signal and program into the position control processor memory.
7. Position transmitter:
    a. Loop powered 2-wire 4-20 milliampere signal that is proportional to actuator position.
    b. Output signal optically isolated from the electronics.
    c. Accuracy:
        1) Linear: Less than 0.25 percent of full stroke.
    d. Resolution: Less than 0.1 percent of full stroke.
    e. Maximum external load: 1,000 ohms.
    f. Provide position transmitter auxiliary boards containing an alarm relay. If the actuator is unable to follow the applied control signal, this will change the state (de-energize). This includes error codes, placing the actuator in LOCAL or SETUP and loss of power:
        1) Response: 1/2 second of any “fail to operate” condition.

2) Type: Single pole, double throw (SPDT).
3) Rating: 1 amp at 30 volts direct current.

8. See drawings for required I/O signals.

E. Power requirements:
1. Provide alternating current power supply to the controller box indicated in the schedule.

F. Identification tagging requirements:
1. Provide a 1-1/2 inch minimum diameter heavy brass tag bearing valve tag number indicated on electro-hydraulic actuators schedule in this Section.
2. Attach tags to actuators by soldering split key rings so that the ring and tag cannot be removed:
a. Use block type numbers and letters with 1/4 inch minimum high characters stamped on the tag and filled with black enamel.

G. Appurtenances:
1. Provide lifting lugs for each actuators over 100 pounds in total weight.
2. Provide mounting supports and anchor bolts if needed for each actuator so that the actuator is fully self-supporting without bearing on the valve shaft and valve supports:
a. Mounting supports: Type 316 stainless steel.
b. Anchor bolts: As specified in Section 05190 except that the material shall be Type 316 stainless steel.

PART 3 EXECUTION

3.01 SOURCE QUALITY CONTROL

A. Check out as specified in Section 15958.

B. Perform factory standard test for the electro-hydraulic actuator.

C. Verify functionality of all alarms, monitoring, and control signals.

D. Provide a test certificate for each electro-hydraulic actuator.

E. The valves and actuators shall be purchased separate from each other by the contractor. The chosen valve & actuator OEMs shall coordinate the following requirements in conjunction with the contractor and engineer:
1. Upon orders being placed by the contractor, the chosen valve OEM shall disclose all torque requirements to the actuator manufacturer for proper design and sizing of the actuator. Required is a raw value for the maximum operating torques, without a safety factor included. Also required is the raw value for the maximum allowable stem/seating torques, also without a safety factor included. The actuator OEM shall design according to these given values, applying the 1.5x safety values, where applicable.
2. Mounting hardware for attaching the actuator to the valve shall be designed and fabricated by the actuator manufacturer. Chosen valve OEM shall disclose valve top-works to the actuator OEM for design of said mounting hardware.

3. The actuator shall be connected to the valve at the valve OEM.
4. The actuator OEM shall also send a technician to the installation site to oversee and commission the installation of the actuators. Start-up of these actuators shall not commence until the technician is on-site. Pricing for this actuator technician to be on-site for one full day max for each valve on this project shall be included in the proposal

3.02 INSTALLATION

A. Install operators in accordance with manufacturer's instructions.

3.03 MANUFACTURER'S FIELD SERVICES

A. Coordinate field service work with the manufacturer's representative, Owner, and Engineer prior to initiating such work.

B. Manufacturer's representative: Furnish services of a representative experienced in erection and operation of the furnished electro-hydraulic valve operators.

C. Actuator OEM shall arrange to send a technician to job-site for assisting with the installation of the actuator, as well as starting up and calibrating the equipment, as follows:
   1. Contractor shall be notified of ship date of actuator from actuator OEM.
   2. Actuator OEM shall provide contractor step-by-step site prep procedure for initial install of actuator.
   3. Contractor shall give actuator OEM 2 week notice of when the technician is needed to start up the actuator.
   4. Actuator OEM shall send a technician to job-site for one full day to inspect and start-up the actuator in coordination with the contractor.
   5. Actuator OEM shall also include a second full day to train the end-user on proper operation of the equipment, which may be conducted at a later date with the plant personnel.
   6. All expenses for these trips will be covered in the actuator scope of supply.

D. Require manufacturer's representative to complete all certificates, reports, and forms in Section 01756.

3.04 SCHEDULE

A. Abbreviations relating to actuators function:
   1. O/C = Open Close Service.
   2. MOD = Modulating Service.

Tag No.	Service	Valve Size, Inches	Valve Type	Actuators Function	Rexa Model No.	Power Supply	Seconds per 90º Rotation
HAM-2651	Secondary Clarifier No. 5 RAS Plug Valve	16	Plug	MOD	R-20 Series	120	30

END OF SECTION

SECTION 13446

MANUAL ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Valve and gate actuators.
   2. Handwheel actuators.
   3. Hand-cranked geared actuators.
   4. Floor Boxes.
   5. Floor stands.
   6. Key operated valves.
   7. Bench stands.
   8. Accessory equipment and floor boxes.

B. Related sections:
   1. Section 05190 - Mechanical Anchoring And Fastening To Concrete And Masonry.
   2. Section 09960 - High-Performance Coatings.
   3. Section 13447 - Electric Motorized Actuators.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45 - Designation System for Aluminum Finishes.

B. American Water Works Association (AWWA).

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

D. National Electrical Code (NEC).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.
   2. Type 7 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Shop drawings: Include shop drawings and product data with associated gate or valve as an integrated unit.

1.05 QUALITY ASSURANCE

A. Provide valve actuators integral with valve or gate, except for valve actuators utilizing T-wrenches or keys, and portable actuators intended to operate more than 1 valve.

B. Provide similar actuators by 1 manufacturer.

C. Provide gates and hand operating lifts by 1 manufacturer.

D. Provide hydraulic gate lifts by 1 manufacturer.

E. Provide hydraulic valve actuators and motorized actuators by 1 manufacturer.

1.06 MAINTENANCE

A. Extra materials:
   1. Key operated valve keys or wrenches: Furnish a minimum 4 keys with 4-foot shafts and 3-foot pipe handles or wrenches with 4-foot shafts and 3-foot handles for operating key operated valves.

PART 2 PRODUCTS

2.01 VALVE AND GATE ACTUATORS

A. Valve actuators:
   1. Motorized actuators are specified in Section 13447.
   2. Manual actuators:
      a. Material: Type 316 stainless steel.
      b. Design: Hand lever.
      c. Spring release handle: 12-inch.
      d. Notch plate: 10 position.
      e. Secure with mounting bolts.
      f. Locking device so that valve can be locked in any position with a wing nut.
   3. Stem and cover:
      a. For submerged valves, provide extension stem as indicated on the Drawings.
   4. Limit switches: Provide limit switches on manually actuated valves where indicated on the Drawings:
      a. Limit switches: Heavy-duty, industrial grade, oiltight, with not less than 2 auxiliary contacts.
      b. Rating: Rated for 10 amps, 120 volts alternating current.
      c. Enclosure: NEMA Type 4X enclosure and with stainless steel levers and arms. Provide switch with NEMA Type 7 enclosure when switch is located within areas with NEC Class 1, Division 1 or Class 1, Division 2 designations as indicated on the Drawings.

B. Stem covers:
   1. Aluminum pipe.
   2. Threaded cap on top.
   3. Bolted aluminum flange on bottom.

4. Slots cut 1- by 12-inch at 18 inches on center in front and back of pipe.
5. Capable of covering threaded portion of greased stems that project above actuators when gates or valves are opened or closed.
6. Ultraviolet light resistant, clear butyrate plastic or polycarbonate pipe:
    a. Capped on the upper end.
    b. Either threaded into the top of the gate operators or held in place by bolt-down aluminum brackets.
    c. Capable of covering threaded portion of greased stems that project above actuators when gates or valves are opened or closed.
7. Staff gauges:
    a. Adhesive-backed mylar, suitable for outdoor service.
    b. Calibrated in hundredths of feet.
    c. Read the weir crest elevations directly.
    d. Gauge range: 1.5 feet minimum.
    e. Indicate the following elevations on each staff gauge:
        1) -0.75, -0.50, -0.25, 0.0, 0.25, 0.50, 0.75.
    f. Supplement with a stem-mounted pointer or indicator that permits direct observation of the weir gate crest elevation.
    g. Apply staff gauges to each stem cover after installation of the cover and after calibration and testing of the weir gates.
    h. Set gauges precisely by a survey crew using instruments acceptable to the Engineer.

C. Stem cover flanges, pipes and caps:
1. After fabrication, etch and anodize to produce the following chemical finishes in accordance with AA publication DAF-45:
    a. A 41 - Clear Anodic Coating.
    b. C 22 - Medium Matte Finish.

D. Gate stem covers: Concentric with stem.

E. Position indicators:
1. For all aboveground worm gear or traveling nut manual actuators, provide position indication on the actuator enclosure.
2. Tail rods on hydraulic cylinders, or dial indicators with clear full-open and closed position indicators, calibrated in number of turns or percentage of opening.

F. Manual or power actuator size:
1. Sized to deliver maximum force required under most severe specified operating condition, including static and dynamic forces, seat and wedge friction, and seating and unseating forces with safety factor of 5, unless otherwise specified.

G. Actuator size: Capable of supporting weight of suspended shafting unless carried by bottom thrust bearings; shaft guides with wall mounting brackets.

H. Provisions for alternate operation: Where specified or indicated on the Drawings, position and equip crank or handwheel operated geared valve actuators or lifts for alternate operation with tripod mounted portable gate actuators.

I. Operation: Counterclockwise to open with suitable and adequate stops, capable of resisting at least twice normal operating force to prevent overrun of valve or gate in open or closed position.

J. Open direction indicator: Cast arrow and legend indicating direction to rotate actuator on handwheel, chain wheel rim, crank, or other prominent place.

K. Buried actuator housing: Oil and watertight, specifically designed for buried service, factory packed with suitable grease, completely enclosed space between actuator housing and valve body so that no moving parts are exposed to soil; provide actuators with 2-inch square AWWA operating nut.

L. Worm gear actuators: Provide gearing on worm gear actuators that is self-locking with gear ratio such that torque in excess of 160 foot-pounds will not need to be applied to operate valve at most adverse conditions for which valve is designed.

M. Traveling nut actuators: Capable of requiring maximum 100 foot-pounds of torque when operating valve under most adverse condition; limit stops on input shaft of manual actuators for fully open and closed positions; non-moving vertical axis of operating nut when opening or closing valve.

2.02 HANDWHEEL ACTUATORS

A. Manufacturers: One of the following or equal:
   1. Rodney Hunt Company.
   2. Waterman Industries, Incorporated.

B. Coating: Handwheel as specified in Section 09960.

C. Mounting: Floor stand or bench stand. Unless otherwise indicated on the Drawings position actuator 36 inches (nominal) above top of walkway surface.

D. Bearings above and below finished threaded bronze operating nut: Ball or roller.

E. Wheel diameter: Minimum 24 inches.

F. Indicator: Counterclockwise opening with arrow, and word OPEN cast on top of handwheel indicating direction for opening.

G. Pull to operate: Maximum 40 pounds pull at most adverse design condition.

H. Stem travel limiting device: Setscrew locked stop nuts above and below lift nut.

I. Grease fittings: Suitable for lubrication of bearings.

2.03 HAND-CRANKED GEARED ACTUATORS

A. Type: Single removable crank; fully enclosed.

B. Mounting: Floor and bench stand. Unless otherwise indicated on the Drawings position actuator 36 inches (nominal) above top of walkway surface.

C. Operating nut: When scheduled for portable actuators.

D. Geared lifts: 2-speed with minimum ratio of 4 to 1.

E. Teeth on gears, spur pinions, bevel gears, and bevel pinions: Cut.

F. Lift nuts: Cast manganese bronze.

G. Exterior surfaces on cast-iron lift parts: Smooth.

H. Bearings above and below flange on lift nuts: Ball or roller; capable of taking thrust developed by opening and closing of gates under maximum operating head; with bronze sleeve bearings and sufficient grease fittings for lubrication of moving parts, including bearings and gears.

I. Crank rotation indicator: Cast arrow with word OPEN in prominent location readily visible indicating correct rotation of crank to open gate.

J. Hand cranks: 15-inch radius; requiring maximum 25 pounds pull to operate gate at maximum operating head; with:
   1. Revolving brass sleeves.
   2. Gears, spur pinions, bevel gears, and bevel pinions with cut teeth.
   3. Cast manganese bronze lift nuts.
   4. Cast-iron lift parts with smooth exterior surfaces.

K. Indicator: Dial position type mounted on gear actuator; enclosed in cast-iron or aluminum housing with clear plastic cover; marked with fully open, 3/4, 1/2, 1/4, and closed positions.

2.04 FLOOR BOXES

A. Manufacturers: One of the following or equal:
   1. Waterman industries, Inc.

B. Floor boxes: Cast-iron; with:
   1. Counter type indicator.
   2. Hinged, lockable lid with directional arrow.
   3. 2-inch square AWWA operating nut.
   4. Packing gland providing drip-tight seal around valve shaft.

2.05 FLOOR STAND

A. Manufacturers: One of the following or equal:
   1. Rodney Hunt Company.
   2. Waterman industries, Inc.

B. Floor stand assemblies: Heavy-duty cast-iron, suitable for mounting specified actuator.

2.06 BENCH STANDS

A. Manufacturers: One of the following or equal:
   1. Rodney Hunt Company.
   2. Waterman industries, Inc.

B. Bench stands: Handwheel actuators or hand crank, geared actuators conforming to hand-cranked geared actuator requirements, except capacity to be mounted on haunch, wall bracket, or self-contained gate yoke.

2.07 ACCESSORY EQUIPMENT

A. Wall brackets or haunches: As indicated on the Drawings.

B. Stems: Stainless steel; sized to match output of actuator; minimum gate or valve operating stem diameter; maximum 200 slenderness ratio.

C. Stem couplings: Stainless steel; internally threaded to match stem; lockable to stem by set screw.

D. Stem guides: Cast-iron with silicon bronze bushing; maximum 200 slenderness ratio; capable of being mounted with wall bracket; adjustable in 2 directions.

E. Wall brackets: Cast-iron, capable of withstanding output of actuator, adjustable in 2 directions.

F. Stem stuffing boxes: Cast-iron, with adjustable gland and packing.

G. Fasteners: Type 316 stainless steel.

H. Anchor bolts: As specified in Section 05190 except that the material shall be Type 316 stainless steel.

I. Geared valve actuators: Provided with cut gears, either spur or worm; sized to operate valves at most adverse design condition; with maximum 40-pound pull at handwheel or chain wheel rim.

J. Geared valve traveling nut actuators: Acceptable only where specified or indicated on the Drawings.

K. Accessory equipment for valves and gates requiring remote actuators: Operating stems, stem couplings, stem guides, wall brackets, and stem stuffing boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install floor boxes in concrete floor with lid flush with floor.

B. After installation of gate and stem covers, mark stem covers at point where top of stems are at full-open position and at closed position.

C. Attach floor stand to structure with anchor bolts.

D. Install stem stuffing boxes where operating stems pass through intermediate concrete floor slabs.

3.02 SCHEDULES

A. Geared actuators: Provide geared actuators for following valves:
   1. Butterfly valves larger than 6 inches, nominal size, on liquid service.
   2. Butterfly valves larger than 10 inches, nominal size, on gas and air service.
   3. Plug valves 6 inches, nominal size, and larger.

B. Handwheel actuators: Provide handwheel actuators for valves mounted 6 feet or less above floors.

C. Chain wheel actuators: Provide chain wheel actuators for valves mounted more than 6 feet to centerline above floors.

END OF SECTION

SECTION 13447

ELECTRIC ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Electric motor-driven actuators for valves and gates as identified in the valves and gates schedule as EAM, EDM, OR EDR, except for specialty actuators specified with individual valves.

B. Related sections:
   1. Section 11294B - Heavy-Duty Fabricated Stainless Steel Slide Gates.
   2. Section 15111 - Ball Valves.
   3. Section 15112 - Butterfly Valves.
   4. Section 15115 - Gate, Globe, and Angle Valves.
   5. Section 15116 - Plug Valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C504 - AWWA Standard for Rubber-Seated Butterfly Valves.
   2. C540 - AWWA Standard for Power-Actuating Devices for Valves and Slide Gates.

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS:

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.
   2. Type 6P enclosure in accordance with NEMA 250.
   3. Type 7 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Provide a complete list/schedule of all actuators being provided with their associated tag names as indicated on the design drawings and/or specifications, service process area and the size of the valve they are actuating.

B. Clearly identify any exceptions in terms of quantities and/or quality of actuator(s) being submitted.

C. Product data:
   1. Electrical ratings:
      a. Voltage and number of phases.
      b. Starting and running current.
      c. Voltage levels and source for control and status.

2. Description of integral control interface.
3. Environmental ratings, including NEMA enclosure rating and submergence capabilities.
4. Gear ratios for both manual and motorized actuation.
5. Opening and closing directions.
6. Allowable starts per hour.
7. List of all included options and accessories.
8. Full travel times.
9. Gearbox data including gear ratio, and gearbox efficiency.
10. Affidavit in accordance with AWWA C540.

D. Shop drawings:
1. Wiring diagrams:
a. Include all options and expansion cards furnished with each actuator.
2. Dimensioned drawings of each valve and actuator combination.
3. Dimensioned drawings of each valve gearbox.
4. Electric motor data.

E. Calculations: Submit the following for each valve/gate size and class:
1. Operating torque calculations.
2. Maximum torque calculations for seating and unseating.
3. Maximum operating torque at starting and normal operation.

F. Test reports:
1. Factory test report and certificate.
2. Each actuator must be performance tested with a simulated load at the factory and individual test certificates and detailed test reports shall be provided:
a. The test equipment used should simulate a typical valve load.

G. Manufacturer's instructions:
1. Include manufacturer's instructions, description of system operation, start-up data, and troubleshooting checklist.

H. Operations and maintenance data:
1. Include manufacturer's literature; cleaning procedures, replacement part lists, wiring diagrams, and repair data.
2. Include a list of all configurable parameters, and the final values for each.
3. List of recommended spare parts.
4. List of special tools necessary for proper operation and/or maintenance.
5. Exploded view drawings that illustrate all assemblies, sub-assemblies, and components.
6. Routine test procedures for all electronic and electrical circuits.
7. Troubleshooting chart covering the complete valve and controls/electrical power systems, showing description of trouble, probable cause, and suggested remedy.
8. Certified factory and field-test results.

1.05 QUALITY ASSURANCE

A. Obtain required information from the valve/gate supplier, including but not limited to:
1. Interface to gate or valve.
2. Operating range (In degrees).

3. Quarter turn or multi-turn.
4. Required turns for full travel on multi-turn applications.
5. Direction of rotation for opening and closing.
6. Maximum and normal torque requirements.
7. Additional sizing requirements indicated in the following Specifications:
    a. Section 11294B - Heavy-Duty Fabricated Stainless Steel Slide Gates.
    b. Section 15111 - Ball Valves.
    c. Section 15112 - Butterfly Valves.
    d. Section 15115 - Gate, Globe, and Angle Valves.
    e. Section 15116 - Plug Valves.

B. All motorized, intelligent actuators shall be the product of a single manufacturer for all valve and gate applications on this project, regardless of gate or valve type, manufacturer, or supplier, unless otherwise specified.

1.06 SPARE PARTS

A. Provide the following spare parts (minimum 10 percent of total number of actuators of each model type furnished, but not less than 1 for each model of actuator furnished):
1. Stem nut.
2. Worm shaft subassembly.
3. Drive sleeve subassembly.
4. Complete actuator seal kit.
5. Actuator gearbox oil (sufficient quantity to fill 4 gearboxes).
6. Encoder.
7. Control module.

B. Provide 1 spare motor for each size motor furnished.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or Engineer approved equal:
1. Acceptable manufacturer for lines 3 inch and smaller:
    a. Rotork Controls Inc.:
        1) ROMpak (Quarter-Turn).
        2) CMA Range:
            a) CMR - Multi-Turn.
2. Acceptable manufacturers for lines 4 inch and larger:
    a. Rotork Controls Inc.:
        1) IQ3 (Multi-turn).
        2) IQT (Quarter-turn).
    b. Limitorque Corporation:
        1) Accutronix MX (Multi-Turn).

2.02 CHARACTERISTICS FOR ACTUATORS ON LINES 3 INCHES AND SMALLER

A. Actuators for valves 3 inches and smaller:
1. Provide actuators complete and operable with all components and accessories required for operation.

2. Power supply:
    a. Valve motion independent of power supply phase rotation.
    b. 120 VAC single phase.
3. Size actuator to move valves from full open to closed position within the time indicated in the Motorized Actuator Schedule:
    a. If an operating time is not indicated on the Schedule, size the actuator to move valves at minimum 12 inches per minute under maximum load. Measure rate of closure for valves at maximum diameter of disc, plug, or ball.
4. Control inputs:
    a. Capable of using discrete 24 VDC.
    b. Controls the valve when local-stop-remote is in REMOTE.
    c. Material: Type 316 stainless steel.
    d. Provide the following inputs at the actuator:
        1) OPEN.
        2) CLOSE.
5. Status outputs:
    a. Dry contact outputs configured for the functions indicated on the Drawings. Provide the following outputs for all actuators:
        1) FULLY CLOSED.
        2) FULLY OPEN.
        3) REMOTE.
        4) HIGH TORQUE.
    b. All output contacts rated for 5 amps, 24 VDC.
6. Analog input:
    a. Provide a 4-20 milliamp analog input for analog modulating valves when indicated on the Drawings.
    b. Modulate valve to maintain position based on analog input value.
    c. Maximum input impedance 250 ohms.
7. Analog output:
    a. Provide an isolated 4-20 milliamp analog output when indicated on the Drawings.
8. Materials:
    a. Construct motorized actuators of materials suitable for the environment in which the valve or gate is to be installed.
9. Components:
    a. Motors:
        1) Torque ratings equal to or greater than that required for valve seating and dynamic torques with a 25 percent factor of safety.
        2) Rated for operating under the following conditions without exceeding temperature limits with ambient temperature of 40 degrees Celsius:
            a) Continuous operation for 15 minutes or twice the open-to-close operating time (whichever is greater) at normal operating torque or 33 percent of maximum torque (whichever is greater).
            b) 60 starts per hour minimum for open/close service.
    b. Enclosures:
        1) Actuator housing ratings as indicated in the Motorized Actuator Schedule.
        2) Stainless steel external fasteners.
    c. Manual actuation:
        1) Hand wheel for manual operation.
    d. Gearing: Self-locking, high alloy steel gears.

2.03 CHARACTERISTICS FOR ACTUATORS ON LINES 4 INCHES AND LARGER

A. Provide actuators complete and operable with all components and accessories required for operation.

B. Power supply:
   1. Voltage and phases as indicated in the Schedule.
   2. Valve or gate motion independent of power supply phase rotation.
   3. Provide an internal backup power source to maintain settings and track valve position when main power is off.
   4. The actuators shall incorporate all major components such as the motor, starter, local controls, terminals etc. housed within a self-contained, sealed enclosure.

C. Size actuator to move gates or valves from full open to closed position within the time indicated in the Schedule:
   1. If an operating time is not indicated on the Schedule, size the actuator to move gates or valves at minimum 12 inches per minute under maximum load. Measure rate of closure for valves at maximum diameter of disc, plug, or ball.
   2. Size actuators so that gear boxes are not required where possible.

D. Control interface:
   1. Configuration:
      a. Provide a non-intrusive, non-contacting interface for configuring all input and output settings, control values, ranges, torque switch settings, valve positions switch settings, and options:
         1) Configurable from a hand-held configuring tool or input devices on the actuator.
   2. Local interface, integral to actuator:
      a. Non-intrusive, non-contacting selector switches:
         1) LOCAL-STOP-REMOTE:
            a) Motor actuator operation is prevented with the switch in STOP.
         2) OPEN-CLOSE:
            a) Controls the valve when LOCAL-STOP-REMOTE is in LOCAL.
            b) Spring return to center.
            c) Configurable between maintained (actuator runs until end of travel, high torque, or a LOCAL-STOP-REMOTE is switched to STOP) and momentary (actuator stops when lever is released).
      b. Local display:
         1) Valve fully open and fully closed indicators.
         2) Numerical display showing actual valve or gate position in percent of travel.
   3. Remote control station - (VCP):
      a. Provide remote control stations for all actuators located more than 5 feet above finished floor/grade or where indicated on the Drawings or Intelligent Actuator Schedule:
         1) NEMA rating as listed in the Valve and Gate Intelligent Actuator Schedule:
            a) Where the rating is not listed, use NEMA Type 4X enclosures for non-hazardous areas, and explosion proof (XP) Class I Division 1 for hazardous areas.

b) All pilot devices shall 30 mm and pilot lights shall be illuminated by LEDs.
2) LOCAL-STOP-REMOTE selector switch.
3) LOCAL mode control devices:
a) Operate valve when LOCAL-STOP-REMOTE integral to actuator is in REMOTE and LOCAL-STOP-REMOTE on remote control station is in LOCAL.
b) OPEN-STOP-CLOSE maintained switch or OPEN, STOP and CLOSE pushbuttons where Maintained operation is indicated in the Valve and Gate Intelligent Actuator Schedule.
c) OPEN-CLOSE spring-return switch or OPEN and CLOSE pushbuttons where momentary operation is indicated in the Valve and Gate Intelligent Actuator Schedule.
4) Pilots lights to indicate valve position:
a) Fully open.
b) Fully closed.

4. Control inputs:
a. Capable of using 24 VDC inputs.
b. Controls the valve when LOCAL-STOP-REMOTE is in REMOTE.
c. Isolated inputs capable of operating from external control voltage source or internal power supply:
1) Furnish 120 VAC and 24 VDC control power supplies within the actuator.
d. Provide the following inputs:
1) OPEN.
2) CLOSE.
3) STOP.
e. OPEN and CLOSE inputs configurable between maintained (actuator runs until end of travel, high torque, or a STOP input) and momentary (actuator stops when command is removed).
5. Status outputs:
a. Monitor relay output: Dry contact, normally closed, opens when actuator is not in REMOTE or in the event of any internal fault or alarm condition.
b. Dry contact outputs configured for the functions indicated on the Drawings. Provide the following outputs for all actuators:
1) Fully closed.
2) Fully open.
3) LOCAL-STOP-REMOTE in REMOTE position.
4) High Torque.
c. All output contacts rated for 5 amps, 24 VDC.
6. Analog input:
a. Provide a 4-20 milliampere analog input for analog modulating valves when indicated on the Drawings.
b. Modulate valve to maintain position based on analog input value.
c. Maximum input impedance 250 ohms.
7. Analog output:
a. Provide an isolated 4-20 milliampere analog output when indicated on the Drawings:
1) Loop power sourced from the actuator power supply.
2) Capable of driving into a load up to 500 ohms.
3) Output proportional to process value(s) indicated on the Drawings.
4) Valve or gate position.

E. Features:
   1. Time delay on reversal: Incorporate time delay between stopping actuator and starting in opposite direction to limit excessive current, torque, and heating from instantaneous reversal.
   2. Data logging:
      a. Store diagnostic data and reference data.
      b. Time-stamped historical operating data, including number of operations and most recent operations.
      c. Torque profiles showing actual torque at each valve position through the operating range. Starting torque, maximum running torque, and end of travel torque:
         1) Store reference data (recorded during commissioning) and data from last operation.
   3. Provide display of logged data on the actuator, or provisions to download to a personal computer.

F. Materials:
   1. Construct motorized actuators of materials suitable for the environment in which the valve or gate is to be installed.

G. Components:
   1. Motors:
   2. Specifically designed for valve actuator service with high starting torque, totally enclosed non-ventilated construction.
   3. Torque ratings equal to or greater than that required for valve seating and dynamic torques with a 25 percent factor of safety:
      a. Design requirements for rubber-seated AWWA butterfly valves:
         1) Design actuators for maximum gate or valve operating torque, in accordance with and using safety factors required in AWWA C504 and AWWA C540:
            a) Valve actuator torque requirement for open-close service: Not less than the required valve-seating and dynamic torques under design operating conditions in accordance with AWWA C504.
            b) Valve actuator torque requirement for modulating service: Not less than twice the required valve dynamic torque under design operating conditions in accordance with AWWA C504.
      b. Design requirements for slide gates, gate valves, knife gate valves, globe valves, and diaphragm valves:
         1) Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C540.
         2) Design for the maximum torque and thrust running load over the full cycle.
         3) Maximum torque or thrust rating: The actuator stall torque or maximum thrust output shall not exceed the torque or thrust capability of the valve or gate, as determined by the valve or gate manufacturer.
   4. Capable of being removed and replaced without draining the actuator gear case.
   5. Motor bearings shall be amply proportioned of the anti-friction type and permanently lubricated.

6. Rated for operating under the following conditions without exceeding temperature limits with ambient temperature of 40 degrees Celsius:
    a. Continuous operation for 15 minutes or twice the open-to-close operating time (whichever is greater) at normal operating torque or 33 percent of maximum torque (whichever is greater).
    b. 60 starts per hour for open/close service or 1,200 starts per hour for modulating service.
7. Provide the following motor protection features:
    a. Jammed valve (no valve motion detected through a time delay).
    b. High motor temperature (sensed by an embedded thermostats).
    c. High torque.
    d. Single phasing protection.

H. Enclosures:
1. Actuator housing ratings as indicated in the Schedule.
2. Stainless steel external fasteners.
3. Provide 'O' ring seals for each of the following areas:
    a. Between the terminal compartment and the internal electrical elements.
    b. Between the mechanical and electrical portions to protect from the ingress of oil, and to protect the mechanical components of oil from dust and moisture when the electrical terminal is open.
4. Provide the following minimum enclosure ratings:
    a. NEMA Type 4X enclosure for general applications.
    b. NEMA Type 6P rated for actuators in underground vaults or where possible submergence is indicated in the Drawings:
        1) Suitable for a minimum of 48 hours submerged under 3 meters of water.
5. NEMA Type 7 certified by FM for Class I, Division 1, Groups C, D, E, F and G, for actuators installed in Class I, Division 1 and 2 areas.

I. Position sensing:
1. Electronic and adjustable using a solid-state encoder wheel:
    a. Mechanical limit switches and potentiometers are not acceptable.
2. Capable of retaining position and monitoring valve or gate motion when valve is manually actuated and when main power is not present.
3. Valve range and position switch outputs field adjustable.

J. Torque sensing:
1. Torque shutdown setting: 40 percent to 100 percent rated torque:
    a. Adjustable in 1 percent increments.
2. Capable of interrupting control circuit during both opening and closing and when valve torque overload occurs.
3. Independent of variations in frequency, voltage, or temperature.
4. Provide a temporary inhibit of the torque sensing system during unseating or during starting in mid-travel against high inertia loads.
5. Provide visible verification of torque switch status without any housing disassembly.

K. Manual actuators:
1. Hand wheel for manual operation:
    a. Maximum 80 pound pull on rim when operating gate or valve under maximum load.

b. Provide pull chain when motorized actuator is located more than 6 feet above floor surface:
   1) Chain shall be of sufficient length to reach approximately 4 feet above the operating level.
   2) Where the chain obstructs an aisle or walkway, provide holdback or other means to ensure chain does not create a nuisance or hazard to operating personnel.

2. Declutch lever: Padlockable, capable of mechanically disengaging motor and related gearing and freeing hand wheel for manual operation.

L. Gearing: Hardened alloy steel spur or helical gears and self-locking, alloy bronze worm gear set:
   1. Accurately cut to assure minimum backlash.

M. Bearings:
   1. Anti-friction bearing with caged balls or rollers throughout.
   2. Sealed-for-life type thrust bearings housed in a separate thrust base.

N. Drive bushing:
   1. Easily detachable for machining to suit the valve stem or gearbox input shaft.
   2. Positioned in a detachable base of the actuator.

O. Lubrication:
   1. Provide totally enclosed actuator gearing with oil filled gear case suitable for operation at any angle.
   2. Suitable for standard SAE80EP gear oil.
   3. Actuators requiring special or exotic lubricants are not acceptable.

2.04 ACCESSORIES

A. Setting tool:
   1. If required for setting or configuring the actuator, provide a hand-held setting tool.

B. Termination module cover:
   1. For actuators on a valve network provide a means to keep the valve network in service, in the event where the actuator must be removed.
   2. Provide sunshades for all outdoor installations to cover actuator body and control devices.

2.05 SOURCE QUALITY CONTROL

A. Factory test:
   1. Test each actuator in the factory, and submit an individual test certificate for each actuator.
   2. Perform a high potential test and record the following information:
      a. Test voltage.
   3. Simulate a maximum and typical valve loads and record the following information:
      a. Current and power factor at maximum and set torque values.
      b. Torque as measured by the actuator.
      c. Actuator output speed or operating time.

4. Performance testing: Conduct performance test for each actuator simulating valve operating torque from full-open to full-close and from full-close to full-open. The following information shall be recorded during each performance test:
    a. Torque at maximum torque setting.
    b. Current at maximum torque setting.
    c. Test voltage and frequency.
    d. Actuator output speed and operating time for full-open to full-close.
    e. Amperage draw on motors at breakaway and under normal operation.

B. Field verify characteristics prior to sizing motor actuator.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install actuators in accordance with manufacturer's instructions.

3.02 MOTORIZED ACTUATOR SCHEDULE

A. Provide all actuators indicated on the Drawings:
    1. Major process actuators are listed in the Intelligent Actuator Schedule in this section.
    2. The schedule does not include all number and types of actuators required for the Project.

B. Abbreviations relating to type:
    1. BFV = Butterfly Valve.
    2. BV = Ball Valve.
    3. PV = Plug Valve.
    4. SG = Slide Gate.

C. Abbreviations relating to actuator type:
    1. O/C = Open and Close Service.
    2. MOD = Modulating Service.

D. Abbreviations relating to controls:
    1. A = Analog (4-20mA) control, modulating duty.
    2. D = Discrete control, modulating duty.
    3. D-O/C = Discrete Open/Close.

END OF SECTION

INTELLIGENT ACTUATOR SCHEDULE

Item	Reference DWG	Type	Size	Actuator Type	Rating	Voltage /Phase /Hz	Notes	Open Time	Controls
Mixed Liquor Flume No.4 Flow Control Gate	01YS03	SG	42”	MOD	4X	480/3/60	1	300 s	A
Mixed Liquor Flume No.5 Flow Control Gate	01YS03	SG	42”	MOD	4X	480/3/60	1	300 s	A

Notes:
(1) Provide actuators with remote control station.
(2) New motorized actuator to be installed on existing equipment.
(3) Provide Battery Backup Unit.

SECTION 14624

MONORAIL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Monorail system, including trolley, hoist, monorail beam, restraint bracing, end stops, hangers and hanger connections to beams, and accessories.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor’s responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor’s Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01612 - Seismic Design Criteria.
      b. Section 09960 - High-Performance Coatings.
      c. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
      d. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B30.11 - Monorails and Underhung Cranes.
   2. B30.16 - Overhead Hoists (Underhung).

B. American Institute of Steel Construction (AISC):
   1. Specifications for Design, Fabrication, and Erection of Structural Steel for Buildings.

C. American Welding Society (AWS).

D. Occupational Safety and Health Administration (OSHA).

E. Monorail Manufacturers' Association (MMA):
   1. MH27.1 - Specifications for Underhung Cranes and Monorail Systems.

F. National Electrical Code (NEC):
   1. Article 610 - Cranes and Hoists.

G. National Electrical Manufacturer's Association (NEMA):
   1. 250 – Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA 4X enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Hoisting system: In accordance with ASME B30.11, ASME B30.16, and OSHA standards.
   2. Design monorail crane system for seismic design criteria as specified in Section 01612.
   3. Structural steel construction: In accordance with AISC Specifications.
   4. Safety factor of castings, forgings, and stampings: Minimum 5 with regard to ultimate strength.
   5. Perform welding in accordance with AWS Standards.
   6. Electrification in accordance with NEC 610.
   7. Design equipment in accordance with MMA MH27.1.

B. Performance requirements:
   1. Service classification: HMI H3, moderate service.
   2. Capacity: 2 tons.
   3. Arrange working parts for convenient inspection, lubrication, adjustment, repair, or replacement.

1.05 SUBMITTALS

A. Shop drawings: Include support types, sizes, spacing, bridging, connections, anchoring, bearing plates, erection instructions, and electrical drawings.

B. Product data.

C. Calculations: Signed and stamped by registered engineer in state where Project is located.

D. Certificates:
   1. Certificate of tests conducted by the monorail manufacturer in accordance with industry standards and federal regulations prior to shipment of equipment.
   2. OSHA certificate upon completion of field load testing.

E. Operations and maintenance data.

1.06 QUALITY ASSURANCE

A. Installer qualifications: Minimum 3 years experience in, and regularly engaged in, field installation of monorail hoist systems.

B. Unload, store, and install monorail system under direct supervision of manufacturer.

1.07 DELIVERY, HANDLING, AND STORAGE

A. Assemble, paint, test, and adjust monorail system in manufacturer's shop before shipment as far as practical.

B. Protection: Use all means necessary to protect the materials before, during, and after installation.
   1. Replacement: In the event of damage, immediately make all repairs and replacements to the original condition of the equipment.

C. Storage: Store and handle materials in such a manner as to avoid damage. All equipment shall be stored and protected in accordance with manufacturer's requirements.

PART 2 PRODUCTS

2.01 MONORAIL

A. Manufacturers: One of the following or equal:
   1. Cordell & Associates, Inc.
   2. Trambeam Corporation.

B. Maximum vertical deflection of monorail beam: Maximum span of monorail beam divided by 600.

C. Maximum lateral deflection of monorail beam: Maximum span of monorail beam divided by 360 when subjected to a lateral load of 20 percent of the lifted load.

D. Stops and bumpers: Adequate to absorb energy of and stop moving trolley at end of permitted travel.

E. Hangers: Adjustable, able to level and accurately align system within 1/8-inch tolerance, able to support monorail from building structure.

F. Labeling: Paint hoist capacity on monorail with minimum 4-inch high letters and numbers where clearly visible from operating floor.

G. Coating: Provide prime coat, intermediate coat, and finish coat as specified in Section 09960.

2.02 TROLLEY HOISTS

A. Manufacturers: One of the following or equal:
   1. Cordell Hoist.
   2. Cleveland Tram Rail.
   3. Yale.

B. Type: Combination electric motor-driven trolleys and hoists, single-speed with trolley cushioned start, including load brake, electric motor brake, upper and lower geared limit switch, upper reverse plugging paddle limit switch, and load limiting device, low headroom.

C. Hoisting speed: 7 and 21 feet per minute (for double-speed).

D. Distance from bottom of rail to inside of hook: Maximum 25 inches with hook in fully raised position.

E. Trolleys wheels: Single-flanged; stainless steel or bronze; fitted with anti-friction bearings with lifetime seals; suitable for adjustment to monorails.

F. Safety lugs: Add safety lugs to manufacturer's standard design.

G. Motors: 460 volt, 3 phase, 60 hertz, totally enclosed non-ventilated (TENV), squirrel-cage induction type operating at maximum 1,800 revolutions per minute, with Class B or F insulation, and motor heaters, horsepower as follows:
   1. Hoist: 3 and 1 (for double-speed).
   2. Trolley: 1/4.
      a. Actual horsepower requirement not to exceed the specified motor horsepower.

H. Drive units: Specially designed for monorail service with cushioned stop holding brakes.

I. Hoisting drum: Stainless steel, 1/2 rope diameter deep grooves; adequate to provide minimum 2 complete rope wraps on drum with hook in lowest position, and to accommodate full length of rope without overlapping when in highest position, with right handed and left handed grooving for true vertical lift.

J. Hoist drive speed reducer: With heat-treated steel helical gears; oil-lubricated with oiltight cases; shafts running in anti-friction bearings.

K. Limit switches and overload device: Manufacturer's standard.

L. Hoisting rope: Specifically designed for specified service loads; preformed, improved plow stainless steel with fiber core; double-reeved.

M. Hoisting block: Steel with forged or cast steel hook supported on ball or roller bearings for true vertical lift.

N. Hook: stainless steel or bronze; safety type; able to rotate freely on bearing support with heavy-duty type safety latches.

O. Bottom block: Shrouded.

P. Coating: Provide prime coat, intermediate coat, and finish coat in as specified in Section 09960.

2.03 ELECTRIFICATION AND CONTROL

A. Electrification type: Cable and spring-loaded swiveled cable reel-mounted on structure, festoon electrification with stainless steel track and stainless steel trolleys supporting flat cable at regular intervals allowing a maximum 3’ loop depth

B. Cable run: From junction box to cable reel, then to control unit.

C. Control unit: Pendant pushbutton station hanging from hoist to maximum 4 feet above operation floor.

D. Control voltage: 120 volts alternating current, supplied from transformer on hoist.

E. Pushbuttons: Momentary-contact, maintain-pressure, automatically de-energizing upon relaxation of pressure; number and functions as follows:
   1. Pushbuttons for hoisting: Two, 1 for each direction.
   2. Pushbuttons for trolley: Two, 1 for each direction.

F. Enclosures for control unit, electrical control, and reel: NEMA 4X and to meet the requirements as specified in Sections 17050 and 17710.

G. Control unit support: Steel cable.

H. Control accessories:
   1. Geared limit switch able to limit up and down travel with second switch operated by hook to stop hoist when highest safe point is reached.
   2. Magnetic contactors for up and down operation and control.
   3. Automatic exerciser module.

I. Junction boxes: Suitable for connection of field services with ground pads.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install monorail crane system in accordance with manufacturer's instructions.

3.02 LOAD TESTING

A. Perform test in presence of OSHA certifier, manufacturer, Engineer, and Owner.

B. Test equipment with minimum load of 25 percent above rated capacity.

C. Provide load and slings for test:
   1. Remove when tests are completed.

D. Operate equipment through complete lift and lowering cycle and through complete travel of trolley to demonstrate quiet, smooth, and safe hoisting, braking, and traveling.

E. Correct defects.

3.03 USE OF MONORAIL CRANE SYSTEM

A. Prohibit hoisting equipment use until receipt of OSHA certificate.

B. Do not use monorail crane system for construction.

3.04 SCHEDULE

Location	Monorail Track & Suspension	No. Trolley Hoists	Capacity (Tons)	Carrier Track
Biotower Pump Station	No	1	2.0	Steel Beam: Standard I-Beam

END OF SECTION

SECTION 15050

COMMON WORK RESULTS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic design and performance requirements for mechanical equipment.

B. Related sections:
1. Section 01600 - Product Requirements.
2. Section 01610 - Project Design Criteria.
3. Section 01612 - Seismic Design Criteria.
4. Section 01756 - Commissioning.
5. Section 01770 - Closeout Procedures.
6. Section 01782 - Operating and Maintenance Data.
7. Section 03600 - Grouting.
8. Section 05190 - Mechanical Anchoring And Fastening To Concrete And Masonry.
9. Section 05120 - Structural Steel.
10. Section 09960 - High-Performance Coatings.
11. Section 10400 - Signage.
12. Section 15052 - Common Work Results For General Piping.
13. Section 15082 - Piping Insulation.
14. Section 15958 - Mechanical Equipment Testing.

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA) Standards:
1. 6001-E08 – Design and Selection of Components for Enclosed Gear Drives.

B. American Bearing Manufactures Association (ABMA) Standards:
1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. American Petroleum Institute (API):
1. 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.

D. ASTM International (ASTM):
1. A36 - Standard Specification for Carbon Structural Steel.
2. A48 - Standard Specification for Gray Iron Castings.
3. A125 - Standard Specification for Steel Springs, Helical, Heat-Treated.
4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

6. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
7. A320 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
8. A536 - Standard Specification for Ductile Iron Castings.
9. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
10. B61 - Standard Specification for Steam or Valve Bronze Castings.
11. B62 - Standard specification for Composition Bronze or Ounce Metal Castings.
12. B505 - Standard Specification for Copper Alloy Continuous Castings.
13. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
14. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
15. F594 - Standard Specification for Stainless Steel Nuts.
16. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. Food and Drug Administration (FDA).

F. Hydraulic Institute (HI).

G. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. Special tools: Tools that have been specifically made for use on unit of equipment for assembly, disassembly, repair, or maintenance.

B. Resonant frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.

C. Rotational frequency: The revolutions per unit of time usually expressed as revolutions per minute.

D. Critical frequency: Same as resonant frequency for the rotating elements or the installed machine and base.

E. Peak vibration velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.

F. Rotational speed: Same as rotational frequency.

G. Maximum excitation frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.

H. Critical speed: Same as critical frequency.

I. Free field noise level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.

J. Operating weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 SYSTEM REQUIREMENTS

A. General:
   1. Product requirements as specified in Section 01600.
   2. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions as specified in this Section.
   3. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.

B. Power transmission systems:
   1. V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a service factor of 1.5 or greater in accordance with manufacturer recommendations:
      a. Apply service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
      b. Apply service factors in accordance with AGMA 6001-E08, other applicable AGMA standards, or other applicable referenced standards.

C. Vibration:
   1. Resonant frequency:
      a. For single speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
      b. For variable speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the range of operating frequencies.
   2. Design, balance, and align equipment to meet the vibration criteria specified in Section 15958.

D. Equipment mounting and anchoring:
   1. Mount equipment on cast iron or welded steel bases with structural steel support frames:
      a. Utilize continuous welds to seal seams and contact edges between steel members.
      b. Grind welds smooth.
   2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.

3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
4. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load specified in Section 01612, and other loads as required for proper operation of equipment.
5. Anchorage of equipment to concrete or masonry:
    a. Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
    b. Unless otherwise indicated on the Drawings, select and provide anchors from the types specified in Section 05190.
    c. Provide bolt sleeves around cast-in anchor bolts for heavy equipment:
        1) Adjust bolts to final location and fill sleeve with polyurethane foam.
6. Anchorage of equipment to metal supports: Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
7. Unless otherwise indicated on the Drawings, install equipment supported on concrete over non-shrink grout pads as specified in this Section.

E. Seismic design:
1. Design equipment anchorage and related details for seismic design criteria as specified in Section 01612.
2. For equipment with operating weight of 400 pounds and greater that is supported 4 feet or less above the floor and all equipment that is supported higher than 4 feet above the floor, provide calculations for:
    a. The operating weight and location of the centroid of mass for the equipment.
    b. Forces and overturning moments.
    c. Shear and tension forces in equipment anchorages, supports, and connections.
    d. The design of equipment anchorage, supports, and connections based on calculated shear and tension forces.

F. Equipment units weighing 50 pounds or more: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.

1.05 SUBMITTALS

A. Product data:
1. For each item of equipment:
    a. Design features.
    b. Load capacities.
    c. Efficiency ratings.
    d. Material designations by UNS alloy number or ASTM Specification and Grade.
    e. Data needed to verify compliance with the Specifications.
    f. Catalog data.
    g. Name plate data.
    h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
2. Gear reduction units:
    a. Engineering information in accordance with applicable AGMA standards.
    b. Gear mesh frequencies.

B. Shop drawings:
   1. Drawings for equipment:
      a. Drawings that include cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
   2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, base plate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
   3. Installation instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial Installation Testing procedures.
   4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer based controls.
   5. Recommended or normal operating parameters such as temperatures and pressures.
   6. Alarm and shutdown set points for all controls furnished.

C. Calculations:
   1. Calculations and other information to substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design strength requirements and seismic design criteria specified in Section 01612.
   2. ABMA 9 or ABMA 11 L10 life for bearings calculation methods for drivers, pumps, gears, shafts, motors, and other driveline components with bearings.
   3. Calculations and other information to substantiate that operating rotational frequencies meet the requirements of this Section.
   4. Torsional analysis of power transmission systems: When torsional analysis specified in the equipment sections, provide:
      a. Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
      b. Results of analysis including first and second critical frequencies of system components and complete system.
   5. Calculations shall be signed and stamped by an engineer.

D. Operation and maintenance manuals:
   1. As specified in Section 01782.
   2. Include manufacturer and model number of every bearing; include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.

E. Commissioning submittals: As specified in Section 01756.

F. Project closeout documents: As specified in Section 01770.

1.06 QUALITY ASSURANCE

A. Manufacturer's field service:
   1. Visit project site and perform tasks necessary to certify installation as specified in Section 01756.

1.07 DELIVERY, HANDLING, STORAGE, AND PROTECTION

A. As specified in Section 01600.

B. Delivery:
   1. Mandatory requirements prior to shipment of equipment:
      a. Bearings:
         1) Separately pack or otherwise suitably protect during transport.
         2) Applying grease and lubricating oil to bearings and similar items.
         3) Separately packing or otherwise suitably protecting bearings.
      b. Gear boxes:
         1) Oil fill or spray with rust preventive protective coating.

C. Storage:
   1. Bearings:
      a. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
   2. Gear boxes:
      a. Inspect to verify integrity of protection from rust.

D. Protection:
   1. Equipment maintenance log shall include description of rotation performed as part of maintenance activities.

1.08 SEQUENCING AND SCHEDULING

A. Equipment anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place.

B. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. Commissioning submittals: As specified in Section 01756:

1.09 SPARE PARTS

A. Spare belts:
   1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit:
      a. Where 2 or more belts are involved, furnish matched sets.
      b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
      c. Package in boxes labeled with identification of contents.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials in contact with drinking water as specified in Section 01600.

B. Ferrous materials:
   1. Steel for members used in fabrication of assemblies: ASTM A36.
   2. Iron castings: ASTM A48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
   3. Ductile iron castings: ASTM A536, Grade 65-45-12, free from flaws and imperfections.
   4. Galvanized steel sheet: ASTM A653, minimum 0.0635 inch (16 gauge).
   5. Expanded metal: ASTM A36, 13 gauge, 1/2-inch flat pattern expanded metal.

C. Nonferrous materials:
   1. Stainless steel: Type 304 or 316 as specified. Provide L grade where welding required.
   2. Bronze in contact with drinking water: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C89833, C89520, or C92200 in accordance with ASTM B61, B62, B505, or B584, when not specified otherwise.
   3. Bronze in contact with wastewater: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C89833, C89520, C92200, or C93700 in accordance with ASTM B61, B62, B505, or B584, when not specified otherwise.

D. Dielectric materials for separation of dissimilar metals:
   1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials as specified.

E. Non-shrink grout: As specified in Section 03600.

2.02 FASTENERS

A. General:
   1. Material: As specified in the individual specifications.
   2. Where fasteners are specified to be galvanized, shall be galvanized in accordance with ASTM A153 or ASTM F2329.

B. Mechanical anchors:
   1. As specified in Section 01612 and Section 05190.
   2. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

C. High-strength fasteners:
   1. As specified in Section 05120.

D. Flange bolts:
   1. As specified in Section 15052.

E. Mechanical assembly fasteners:
   1. Stainless steel:
      a. High Temperature Service or High Pressure Service:
         1) Bolts: ASTM A193, Grade B8 (304 SST) or Grade B8M (316 SST), Class 1, heavy hex.
         2) Nuts: ASTM A194, Grade 8, heavy hex.
         3) Washers: Alloy group matching bolts and nuts.

b. Low Temperature Service:
    1) Bolts: ASTM A320, Grade B8 (304 SST) or Grade B8M (316 SST), Class 1, heavy hex.
    2) Nuts: ASTM A194, Grade 8 (304 SST) or Grade B8M (316 SST), heavy hex.
    3) Washers: Alloy group matching bolts and nuts.
c. General service:
    1) Bolts: ASTM F593, Alloy group 1 (304 SST) or Alloy group 2 (316 SST).
    2) Nuts: ASTM F594, Alloy group 1 (304 SST) or Alloy group 2 (316 SST).
    3) Washers: Alloy group matching bolts and nuts.

2.03 SHAFT COUPLINGS

A. General:
1. Type and ratings: Provide nonlubricated type, designed for not less than 50,000 hours of operating life.
2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.
3. Use: Use of couplings specified in this Section does not relieve Contractor of responsibility to provide precision alignment of driver-driven units as required by equipment manufacturer and alignment criteria specified elsewhere in this Section.

B. Shaft couplings - close coupled: Shaft couplings for close coupled electric motor driven equipment 1/2 horsepower or larger and subject to sudden torque reversals or shock loading:
1. Manufacturers: One of the following or equal:
    a. T.B. Woods, Dura-Flex, L-Jaw C-Jaw or G-Jaw.
    b. Lovejoy, S-Flex.
2. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
3. Manufacture flexible component of coupling from synthetic rubber, or urethane.
4. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
5. Do not allow metal-to-metal contact between driver and driven equipment.
6. Examples of loads where sudden torque reversals may be expected:
    a. Reciprocating pumps, blowers, and compressors.
    b. Conveyor belts.
    c. Reversing equipment.

C. Shaft couplings - direct connected: Shaft couplings for direct connected electric motor driven equipment 1/2 horsepower or larger and subject to normal torque, non-reversing applications:
1. Manufacturers: One of the following or equal:
    a. Rexnord - Falk.
    b. T.B. Woods, Dura-Flex, Sure-Flex or Form-Flex.
2. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.

3. Provide flexible connecting element of rubber and reinforcement fibers.
4. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer couplings: Where cartridge type mechanical seals or non-split seals are specified, provide a spacer type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.

E. Specialized couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer.

2.04 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:
1. Unless otherwise noted in the equipment section, provide cartridge type, double mechanical shaft seals for pumps.
2. Provide a stuffing box large enough for a double mechanical seal.
3. Where packing is specified, provide stuffing box large enough to receive a double mechanical seal.
4. Provide seal or packing flush connections, (3/4-inch size unless another size is indicated on the Drawings).
5. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
6. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open up packing box.
7. Seal or packing flush requirements shall be in accordance with API Standard 682 requirements. Unless otherwise indicated, specified or required by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:
   a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
   b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
   c. Single seal, clean hot water (greater than 180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
   d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water- see Carollo typical detail # M262).
   e. Double seal applications: Plan 54 (External seal water- see Carollo typical detail # M262).

B. Packing: When specified in the equipment section of the specifications, provide the following type of packing:
1. Wastewater, water, and sludge applications:
   a. Asbestos free.
   b. PTFE (Teflon) free.
   c. Braided graphite.
   d. Manufacturers: One of the following or equal:
      1) Chesterton, 1400.
      2) John Crane Inc., equivalent product.
2. Drinking water service:
   a. Approved by the FDA.
   b. As specified in Section 01600.

c. Asbestos free.
d. Material: Braided PTFE (Teflon).
e. Manufacturers: One of the following or equal:
1) Chesterton, 1725.
2) John Crane, Inc., equivalent product.

C. Mechanical seals: Provide seal types specified in the equipment sections and as specified:
1. Provide seal types meeting the following requirements:
a. Balanced hydraulically.
b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
c. O-ring: Viton 747.
d. Gland: Type 316L stainless steel.
e. Set screws: Type 316L stainless steel.
f. Faces: Reaction bonded, Silicon Carbide.
g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.
2. Cartridge type single mechanical: Manufacturers: One of the following or equal:
a. Chesterton, S10.
b. John Crane, 5610 Series.
3. Cartridge type double mechanical: Manufacturers: One of the following or equal:
a. Chesterton, S20.
b. John Crane, 5620 Series.
4. Split face single mechanical: Manufacturers: One of the following or equal:
a. Chesterton, 442.
b. John Crane, 3740.

2.05 GEAR REDUCTION UNITS

A. Type: Helical or herringbone, unless otherwise specified.

B. Design:
1. Made of alloys treated for hardness and for severe service.
2. AGMA Class II service:
a. Use more severe service condition when such is recommended by unit's manufacturer.
3. Cast iron housing with gears running in oil.
4. Anti-friction bearings.
5. Thermal horsepower rating based on maximum horsepower rating of prime mover not actual load.
6. Manufactured in accordance with applicable AGMA standards.

C. Planetary gear units are not to be used.

2.06 BELT DRIVES

A. Sheaves:
   1. Separately mounted on bushings by means of at least 3 pull-up bolts or cap tightening screws.
   2. When 2 sheave sizes are specified, provide separate belts sized for each set of sheaves.
   3. Statically balanced for all; dynamically balanced for sheaves that operates at peripheral speed of more than 5,500 feet per minute.
   4. Key bushings to drive shaft.

B. Belts: Anti-static type when explosion-proof equipment or environment is specified.

C. Manufacturers: One of the following or equal:
   1. Dodge, Dyna-V belts with matching Dyna-V sheaves and Taper-Lock bushings.
   2. T.B. Wood's, Ultra-V belts with matching Sure-Grip sheaves and Sure-Grip bushings.

2.07 BEARINGS

A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

B. Oil lubricated bearings: Provide either pressure lubricating system or separate oil reservoir splash type system:
   1. Size oil lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the temperature 15 degree Fahrenheit above the maximum design temperature as specified in Section 01610.
   2. Provide an external oil cooler when required to satisfy the specified operating conditions:
      a. Provide air cooled system if a water-cooling source is not indicated on the Drawings.
      b. Equip oil cooler with a filler pipe and external level gauge.

C. Grease lubricated bearings, except those specified to be factory sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings:
   1. Lubrication lines and fittings:
      a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
      b. Multiple fitting assemblies: Mount fittings together in easily accessible location.
      c. Use standard hydraulic type grease supply fittings:
         1) Manufacturers: One of the following or equal:
            a) Alenite.
            b) Zerk.

D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 L10 life for bearings rating life of not less than 50,000 hours:
   1. Higher ratings, when specified in other Sections, supersede preceding requirement.

2.08 SAFETY GUARDS

A. Drive assemblies: Enclose sprockets, belts, drive chains, gearings, couplings, and other moving parts on drive assemblies in safety enclosures that are in compliance with applicable Laws and Regulations.

B. Shafts: Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.

C. Hot surfaces: Insulate all surfaces with normal operating temperatures above 120 degrees Fahrenheit when surface is within 7.5 feet height from any operating floor or level; insulation thickness such that temperature is below 120 degrees Fahrenheit; cover insulation with moisture-proof protective jacket; insulation Type 3 and cover Type 5 as specified in Section 15082.

D. Guard requirements:
   1. Allow visual inspection of moving parts without removal.
   2. Allow access to lubrication fittings.
   3. Prevent entrance of rain or dripping water for outdoor locations.
   4. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of 1 belt.

E. Materials:
   1. Sheet metal: Carbon steel, 12 gauge minimum thickness, hot-dip galvanized after fabrication.
   2. Fasteners: Type 304 stainless steel.

2.09 SPRING VIBRATION ISOLATORS

A. Design requirements:
   1. Telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces.
   2. Use steel coil springs.
   3. Design vibration isolators in accordance with seismic design criteria as specified in Section 01612.

B. Performance requirements: Minimum spring deflection of 1 inch under static load and capable of limiting transmissibility to 15 percent maximum at design operating load.

C. Manufacturers: One of the following or equal:
   1. California Dynamics Corporation, Type RJSD.
   2. Mason Industries, equivalent product.

D. Materials:
   1. Fabricate isolators using welded steel or shatterproof ductile iron in accordance with ASTM A536 Grade CS-45-12.
   2. Spring steel: ASTM A125.

2.10 WARNING SIGNS

A. Provide warning signs in accordance with OSHA requirements for equipment that starts automatically or remotely.

B. Material, sign size, and text: As specified in Section 10400.

C. Mount warning signs with stainless steel fasteners at equipment.

2.11 FABRICATION

A. Structural steel members: As specified in Section 05120.

B. Nameplates:
   1. Engraved or stamped on Type 304 stainless steel and fastened to equipment at factory in an accessible and visible location.
   2. Indicate following information as applicable:
      a. Manufacturer's name.
      b. Equipment model number and serial number.
      c. Maximum and Normal rotating speed.
      d. Horsepower.
      e. Rated capacity.
      f. Service class per applicable standards.
   3. Nameplates for pumps: Include:
      a. Rated total dynamic head in feet of fluid.
      b. Rated flow in gallons per minute.
      c. Impeller, gear, screw, diaphragm, or piston size.
   4. Gear reduction units: Include:
      a. AGMA Class of service.
      b. Service factor.
      c. Input and output speeds.

C. Bolt holes in equipment support frames:
   1. Do not exceed bolt diameter by more than 25 percent, up to limiting maximum diameter oversize of 1/4 inch.

D. Shop finishing:
   1. Provide factory and field coating as specified in Section 09960:
      a. Finish painting of motors: Shop finish paint with manufacturer's standard coating, unless otherwise specified in Section 09960.

2.12 SOURCE TESTING

A. As specified in Section 15958 for testing requirements and the individual equipment sections of the Specifications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect component as specified in Section 01610.

B. Inspect fasteners proper torques and tightness.

3.02 INSTALLATION

A. Field measurements:
   1. Prior to shop drawings preparation, take measurements and verify dimensions indicated on the Drawings.
   2. Ensure equipment and ancillary appurtenances fit within available space.

B. Metal work embedded in concrete:
   1. Accurately place and hold in correct position while concrete is being placed.
   2. Clean surface of metal in contact with concrete immediately before concrete is placed.

C. Concrete surfaces designated to receive non-shrink grout:
   1. Heavy sandblast concrete surface in contact with non-shrink grout.
   2. Clean concrete surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bond to non-shrink grout.
   3. Saturate concrete with water. Concrete shall be saturated surface damp at time non-shrink grout is placed.

D. Install equipment in accordance with manufacturer's installation instructions and recommendations.

E. Lubrication lines and fittings:
   1. Lines from fittings to point of use: Support and protect.
   2. Fittings:
      a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
      b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
      c. Fittings for underwater bearings: Bring fittings above water surface and mount on edge of structure above.

F. Alignment of drivers and equipment:
   1. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after complete unit has been leveled on its foundation.
   2. Comply with procedures of appropriate HI, AGMA Standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:
      a. Maximum total coupling offset (not the per plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).

b. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.

3. Use reverse-indicator arrangement dial type or laser type alignment indicators: Mount indicators on the driver/coupling flange and equipment/coupling flange. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
4. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation, and axial spacing tolerances of the coupling.
5. When alignment satisfies most stringent tolerance of system components, grout between base and foundation:
   a. Allow minimum 48 hours for grout to harden.
   b. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment.
   c. Correct alignment as required.
6. After operational testing is complete, dowel motor or drivers and driven equipment:
   a. Comply with manufacturer's instructions.

G. Grouting under equipment bases, baseplates, soleplates, and skids with non-shrink grout:
1. Unless otherwise indicated on the Drawings, grout with non-shrink grout as specified in Section 03600.
2. Comply with equipment manufacturer's installation instructions for grouting spaces, and tolerances for level and vertical and horizontal alignment.
3. Install non-shrink grout only after:
   a. Equipment is leveled and in proper alignment.
   b. Piping connections are complete and in alignment with no strain transmitted to equipment.
4. Do not use leveling nuts on equipment anchors for supporting and leveling equipment bases, baseplates, soleplates, and skids for grouting.
5. Use jack screws for supporting and leveling equipment bases, baseplates, soleplates, and skids for grouting following the procedure defined below:
   a. Drill and tap equipment base plates, sole plates, and skids for jack screws.
   b. Use suitable number and size of jack screws.
   c. End of jack screws shall bear on circular steel plates epoxy bonded to equipment foundation.
   d. Jack screw threads that will be in contact with non-shrink grout: Wrap with multiple layers of tape or other material, acceptable to Engineer, to prevent non-shrink grout from bonding to threads.
   e. Place non-shrink grout.
   f. Cure non-shrink grout.
   g. After non-shrink grout has been cured, remove jack screws and material used to prevent bond to non-shrink grout:
      1) Provide jack screws to Owner for future use.
   h. Tighten equipment anchors in accordance with equipment manufacturer requirements.
   i. Fill holes where jack screws have been removed with non-shrink grout.
   j. Cure non-shrink grout in repaired areas.

6. For equipment bases, baseplates, soleplates, and skids where it is not practical to use jack screws, use steel wedges and shims, using procedure defined below:
    a. Wrap wedges and shims that contact non-shrink grout with multiple layers of tape or other material, acceptable to Engineer, to prevent non-shrink grout from bonding.
    b. Place non-shrink grout.
    c. Cure non-shrink grout.
    d. Remove wedges or shims.
    e. Tighten equipment anchors to in accordance with equipment manufacturer requirements.
    f. Fill voids where wedges and shims have been removed with non-shrink grout.
    g. Cure non-shrink grout in repaired areas.
7. Preparation of equipment bases, baseplates, soleplates, and skids for grouting:
    a. Metal in contact with grout: Grit blast to white metal finish.
    b. Clean surfaces of equipment bases, baseplates, soleplates, and skids in contact with grout of dirt, dust, oil, grease, paint and other material that will reduce bond.
8. Preparation of concrete equipment foundation for grouting:
    a. Rough concrete surfaces in contact with non-shrink grout.
    b. Concrete contact surface shall be free of dirt, dust, laitance, particles, loose concrete, or other material or coatings that will reduce bond.
    c. Saturate concrete contact surface area with water for minimum of 24 hours prior to grouting.
    d. Remove standing water just prior to grout placement, using clean rags or oil-free compressed air.

9. Forms and headboxes:
    a. Build forms for grouting of material with adequate strength to withstand placement of grouts.
    b. Use forms that are rigid and liquid tight. Caulk cracks and joints with an elastomeric sealant.
    c. Line forms with polyethylene film for easy grout release. Forms carefully waxed with 2 coats of heavy-duty paste wax will also be acceptable.
10. Grout placement requirements:
    a. Minimum ambient and substrate temperature: 45 degrees Fahrenheit and rising:
        1) Conform to non-shrink grout manufacturer’s temperature requirements.
    b. Pour non-shrink grout using head box.
    c. Keep level of non-shrink grout in head box above bottom of equipment bases, baseplates, soleplates, and skids at all times to prevent air entrapment in grout.
    d. Non-shrink grout shall flow continuously from head box to other side of forms without trapping air or forming voids.
    e. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove entrapped air.

f. After non-shrink grout sets, remove forms and trim grout at 45 degree angle from bottom edge of equipment bases, baseplates, soleplates, and skids.
g. Water cure non-shrink grout continuously for a minimum of 7 days as specified in Section 03600.

H. Special techniques: Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

I. Tolerances:
1. Completed equipment installations: Comply with requirements for intended use and specified vibration and noise tolerances.

J. Warning signs: Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.03 COMMISSIONING

A. As specified in Section 01756.

END OF SECTION

SECTION 15052

COMMON WORK RESULTS FOR GENERAL PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic piping materials and methods.

B. Related sections:
1. Section 01140 - Work Restrictions.
2. Section 01756 - Commissioning.
3. Section 09960 - High-Performance Coatings.
4. Section 15061 - Pipe Supports.
5. Section 15062 - Preformed Channel Pipe Support System.
6. Section 15211 - Ductile Iron Pipe : AWWA C151.
7. Section 15223 - Reinforced Concrete Low-Head Pressure Pipe: ASTM C361.
8. Section 15230 - Plastic Piping and Tubing.
9. Section 15259 - Chlorinated Polyvinyl Chloride (CPVC) Pipe: ASTM F441.
10. Section 15270 - Steel Pipe: Galvanized and Black, ASTM A53.
11. Section 15286 - Stainless Steel Pipe.
12. Section 15956 - Piping Systems Testing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24.
2. B16.47 - Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard.

B. American Water Work Association (AWWA):
1. C105 – Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
2. C207 - Standard for Steel Pipe Flanges for Waterworks Services-Size 4 In. Through 144 In.

C. ASTM International (ASTM):
1. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
2. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
3. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
4. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
5. F37 - Standard Test Methods for Sealability of Gasket Materials.

D. California Health and Safety Code.

E. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.
   2. 372 - Drinking Water System Components - Lead Content.

1.03 DEFINITIONS

A. Buried pipe: Pipe that is buried in the soil, or cast in a concrete pipe encasement that is buried in the soil.

B. Exposed pipe: Pipe that is located above ground, or pipe that is located inside a structure, supported by a structure, or cast into a concrete structure.

C. Underground piping: Piping actually buried in soil or cast in concrete that is buried in soil.

D. Underwater piping: Piping below tops of walls in basins or tanks containing water.

E. Wet wall: Wall with water on at least 1 side.

1.04 SUBMITTALS

A. Product data:
   1. Escutcheons.
   2. Flange bolts.
   3. Gaskets.
   4. Link -type seals.
   5. Certifications of compliance with reference standard for lead limits.

B. Calculations:
   1. Materials in contact with drinking water provide calculations in accordance with NSF 372.

C. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756.

D. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.

2.02 ESCUTCHEONS

A. Material: Chrome-plated steel plate.

B. Manufacturers: One of the following or equal:
   1. Dearborn Brass Company, Model Number 5358.
   2. Keeney Manufacturing Company, Model Number 102 or Number 105.

2.03 LINK TYPE SEALS

A. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a nylon polymer pressure plate with Type 316 stainless steel hardware. Isolate pressure plate from contact with wall sleeve.

B. Manufacturers: One of the following or equal:
   1. Calpico, Incorporated.
   2. Pipeline Seal and Insulator, Inc., Link-Seal.

2.04 FLANGE BOLTS

A. Ductile iron pipe:
   1. Bolts and nuts for ductile iron pipe flanges located indoors, outdoors above ground, or in dry vaults and structures and where pressures do not exceed 150 pounds per square inch shall be hot-dip galvanized carbon steel, ASTM A307, Grade B A 563 - Standard Specification for Carbon and Alloy Steel Nuts.
   2. Bolts and nuts for ductile iron pipe flanges located indoors, outdoors above ground, or in dry vaults and structures where the pressures exceed 150 pounds per square inch shall be alloy steel, ASTM A193, Grade B7 for bolts and in accordance with ASTM A194, Grade 2H for nuts.
   3. Bolts and nuts for ductile iron pipe flanges submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.
   4. Bolts and nuts for buried ductile iron pipe flanges shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.
   5. Provide a washer for each nut. Washer shall be of the same material as the nut.
   6. Nuts shall be Heavy hex-head.
   7. Cut and finish flange bolts to project a maximum of 1/4 inch beyond outside face of nut after assembly.
   8. Tap holes for cap screws or stud bolts when used.

B. Plastic pipe:
   1. Bolts and nuts for flanges on plastic pipe located indoors, outdoors above ground, or in dry vaults and structures shall be hot-dip galvanized carbon steel, in accordance with ASTM A307, Grade B for bolts and in accordance with ASTM A563, Grade A for nuts.
   2. Bolts and nuts for flanges on plastic pipe submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures and plastic pipe carrying corrosive chemicals shall be-Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.

3. Provide a washer for each nut. Washer shall be of the same material as the nut.
4. Nuts shall be Heavy hex-head.
5. Cut and finish flange bolts to project a maximum of 1/4 inch beyond outside face of nut after assembly.
6. Tap holes for cap screws or stud bolts when used.

C. Steel pipe:
1. Bolts and nuts for ASME B16.5 Class 150 flanges and AWWA C207 Class D flanges located indoors, outdoors above ground, or in dry vaults and structures shall be hot-dip galvanized carbon steel, ASTM A307, Grade B for bolts and in accordance with ASTM A563, Grade A for nuts.
2. Bolts and nuts for ASME B16.5 and B16.47 Class 300 flanges and AWWA C207 Class E and F flanges located indoors, outdoors above ground, or in dry vaults and structures in accordance with ASTM A193, Grade B7 for bolts and in accordance with ASTM A194, Grade 2H for nuts.
3. Bolts and nuts for flanges submerged in water or wastewater, buried, in wet vaults or structures, adjacent to wet walls, or above open water-containing structures shall be Type 316 stainless steel in accordance with ASTM A193, Grade B8M for bolts and in accordance with ASTM A194, Grade 8M for nuts.
4. Provide a washer for each nut. Washer shall be of the same material as the nut.
5. Nuts shall be Heavy hex-head.
6. Cut and finish flange bolts to project a maximum of 1/4 inch beyond outside face of nut after assembly.
7. Tap holes for cap screws or stud bolts when used.

D. Lubricant for stainless steel bolts and nuts:
1. Chloride-free.
2. Manufacturers: One of the following or equal:
a. Huskey FG-1800.
b. Laster.

2.05 GASKETS

A. Gaskets for non-steam cleaned ductile iron and steel piping:
1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 250 degrees Fahrenheit, and raw sewage service.
2. Gasket material:
a. Neoprene elastomer with minimum Shore A hardness value of 70.
b. Reinforcement: Inserted 13-ounce nylon fabric cloth for pipes 20 inch or larger.
c. Thickness: Minimum 3/32-inch thick for less than 10-inch pipe; minimum 1/8 inch thick for 10-inch and larger pipe.
3. Manufacturers: One of the following or equal:
a. Pipe less than 20 inches in diameter:
1) Garlock, Style 7797.
2) John Crane, similar product.
b. Pipe 20 inches in diameter and larger:
1) Garlock, Style 8798.
2) John Crane, similar product.

B. Gaskets for flanged joints in polyvinyl chloride and polyethylene piping:
   1. Suitable for pressures equal and less than 150 pounds per square inch gauge, with low flange bolt loadings, temperatures equal and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
   2. Material: 0.125-inch thick Viton rubber.
   3. Manufacturers: One of the following or equal:
      a. Garlock.
      b. John Crane, similar product.

C. Gaskets for flanged joints in low pressure air piping:
   1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 300 degrees Fahrenheit, and compressed air service.
   2. Material: EPDM elastomer, 1/8 inch thick, 60 Shore hardness, smooth surface.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Style 8314.
      b. John Crane, similar product.

D. Gaskets for flanged joints in ductile iron or steel water piping:
   1. Suitable for hot or cold water, pressures equal and less than 150 pounds per square inch gauge, and temperatures equal and less than 160 degrees Fahrenheit.
   2. Material:
      a. Neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
      b. Teflon ring; or Teflon envelope with non-asbestos filler.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

E. Provide gaskets suitable for the specific fluids and pressure and temperature conditions.

2.06 LEAD LIMITS

A. Pipe, pipe or plumbing fittings or fixtures, solder, or flux used to convey water for human consumption shall be Lead-free as defined in Section 116875 of the California Health and Safety Code.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of existing conditions:
   1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions that may affect construction of underground piping before starting excavation for new underground piping and appurtenances.

2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance:
      a. Functional Testing: for watertight installations only.

3.03 INSTALLATION

A. General:
   1. Piping drawings:
      a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
      b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed:
         1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.
   2. Piping alternatives:
      a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
      b. Alternative pipe ratings:
         1) Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price.
         2) Piping of different material may not be substituted in lieu of specified piping.
      c. Valves in piping sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
      d. For grooved joints, use couplings, flange adapters, and fittings of the same manufacturer:
         1) The grooved joint manufacturer's factory trained representative shall provide on-site training for Contractor's field personnel.
         2) The representative shall periodically visit the jobsite and review Contractor is following best recommended practices in grooved product installation.
         3) A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).
      e. For flanged joints, where 1 of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

3. Unless otherwise indicated on the Drawings, piping at pipe joints, fittings, couplings, and equipment shall be installed without rotation, angular deflection, vertical offset, or horizontal offset.

B. Wall and slab penetrations:
   1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.
   2. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping:
      a. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
      b. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
      c. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
      d. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.
   3. Provide flexibility in piping connecting to structures to accommodate movement due to soil settlement and earthquakes. Provide flexibility using details indicated on the Drawings.
   4. Core drilled openings:
      a. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by Engineer.
      b. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device.
      c. Remove dust and debris from hole using compressed air.

C. Exposed piping:
   1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings:
      a. Install piping runs plumb and level, unless otherwise indicated on the Drawings:
         1) Slope plumbing drain piping with a minimum of 1/4 inch per foot downward in the direction of flow.
         2) Slope digester gas piping to drip traps or low-point drains at a minimum of 1/2 inch per foot where condensate flows against the gas, or at a minimum of 1/4 inch per foot where condensate flows with gas.
   2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.
   3. Support piping: As specified in Sections 15061 and 15062:
      a. Do not transfer pipe loads and strain to equipment.
   4. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.

5. Assemble piping without distortion or stresses caused by misalignment:
    a. Match and properly orient flanges, unions, flexible couplings, and other connections.
    b. Do not subject piping to bending or other undue stresses when fitting piping.
    c. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
    d. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
    e. Alter piping assembly to fit, when proper fit is not obtained.
    f. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

D. Buried piping:
1. Bury piping with minimum 3-foot cover without air traps, unless otherwise indicated on the Drawings.
2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench:
    a. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
3. Laying piping:
    a. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
    b. Place piping with top or bottom markings with markings in proper position.
    c. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
    d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
    e. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.
4. Concrete encase all buried pipe installed under concrete slabs or structures.

E. Venting piping under pressure:
1. Lay piping under pressure flat or at a continuous slope without air traps, unless otherwise indicated on the Drawings.
2. Install plug valves as air bleeder cocks at high points in piping:
    a. Provide 1-inch plug valves for water lines, and 2-inch plug valves for sewage and sludge lines, unless otherwise indicated on the Drawings.
3. Provide additional pipe taps with plug cocks and riser pipes along piping as required for venting during initial filling, disinfecting, and sampling.
4. Before piping is placed into service, close plug valves and install plugs. Protect plugs and plug valves from corrosion in as specified in Section 09960.

F. Restraining piping:
1. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
    a. When piping is underground, use concrete thrust blocks, mechanical restraints, or push-on restraints.

b. When piping is aboveground or underwater, use mechanical or structural restraints.
c. Determine thrust forces by multiplying the nominal cross sectional area of the piping by design test pressure of the piping.

2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
   a. During testing, provide suitable temporary restraints where piping does not require permanent restraints.
3. Place concrete thrust blocks against undisturbed soil.
4. Place concrete so piping joints, fittings, and other appurtenances are accessible for assembly and disassembly.
5. Provide underground mechanical restraints where specified in the Piping Schedule.

G. Connections to existing piping:
   1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
      a. Protect domestic water/potable water supplies from contamination:
         1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
         2) Provide devices approved by Owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
   2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
   4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

H. Connections to in-service piping:
   1. As specified in Section 01140.

I. Connections between ferrous and nonferrous metals:
   1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
   2. Nonferrous metals include aluminum, copper, and copper alloys.

J. Flanged connections between dissimilar metals such as ductile iron pipe and steel pipe:
   1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.04 CLEANING

A. Piping cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris.
   2. Perform special cleaning when required by the Contract Documents.

B. Cleaning and drying of dry chlorine gas or liquid chlorine piping:
   1. Coordinate with Owner and attend a pre-cleaning meeting with Owner before cleaning chlorine piping.
   2. Work with Owner during cleaning and conform to plant operational and shut down constraints.
   3. Clean chlorine pressure piping in accordance with the requirements of the Chlorine Institute-Pamphlet 6 and meet the following requirements.
   4. Do not put water into any of the chlorine gas or liquid piping.
   5. Blow chlorine piping clean of loose debris with compressed air at 4,000 fpm.
   6. Clean chlorine piping by pulling clean cloths saturated with an approved solvent through piping:
      a. Do not use hydrocarbons or alcohols that may react with chlorine.
      b. Use solvents in accordance with manufacturer's safety recommendations to avoid serious physiological effects.
      c. Remove all dirt and debris of any nature from the chlorine lines.
   7. Disassemble and clean valves and equipment that have oil residues before installation.
   8. Dry piping immediately before effecting final connections for service:
      a. Keep piping sealed to prevent moisture from entering chlorine piping.
      b. Supply compressors, air dryers, and dew point testing equipment necessary to dry and test for dryness the new chlorination system piping.
      c. Drying procedure:
         1) Pass dry commercial grade nitrogen gas that has a dew point of minus 40 degrees Fahrenheit or less through the piping until exhausted air at three Engineer-approved locations has a dew point of minus 40 degrees Fahrenheit.
         2) Confirm dew point with a hygrometer.
         3) Allow several hours for drying piping.
         4) Re-dry the chlorine piping system in the event subsequent work opens any part of the system to the atmosphere.

C. Cleaning chlorine piping:
   1. Clean chlorine piping by pulling clean cloths saturated an approved solvent through piping:
      a. Do not use hydrocarbons or alcohols that may react with chlorine.
      b. Use solvents in accordance with manufacturer's safety recommendations to avoid serious physiological effects.
   2. Disassemble and clean valves and equipment that have oil residues before installation.
   3. Dry piping immediately before effecting final connections for service:
      a. Keep piping kept sealed to prevent moisture from entering chlorine piping.
      b. Drying procedure shall be as follows:
         1) Pass steam through piping from the high end until piping is thoroughly heated. While steaming, allow condensate and foreign matter to drain out.
         2) Stop steaming and drain pockets and low points.
         3) While piping is hot, blow dry air through piping until piping is dry:
            a) Use dry air with a dew point of minus 40 degrees Fahrenheit or below.
         4) Continue blowing dry air through piping until exhausted air has a dew point of minus 30 degrees Fahrenheit or below.
         5) Allow several hours for drying piping.

D. Cleaning air piping:
   1. Perform special cleaning of filtered air piping from the intake clean air plenums to the discharge points and high-pressure air piping:
      a. Protect surfaces from contamination.
   2. Special cleaning shall include wire brushing, power tool cleaning, wiping down with lint-free cloths, brooming, and vacuuming to remove rust, scale, weld spatter, dust, dirt, oil, and other matter deleterious to operation of the air system:
      a. Do not sandblast installed piping.
   3. To the greatest extent possible, clean piping immediately prior to final closure of piping systems:
      a. Enter piping, clean and wipe down surfaces, and vacuum out residue.
      b. Clean surfaces not accessible to this cleaning operation after installation within 6 hours preceding installation.
   4. Subsequent to cleaning, protect surfaces from contamination by dust, dirt, construction debris, and moisture, including atmospheric moisture:
      a. Whether or not pipe upstream has been cleaned, temporarily seal openings in partially completed work except when installation is actively in progress.
      b. When installation is actively in progress, seal openings at the end of each day's construction or when construction is temporarily stopped.
   5. Suspend cleaning and seal openings when inclement weather, including dust storms, is imminent.
   6. Use clean, dry air for testing the piping and other elements of the system.
   7. Prior to introduction of air to the system, blow piping clean.
      a. Blow with maximum discharge rate possible for minimum 4 hours, using new blowers or compressors and filters.
   8. Clean surfaces that become contaminated prior to acceptance.

3.05 PIPING SCHEDULE

A. The Piping Schedule is located on the following pages:

PIPING SCHEDULE										
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**	**Comments**
AA	Aeration Air									
	Above ground - Over Aeration Basins	4 - 12	Type 304L SST	SCH10S	15286	WLD or FL	15 psig/AM	None	None	Field welding is prohibited unless approved by the Engineer
CLS	Chlorine Solution									
	Underground	1/2 - 4	CPVC, ASTM D1785	SCH 80	15259	SW or FL	125 psig/HH	None	None	Double Contained - CPVC Carrier Pipe/ PVC Containment Pipe
	Above ground	1/2 - 4	CPVC, ASTM D1786	SCH 80	15259	SW or FL	125 psig/HH	None	Per 09960	
D	Drain									
	Underground	All	PVC	SCH 80	15230	SW	100 psig /HH	None	None	
DW	Groundwater Dewatering									
	All	6 - 12	PVC, ASTM D1785	SCH 80	15230	SW	0	None	None	Perforated pipe where shown on Drawings
ML	Mixed Liquor									
	Underground	</= 12	AWWA C900	Class 150	15230	Rest B&SP	125 psig/HH	None	None	

PIPING SCHEDULE										
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**	**Comments**
	Above ground	</= 12	DIP	Class 350	15211	FL or GE	50 psig/HH	CM	Per 09960	
	Underground	> 12	Steel	AWWA C200	15278	WLD or FL	50 feet/LH	CM	CM	
	Above ground or Submerged	> 12	Steel	AWWA C200	15278	WLD or FL	50 feet/LH	CM	Per 09960	
MLR	Mixed Liquor Return									
	Submerged	All	DIP	Class 53	15211	FL	25 psig/HH	CM	Per 09960	
RAS	Return Activated Sludge									
	Underground	All	DIP	C-51	15211	MJ Rest, Rest B&SP	50 psig/HH	CM	PEE	
	Above Ground	All	DIP	C-53	15211	FL	50 psig/HH	CM	Per 09960	
SA	Service Air									
	Underground	All	Black Steel, ASTM A 53 Grade B	SCH 80	15270	SCRD, Malleable iron	100 psig/HH	None	PE tape with anodes	
	Above ground	All	Black Steel, ASTM A 53 Grade B	SCH 80	15270	SCRD, Malleable iron	100 psig/HH	None	Per 09960	
SE	Secondary Effluent									

PIPING SCHEDULE										
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**	**Comments**
	Underground	All	Steel	AWWA C200	15278	WLD or FL	50 feet/LH	CM	CM	
SSC	Secondary Scum									
	Underground	All	DIP	C-51	15211	MJ, Rest, Rest B &SP	100 psig/HH	Glass	PEE	
	Above ground	All	DIP	C-53	15211	FL	100 psig/HH	Glass	Per 09960	
	Submerged	All	304 SST	SCH 40	15286	FL or WL	50 psig/HH	None	Per 09960	
SD	Storm Drain									
	Underground	All	PVC ASTM D3034	T115	15230	B&SP	15 feet/GR	None	None	
WAS	Waste Activated Sludge									
	Underground	All	DIP	C-51	15211	MJ, Rest, or Rest B&SP.	100 psig/HH	CM	PEE	
	Above ground	All	DIP	C-53	15211	FL	100 psig/HH	CM	Per 09960	

PIPING SCHEDULE

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Comments
2W	Non-Potable Water									
	Underground	< 4	PVC	SCH 80	15230	SW	125 psig /HH	None	None	
		>/= 4	C900 PVC	150	15230	Rest B&SP	125 psig/HH	None	None	
	Aboveground	</= 3	Galvanized steel, ASTM A 53 Grade B	SCH 40	15270	SCRD or FL, 150# galvanized malleable iron	125 psi /HH	None	Per 09960	
		> 3	DIP	C-53	15211	FL	125 psig	CM	Per 09960	

Notes:

(1) All exposed piping shall be painted and/or coated in accordance with section 09960.

(2) All buried piping under concrete slabs and/or structures shall be concrete encased per Typical Detail P040, unless indicated otherwise on the drawings or in the specifications.

PIPING SCHEDULE										
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**	**Comments**

Abbreviations:

1. The following abbreviations used in the column of test method refer to the respective methods as specified in Section 15956.
   - AM Air method
   - GR Gravity method
   - HH High head method
   - LH Low head method
   - SC Special case
2. Abbreviations to designate piping include the following:
   - B&SP Bell and spigot
   - CI Cast iron
   - CISP Cast iron soil pipe
   - CL Class, followed by the designation
   - CM Cement mortar
   - CTP Coal tar pitch
   - DIP Ductile iron piping
   - EPP Epoxy polyurethane coating
   - FL Flange
   - GA Gauge, preceded by the designation
   - GE Grooved end joint
   - GL Glass lined
   - GSP Galvanized steel pipe
   - MJ Mechanical joint
   - NPS Nominal pipe size, followed by the number in inches
   - psi pounds per square inch
   - psig pounds per square inch gauge
   - PE Polyethylene
   - PEE Polyethylene encasement
   - PTW Polyethylene tape wrap
   - PVC Polyvinyl Chloride
   - SCH Schedule, followed by the designation
   - SCRD Screwed-On
   - SST Stainless steel
   - SW Solvent welded
   - VCP Vitrified clay piping
   - WLD Weld

END OF SECTION

SECTION 15058

PLASTIC LINER FOR CONCRETE PIPE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Plastic liner for concrete pipe.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 412 - Rubber Properties in Tension.

1.03 PERFORMANCE REQUIREMENTS

A. Plastic liner:
   1. Impermeable to sewage gases and liquids.
   2. Nonconductive to bacterial and fungus growth.
   3. Impact resistant.
   4. Flexible.
   5. Have elongation sufficient to bridge up to 1/8-inch settling cracks.
   6. Attached to concrete by T-lock mechanism.
   7. Adhesive bond not allowed unless otherwise indicated on the Drawings specific locations.
   8. Withstand 15 pounds per square inch back hydrostatic pressure applied to liners under surface without losing anchorage and without rupture and leakage.

1.04 SUBMITTALS

A. General: Submit as specified in Section 01330.

B. Submit:
   1. Fabrication drawings.
   2. Product data.
   3. Samples.

4. Manufacturer's installation instructions.
5. Design data.
6. Test reports.
7. Certificates.
8. Manufacturer's field reports.
9. Spark type detector proposed for testing.

C. Fabrication drawings: Indicate the following:
1. Dimensions.
2. Materials.
3. Details of construction.
4. Location and type of field welds.

D. Fabrication drawings: Indicate materials, dimensions, details of construction; proposed layout of liner sheets for cast-in-place structures; location and type of field welds; installation details of how piping will be lined, and how returns, corners, joints, and coverage will be accomplished.

E. Product data: Submit manufacturer's literature and illustrations for all components indicating size, dimensions, and configuration. Include manufacturer's installation instructions.

F. Samples:
1. 12-inch by 12-inch plastic liner.
2. All joint and weld strips.

G. Design data.

H. Test reports.

I. Certificates.

J. Manufacturer's field reports.

K. Spark type detector proposed for testing.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: Minimum 5 years experience manufacturing specified product, with satisfactory performance record.

B. Installer qualifications: Manufacturer-approved installer of products similar to specified products on minimum 3 projects of similar scope as Project with satisfactory performance record.

C. Qualifications of welders:
1. Welder shall prequalify by successfully passing welding test before performing welding of liner.
2. Re-qualification may be required.
3. Make test welds in presence of Engineer.
4. Submit weld specimen for testing.

5. Welding test procedure:
    a. Lap 2 minimum, 15-inch long by 9-inch wide pieces of liner 1-1/2 inches along longer edge.
    b. Hold pieces of liner vertically.
    c. Position minimum 19-inch long welding strip over edge of lap with 2-inch tabs at top and bottom.
    d. Weld strip to both pieces of liner.
6. Engineer will test welds as follows:
    a. Test each welding strip tab separately.
    b. Apply 10-pound pull normal to face of liner with liner being held firmly in place.
    c. Pull test results:
        1) Satisfactory: No separation between welding strip and liner when tested.
    d. Cut 3 test specimens from welded sample.
    e. Test specimens for tension across welds.
    f. Tension test results:
        1) Satisfactory: No failed specimen.
        2) Retest: 1 failed specimen.
        3) Disqualified: More than 1 failed specimen.
    g. Retest:
        1) Test 3 additional specimens cut from original welded sample.
        2) Satisfactory: No failed retest specimen.
7. Disqualified welders may submit new welding samples when disqualified welders have had sufficient off-the-job training or experience to warrant re-examination.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following or equal:
    1. Ameron, T-Lock Amer-Plate.

2.02 MATERIALS

A. Field sheets:
    1. Material: Polyvinyl chloride.
    2. Thickness: 60 mils.
    3. Manufactured from inert products combined with synthetic resins, pigments, and plasticizers.
    4. Color: White.

B. Performance characteristics:
    1. Chemical resistance: Resistant to oxidizing agents; sulfuric, phosphoric, nitric, chromic, oleic, and stearic acids; sodium and calcium hydroxides; ammonia, sodium, calcium, magnesium, and ferric chlorides; ferric sulfate, petroleum oils and greases; vegetable and animal oils, fats, greases, and soaps.
    2. Permeability to sewer gases and liquids: None.
    3. Conductivity to bacterial and fungus growth: None.

4. Elongation: Sufficient to bridge up to 1/8-inch cracks without damage to the lining.
5. Repairability: Repairable during lifetime of pipe.
6. Tensile strength: Maximum 2,200 pounds per square inch initially and 2,100 pounds per square inch after 112 days when tested in accordance with ASTM D 412, Die B.
7. Elongation at break: Minimum 200 percent initially and after 112 days when tested in accordance with ASTM D 412, Die B.
8. Durometer hardness: From 50 to 60 Type D Shore initially and from 35 to 50 Type D Shore Durometer after 112 days when tested in accordance with ASTM D 412, Die B.
9. Locking extension embedment: Capable of withstanding a pull of 100 pounds per linear inch applied perpendicularly to concrete surface for 1 minute without rupture of liner anchor and without withdrawal of liner anchor from concrete when tested at between 70 and 80 degrees Fahrenheit.
10. Back pressure resistance: Minimum 40 pounds per square inch without losing anchorage of liner anchors, or rupturing or liner without need of bonding adhesive or adhesive bond of concrete.

C. Joint welding strips: Same material as liner without liner anchors; approximately 1-inch, minimum 7/8-inch wide; with beveled edges.

D. Liner patches: Same material as liner without liner anchors.

E. Liner adhesive: As recommended by liner manufacturer.

2.03 FABRICATION

A. Integrally mold with heat and pressure or extrude T-shaped and L-shaped liner anchors on back of liner, capable of providing stability under anticipated loads including loads imposed by steel bands and wires used to secure liner to forms.

B. Provide L-shaped liner anchors at edges of liner. Provide T-shaped liner anchors in field of liner.

C. Locate first line of ribs at 2-1/2 inches from ends of end liner anchors.

D. Leave minimum 1-inch wide gaps for the full height of ribs.

E. Center ribs between liner anchors.

F. Provide transverse reinforcement to keep ribs stable under loads.

G. Heat weld joints continuously with welding strips to form pipe size sheets.

H. Extend integrally molded joint strips approximately 3 inches beyond end of pipe.

2.04 SOURCE QUALITY CONTROL

A. Reject liners, including liner anchors, joint strips, corner strips, and welding strips, that have cracks, cleavages, and other defects that adversely affect the protective characteristics of liners.

B. Check liners electrically to determine presence of porosity or pin holes:
   1. Reject liners with porosity or pinholes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install liner in accordance with manufacturer's recommendations.

B. Install liner in upper 270 angular degrees of pipe interior.

C. Do not nail through liner.

D. Install liner with liner anchors parallel with longitudinal axis of pipe.

E. Hold liner snugly in place against inner forms with light gauge steel wire, light steel banding straps, or other suitable means.

F. Set liner flush with inner edges of bells or grooved ends of pipe and extend to spigot or tongue end or to approximately 3 inches beyond tongue ends, depending upon the type of liner of the adjoining pipe.

G. Where lined pipe joins unlined pipe, such as brick structures, concrete pipe, cast-in-place structures, or clay pipe, extend enough liner to go over and around ends of pipe and back into the structure for a minimum of 4 inches.

H. Where unlined pipe spurs are installed through lined pipe, extend enough liner to return liner a minimum of 3 inches from surface of contact:
   1. Seal liner and spur with an acceptable adhesive.
   2. Where joint spaces are too wide or joint space surfaces too rough to allow satisfactory sealing with adhesive, fill joint spaces with 2 inches of densely caulked lead wool or other accepted caulking material.

3.02 PLASTIC LINER REPAIRS

A. Patch liner defects in accordance with liner manufacturer's published instructions.

B. Patch small defects, such as nails, form tie holes, and small repairs and abraded areas, by fusing welding strips over defects to liner.

C. Patch larger defects by adhering smooth liner patches over defects, plus minimum 1-inch around defects, to liner with adhesive, centering welding strips over edges of patches, and fusing welding strips to liner and patches.

D. Cut out bubbles less than 2 inches in greatest dimension, adhere smooth liner patches over cut out areas plus minimum 1 inch around defects with adhesive, centering welding strips over edges of patches, and fusing welding strips to liner and patches:
   1. Reject pipe with larger bubbles.

3.03 CONCRETE OPERATIONS

A. Concrete placement:
   1. Carefully vibrate concrete placed against liner to avoid damage to liner and to produce dense, homogeneous concrete securely anchoring locking extensions into concrete.
   2. Use external vibrators in addition to internal vibrators, particularly along lower terminal edge of plastic liner.

B. Removing forms:
   1. In removing forms, protect liner from damage.
   2. Do not use sharp instruments to pry forms from lined surfaces.

3.04 FIELD JOINTING OF LINER

A. General:
   1. Make no field joint in liner until structure has been backfilled and 30 days have elapsed.
   2. Where groundwater is encountered, do not make joint until pumping of groundwater has been discontinued for at least 30 days and no visible leakage is evident at joint.
   3. Liner at joints shall be free of mortar and other foreign materials and shall be clean and dry before joints are made.
   4. Do not bring hot joint compound in contact with liner.
   5. Do not apply coating over joints, corners, or welding strips.

B. Field joints in cast-in-place structures shall be one of following types:
   1. Type C-1:
      a. Make joints with 4-inch joint strips, and secured along each edge to adjacent liner by welding strips.
      b. Gaps between ends of lock extensions shall not exceed 4 inches.
      c. Width of spaces between adjacent sheets of liner shall not exceed 1/2 inch.
      d. Use joint at transverse contraction joints in concrete.
   2. Type C-2:
      a. Make joints by overlapping sheets not less than 1-1/2 inches and securing overlaps to adjacent liner with welding strips.
      b. Upstream sheet shall overlap downstream sheet.
      c. Length of overlapping sheet parts without locking extensions shall not exceed 4 inches.
      d. Apply welding strips to back of joint.
      e. Use joint at longitudinal joints in concrete and transverse liner joints other than at transverse contraction joints in concrete.
   3. Type C-3:
      a. Make joints by putting sheets of liner together and applying welding strips over back of joints before concrete is poured, and applying welding strips over front of joint, after concrete is poured.
      b. Do not use this type of joint at transverse joints which extend to lower terminal edges of liner or at joints where gaps between adjoining sheets of liner exceed 1/8 inch.

C. Installation of welding strips:
   1. Employ qualified welders to fusion weld welding strips to joint strips and liner.
   2. Continuously weld joint in one operation until joint has been completed.
   3. At lower terminal edges of liner, extend each transverse welding strip at least 2 inches to provide tabs.
   4. Engineer may test each transverse weld by applying 10-pound pull to tab, normal to face of structure.
   5. Hold liner adjoining welding strip in place during application of force.
   6. When weld failure develops, maintain 10-pound pull until no further separation occurs.
   7. Defective welds will be retested after repairs have been made.
   8. Trim tabs away neatly after welding strip has passed test.

D. Joint reinforcement:
   1. Apply 12-inch long welding strips as reinforcement across transverse joints in liner which extends to lower terminal edge of liner on each side structure.
   2. Center reinforcement strips over joint being reinforced, locating as close to lower edge of liner as practicable.
   3. Weld reinforcement strips in place after transverse welding strips have been tested and test tabs removed.

3.05 FIELD QUALITY CONTROL

A. Provide equipment required to test liner in accordance with manufacturer's published instructions and as follows.

B. Polyvinyl chloride liner pull test:
   1. Perform test on a minimum of 1 pipe section for each 400 feet of pipe produced for the project.
   2. Perform test in a location within 2 feet of the end of the pipe that was up during the manufacturing process.
   3. When one pipe section fails the liner pull test, test 2 other pipe sections from the same manufacturing run as the failed section:
      a. If both additional pipe sections satisfactorily pass the pull test, the remainder of the pipe in that manufacturing run will be accepted.
      b. This acceptance is conditional upon satisfactory completion of the other pull tests specified under Polyvinyl Chloride Liner Pull Test.
      c. If either of the additional pipe sections fail the pull test, the remainder of the pipe sections produced in that manufacturing run shall be subjected to the pull test.

C. After pipe installation, test surfaces of liner with electrical holiday detector with the instrument set at 15,000 volts.

D. Physically test welds by non-destructive probing.

E. Testing liner welds:
   1. Provide welding strips for testing liner welds:
      a. Extended welding straps 2 inches below liner to form a tab.
   2. Apply a 10-pound pull normal to faces of pipe with spring balances.
   3. Hold liner adjoining welding strips against concrete during application of force.

4. Maintain 10-pound pull where weld failures develop until further separation does not occur.
5. Repair defective welds then repeat test procedure.
6. Test repaired welds until no longer defective.
7. Trim tabs away neatly after successful testing of weld strips.

3.06 PROTECTION AND REPAIR

A. Take necessary measures and precautions to prevent damage to liner from equipment and materials used in, or taken through Work.

B. Repair damage to installed liner as follows:
   1. Patch nail and tie holes and cuts, tears, and abraded areas.
   2. Fuse patches made entirely with welding strip to liner over entire patch:
      a. Limit use of this method to patches which can be made with single welding strip.
   3. Do not use parallel, overlapping, or adjoining welding strips.
   4. Larger patches may consist of smooth liner over damaged area with edges covered with welding strips fused to patch and to liner adjoining damaged area.
   5. Limit width of single patch of latter type to 4 inches.

END OF SECTION

SECTION 15061

PIPE SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Supports for pipe, fittings, valves, and appurtenances.

B. Related sections:
   1. Section 01410 - Regulatory Requirements.
   2. Section 01756 - Commissioning.
   3. Section 05120 - Structural Steel.
   4. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   3. A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

B. Manufacturer's Standardization Society (MSS):
   1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.

1.03 SUBMITTALS

A. Shop drawings: Include schedule, indicating where supports will be installed, and drawings of pipe support system components.

B. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756.

C. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Hot dip galvanized:
      a. Fabricate as specified in Section 05120.
      b. Hot dip after fabrication of support in accordance with ASTM A123.
      c. Repair galvanized surface as specified in Section 05120.
   2. Stainless steel.
      a. Fabricate as specified in Section 05120.

b. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.
c. At the shop, perform pickling and passivation on all surfaces inside and out in accordance with ASTM A380 or A967:
1) Passivation treatments using citric acid are not allowed.
d. Field welding is prohibited unless specifically allowed by the Owner. All field welds shall be passivated.

B. Outdoor areas: Areas exposed to the natural outdoor environment:
1. Hot Dip Galvanized.

C. Indoor areas: Areas exposed to an indoor environment including galleries and tunnels:
1. Hot Dip Galvanized.

D. Submerged, 3 feet or less above water level in a structure, or inside a water bearing structure:
1. Type 316L Stainless Steel.

E. Stainless steel piping system:
1. Type 316L Stainless Steel.

F. Chemical containment areas and chemical piping:
1. Type 316L Stainless Steel.

G. Fasteners:
1. As specified in Section 05120.

2.02 PIPE SUPPORTS

A. Hanger rods: Sized to match suspended pipe hanger, or as indicated on the Drawings:
1. Manufacturers: One of following or equal:
a. For stainless steel piping:
1) Bergen-Power, Figure 133.
2) Nibco-Tolco, Figure 103.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 140.
2) Bergen-Power, Figure 133.
3) Cooper B-Line Systems, Inc., Figure B3205.

B. Hanger rods, continuously threaded: Sized to match suspended pipe hanger, or as indicated on the Drawings:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Bergen-Power, Figure 94.
2) FM Stainless Fasteners.
b. For steel and ductile iron piping:
1) Anvil International, Figure 146.
2) Bergen-Power, Figure 94.

C. Eye bolts:
   1. For stainless steel piping:
      a. Type 316 stainless steel, welded and rated equal to full load capacity of rod.
   2. For all other piping, unless indicated on the Drawings:
      a. Welded and rated equal to full load capacity of rod.

D. Welded eyebolt rod:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 101.
         2) FM Stainless Fasteners.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 278.
         2) Bergen-Power, Figure 93.
         3) Cooper B-Line Systems, Inc., Figure B3210.

E. Adjustable ring hangers: MSS SP-58, Type 7 or Type 9 (system dependent):
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 1C.I.
         2) Bergen-Power, Figure 100SS.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 97.
         2) Cooper B-Line Systems, Inc., Figure B3172.

F. Adjustable clevis hangers: MSS SP-58, Type 1:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Cooper B-Line Systems, Inc., Figure B3100 or B3102.
         2) FM Stainless Fasteners, Figure 60.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 260 or Figure 590.
         2) Bergen-Power, Figure 100.
         3) Cooper B-Line Systems, Inc., Figure B3100 or B3102.

G. Adjustable clevis hangers for insulated pipe: Oversize:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 1A.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 300.
         2) Bergen-Power, Figure 100EL.
         3) Cooper B-Line Systems, Inc. Figure B3108.

H. Single rod hangers for steam pipe: MSS SP-58, Type 43; malleable iron or steel yoke and roller hangers; swivel to allow rotation of yoke on rod:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 324.
         2) Cooper B-Line Systems, Inc., Figure B3110.
         3) FM Fasteners, Figure 81.

b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 181.
2) Cooper B-Line Systems, Inc., Figure B3110.

I. Double rod hangers for steam pipe: MSS SP-58, Type 41:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) FM Stainless Fasteners, Figure 71.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 171.
2) Cooper B-Line Systems, Inc., Figure B3114.

J. Brackets: MSS SP-58, Type 32 with back plate; rated for 1,500 pounds:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Nibco-Tolco, Figure 30M.
2) Cooper B-Line Systems, Inc., Figure B3066.
3) FM Stainless Fasteners, Figure 98.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 195.
2) Cooper B-Line Systems, Inc., Figure B3066.

K. Brackets, heavy duty: MSS SP-58, Type 33 with back plate; rated for 3,000 pounds:
1. Manufacturers: One of following or equal:
a. Anvil International, Figure 199.
b. Cooper B-Line Systems, Inc., Figure B3067.

L. Standard U-bolt: MSS SP-58, Type 24:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Nibco-Tolco, Figure 110.
2) Cooper B-Line Systems, Inc., Figure B3188.
3) FM Stainless Fasteners, Figure 37.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 137.
2) Bergen-Power, Figure 283.
3) Cooper B-Line Systems, Inc., Figure B3188.

M. Riser clamps: MSS SP-58, Type 8:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure B3373.
2) FM Stainless Fasteners, Figure 61.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 261.
2) Bergen-Power, Figure 126.
3) Cooper B-Line Systems, Inc., Figure B3373.

N. Pipe clamps: MSS SP-58, Type 4:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 4.
         2) Cooper B-Line Systems, Inc., Figure 3140.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 212.
         2) Bergen-Power, Figure 175.
         3) Cooper B-Line Systems, Inc., Figure B3140.

O. Adjustable offset pipe clamp:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 4.
         2) Cooper B-Line Systems, Inc., Figure B3149.
         3) FM Stainless Fasteners, Figure 63.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 100.
         2) Cooper B-Line Systems, Inc., Figure B3149.

P. Offset pipe clamp:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 8.
         2) Cooper B-Line Systems, Inc., Figure 3148.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 103.
         2) Cooper B-Line Systems, Inc., Figure B3148.

Q. Floor stand or stanchion saddles: MSS SP-58, Type 37. Provided with U-bolt hold down yokes:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 318.
         2) FM Stainless Fasteners, Figure 59.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 259.
         2) Bergen-Power, Figure 125.
         3) Cooper B-Line Systems, Inc., Figure B3090.
      c. Threaded pipe stand support stanchion. Match pipe support material:
         1) Anvil International, Figure 63T.
         2) Bergen-Power, Figure 138.
         3) Cooper B-Line Systems Inc., Figure B3088ST.

R. Spring hangers:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Bergen-Power, Figure 920.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure B-268, Type G.
         2) Bergen-Power, Figure 920.

S. One hole pipe clamps:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Not used.
        b. For all other piping:
            1) Anvil International, Figure 126.
            2) Carpenter & Paterson, Figure 237S.

T. Welded beam attachment: MSS SP-58, Type 22:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 304.
            2) Cooper B-Line Systems, Inc., Figure 3083.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 66.
            2) Bergen-Power, Figure 113A or 113B.
            3) Cooper B-Line Systems, Inc., Figure B3083.

U. Heavy pipe clamp: MSS SP-58, Type 4:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 4H.
        b. For all other piping, unless called out otherwise on the Drawings:
            1) Anvil International, Figure 216.
            2) Bergen-Power, Figure 298.

V. PTFE pipe slide assembly: MSS SP-58, Type 35 with lateral and vertical restraint:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 426.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 257, Type 3.
            2) Cooper B-Line Systems, Inc., Figure B3893.

W. Anchor bolts, concrete anchors, concrete inserts, powder-actuated fasteners, and sleeve anchors: As specified in Section 05120.

PART 3 EXECUTION

3.01 INSTALLATION

A. Support, suspend, or anchor exposed pipe, fittings, valves, and appurtenances to prevent sagging, overstressing, or movement of piping; and to prevent thrusts or loads on or against connected pumps, blowers, and other equipment.

B. Field verify support location, orientation, and configuration to eliminate interferences prior to fabrication of supports.

C. Carefully determine locations of inserts. Anchor to formwork prior to placing concrete.

D. Use flush shells only where indicated on the Drawings.

E. Do not use anchors relying on deformation of lead alloy.

F. Do not use powder-actuated fasteners for securing metallic conduit or steel pipe larger than 1 inch to concrete, masonry, or wood.

G. Suspend pipe hangers from hanger rods and secure with double nuts.

H. Install continuously threaded hanger rods only where indicated on the Drawings.

I. Use adjustable ring hangers or adjustable clevis hangers, for 4 inch and smaller diameter pipe.

J. Use adjustable clevis hangers for pipe larger than 4 inches in diameter.

K. Secure pipes with double nutted U-bolts or suspend pipes from hanger rods and hangers:
   1. For stainless steel piping, use stainless steel U-bolts.
   2. For all other piping, use galvanized U-bolts.

L. Support spacing:
   1. Support 2-inch and smaller piping on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.
   2. Support larger than 2-inch piping on horizontal and vertical runs at maximum 10 feet on center, unless otherwise specified.
   3. Support exposed polyvinyl chloride and other plastic pipes at maximum 5 feet on center, regardless of size.
   4. Support tubing, PVC pipe 1-inch and smaller, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing at intervals close enough to prevent sagging greater than 1/4 inch between supports.
   5. Do not suspend or support valves, pipe and fittings from another pipe or conduit.

M. Install supports at:
   1. Any change in direction.
   2. Both sides of flexible pipe connections.
   3. Base of risers.
   4. Floor penetrations.
   5. Connections to pumps, blowers, and other equipment.
   6. Valves and appurtenances.

N. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

O. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

P. Provide elbows or tees supported from floors with base fittings where indicated on the Drawings.

Q. Support base fittings with metal supports or when indicated on the Drawings support on concrete piers.

R. Do not use chains, plumbers' straps, wire, or similar devices for permanently suspending, supporting, or restraining pipes.

S. Support plumbing drainage and vents in accordance with plumbing code as specified in Section 01410.

T. Supports, clamps, brackets, and portions of support system bearing against copper pipe: Copper plated, copper throughout, or isolated with neoprene or polyvinyl chloride tape.

U. Where pipe is insulated, install over-sized supports and hangers.

V. Install insulation shield in accordance with MSS SP-58, Type 40. Shield shall be galvanized steel unless otherwise specified or indicated on the Drawings.

W. Install riser clamps at floor penetrations and where indicated on the Drawings.

X. Coat support system components as specified in Section 09960.

3.02 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. Manufacturer services for each type of pipe support:
   1. Provide Manufacturer’s Certificate of Source Testing.
   2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance.

END OF SECTION

SECTION 15062

PREFORMED CHANNEL PIPE SUPPORT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preformed channel pipe support system consisting of preformed channels, fittings, straps, and fasteners engineered to support piping.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01612 - Seismic Design Criteria.
   3. Section 01756 - Commissioning.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC).

B. American Iron and Steel Institute (AISI).

C. Manufacturer's Standardization Society (MSS):
   1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.
   2. SP-69 - Pipe Hangers and Supports - Selection and Application.

1.03 SYSTEM DESCRIPTION

A. Design responsibility:
   1. The manufacturer of the preformed channel pipe support system is responsible for the design of the support system.
   2. Prepare design calculations utilizing the design criteria included in these Specifications.
   3. Prepare detailed shop drawings illustrating the layout of the support system and identifying the components of the support system.

B. Design criteria:
   1. Include live, dead, and seismic loads associated with piping, valves, and appurtenances. Consider the content of the pipes in load calculations.
   2. Minimum gauge thickness: 12-gauge.
   3. Allowable stress of channels:
      a. Steel channels: The lesser of 25,000 pounds per square inch, or 0.66 times yield stress of steel.
      b. Stainless steel channels: 0.66 times the yield stress of the stainless steel alloy.
   4. Maximum deflection: 1/240 of span.
   5. Allowable column loads: As recommended by manufacturer in published instruction for column's unsupported height and "K" value for calculating effective column length of not less than 1.0.

6. Future loads:
    a. Support systems indicated on the Drawings may include spaces intended to accommodate future pipes.
    b. Assume such spaces are occupied by 6-inch diameter ductile iron pipes. Only the number of pipes that would physically fit into the space need be considered.
    c. Include the weight of the pipe contents in determining future loads. Assume pipe contents are water.
7. Seismic design criteria: As specified in Section 01612 as specified for mechanical equipment.
8. Spacing of supports: As required to comply with design requirements but not more than 5 feet.

C. Supports below the top of walls of water bearing structures: Use Type 316 stainless steel for support system components:
    1. Supports in other locations: Use hot-dipped galvanized components unless other materials are specifically indicated on the Drawings.

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Shop drawings: Include layout of support system including pipe loads, selected channel size, fittings, and appurtenances.

C. Structural design calculations.

D. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756.

E. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.05 QUALITY ASSURANCE

A. Design preformed channel pipe support system for loads in accordance with applicable provisions of:
    1. AISC Manual of Steel Construction.
    2. AISI Cold-Formed Steel Design Manual.

B. Product standards:
    1. Pipe support components: In accordance with MSS SP-69.
    2. Pipe support materials: In accordance with MSS SP-58.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fabricate preformed channel pipe support system using, as a minimum, parts specified below and meeting the requirements specified under Design Criteria:
    1. Manufacturers: One of the following or equal:
        a. Unistrut, Series P1000 or P1001; P5500 or P5501.

b. Allied Support Systems, Power Strut, Figure PS-200 or PS-200 2TS; PS-150 or PS-150 2TS.
c. Cooper Industries, B-Line, Channel Type B22 or B22A; B12 or B12A.

2.02 ACCESSORIES

A. Preformed channel concrete inserts: Minimum 12 inches long:
1. Manufacturers: One of the following or equal:
a. Unistrut, Series P-3200.
b. Allied Support Systems, Figure 282.
c. Cooper Industries, B-Line Series B32I.

B. 90-degree angle fittings:
1. Manufacturers: One of the following or equal:
a. Unistrut, P1026.
b. Allied Support Systems, Power Strut, P603.

C. Pipe straps:
1. For pipes 8 inches in diameter and smaller: Use 2-piece universal strap with slotted hex head screw and nut:
a. Manufacturers: One of the following or equal:
1) Unistrut, Series P1109 through P1126.
2) Allied Support Systems, PS1100.
3) Cooper Industries, B-Line Series B2000.
2. For pipes greater than 8 inches in diameter: Unless different material is otherwise indicated on the Drawings use 1-piece 1 inch wide by 1/8 inch thick steel strap, hot-dip galvanized after fabrication.
3. For stainless steel pipes: Use type of strap required for the pipe sizes specified above, but use Type 316 stainless steel materials.

D. Prefabricated double channel bracket:
1. Manufacturers: One of the following or equal:
a. Unistrut, P2542-P2546.
b. Cooper Industries, B-Line Series B297.

E. Touch-up paint for galvanized surfaces:
1. Manufacturers: One of the following or equal:
a. Galvinox, Galvo-Weld.

F. Touch-up paint for painted surfaces: Same formulation as factory paint.

2.03 FABRICATION

A. Hot-dip galvanize support system components after fabrication to required length and shape.

B. Do not galvanize or paint stainless steel components.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install preformed channel concrete inserts for vertical support, quantity based on manufacturer's structural design calculations.

B. Fasten preformed channel pipe supports to existing walls using Z-fittings and concrete anchors as indicated on the Drawings.

C. Fasten preformed channel pipe supports to preformed channel concrete inserts embedded in ceiling using U-shaped fittings.

D. Suspend threaded rods from concrete inserts embedded in ceiling. Support preformed channel pipe supports with threaded rods.

E. Touchup cut or damaged galvanized surfaces.

F. Prevent contact between pipes and support components of dissimilar metals. Utilize rubber coated, plastic coated, or vinyl coated components, stainless steel components, or wrap pipe with PVC or polyethylene tape.

G. Install support as near as possible to concentrated loads.

H. Install support within 2 feet of horizontal and vertical changes in pipe alignment.

I. Adjust supports or install shims to obtain specified slope or elevation.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer’s Certificate of Source Testing.
   2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance.

END OF SECTION

SECTION 15075

EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Equipment nameplates.
   2. Special items.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01600 - Product Requirements.
   3. Section 01756 - Commissioning.
   4. Section 01770 - Closeout Procedures.
   5. Section 09960 - High-Performance Coatings.

1.02 SUBMITTAL

A. Submit as specified in Section 01330.

B. Shop Drawings:
   1. Product data.
   2. Installation instructions.

C. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756.

D. Samples.

E. Submit following as specified in Section 01770:
   1. Warranty.

PART 2 PRODUCTS

2.01 EQUIPMENT NAMEPLATES

A. Material and fabrication:
   1. Stainless steel sheet engraved or stamped with text, holes drilled, or punch for fasteners.

B. Fasteners:
   1. Number 4 or larger oval head stainless steel screws or drive pins.

C. Text:
   1. Manufacturer's name, equipment model number and serial number, identification tag number; and when appropriate, drive speed, motor horsepower with rated capacity, pump rated total dynamic head, and impeller size.

2.02 SPECIAL ITEMS

A. In addition, special coating of following items will be required:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and black stripes
Steel guard posts	In accordance with standard details

B. Paint minimum 2 inches high numbers on or adjacent to accessible valves, pumps, flowmeters, and other items of equipment which are indicated on the Drawings or in Specifications by number.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01600.

3.02 PREPARATION

A. Prepare and coat surfaces of special items as specified in Section 09960.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. As specified in Section 01756 and this Section.

END OF SECTION

SECTION 15076

PIPE IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pipe identification including the following:
   1. Pipe identification by color and legend.
   2. Underground warning tape.
   3. Tracer wire.
   4. Witness markers.
   5. Valve identification.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.
      b. Section 01600 - Product Requirements.
      c. Section 01770 - Closeout Procedures.
      d. Section 09960 - High-Performance Coatings.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit as specified in Section 01330.

B. Submit following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following as specified in Section 01770:
      a. Operation and Maintenance Data.
      b. Warranty.

PART 2 PRODUCTS

2.01 ABOVE GROUND AND IN-CHASE PIPE IDENTIFICATION

A. Manufacturers:
   1. One of the following or equal:
      a. Seton, Opti Code Pipe Markers.
      b. Lab Safety Supply.
      c. Marking Services, Inc.

B. Materials:
   1. Pipe markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.
      a. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5	1/2 inch
1.5 inches to 2 inches	3/4 inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

      b. Marker colors:
         1) See schedule in Part 3, if not identified use the following:

Service	Lettering	Background
Flammables, chemicals, toxics	Black	Yellow
Water, nontoxic solutions or low hazard liquids	White	Green
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO_2 Halon)	White	Red

   2. Coating: As specified in Section 09960.
   3. Pipe identification tags: Aluminum or stainless steel with stamped-in 1/4 inch high identifying lettering.
   4. Pipe identification tag chains: Aluminum or stainless steel.
   5. Snap-on markers: Markers with 3/4 inch high letters for 3/4 to 4 inch pipe or covering, or 5 inch high letters for 5 inch or larger pipe or cover, as manufactured by one of following:
      a. Brady Bradysnap-On B-915.
      b. Seton Setmark.

2.02 BURIED PIPELINE IDENTIFICATION

A. Underground warning tape:
   1. Manufacturer: One of the following or equal:
      a. Seton Name Plate Company, Branford, CT.
      b. T. Christy Enterprises, Inc.

2. Material:
    a. Polyethylene tape for prolonged underground use.
    b. Minimum tape thickness: 4 mils.
    c. Overall tape width: 6 inches.
    d. Message: “CAUTION” with the name of the service followed by “LINE BURIED BELOW.” in black lettering on colored background in accordance with approved APWA colors:
        1) Water: Blue.
        2) Sewer: Green.
        3) Telephone: Orange.
        4) Gas and other services: Yellow.
    e. Aluminum backing.

B. Tracer wire:
    1. Manufacturers: One of the following or equal:
        a. Kris-Tech Wire.
        b. Corrpro.
    2. Materials: One of the following or equal:
        a. Solid copper conductor with 30 mil HMWPE.
        b. 10 gauge or thicker wire.
        c. Match insulation color to the color of the pipe being installed.

C. Witness markers:
    1. Manufacturers: One of the following or equal:
        a. Carsonite Composites, Utility Marker.
        b. Hampton Technical Associates, Inc.
    2. Materials:
        a. Glass fiber and resin reinforced thermosetting composite material.
        b. UV resistant.
    3. Constructed as a single piece.
    4. Pointed at the bottom end.
    5. Information to be included on the marker:
        a. “Caution” (type of service) “Pipeline”.
        b. Phone number for Underground Service Alert.
        c. Phone number for Owner in case of emergency.
        d. Station number.
        e. Offset:
            1) Only provide offset if marker is not directly over the pipe.
        f. Name of appurtenance or fitting (e.g. 45, BO, ARV etc.).

2.03 VALVE IDENTIFICATION

A. The Contractor shall furnish and install tags for all valves and gates required for the Work:
    1. Tags shall be 2-in diameter round, stainless steel or PVC for buried applications.
    2. Tags shall be furnished with a non-corrosive metal wire suitable for attaching the tag to the operator base.
    3. Tags shall be stamped in 1/4-inch high letter:
        a. Tags shall not be attached in such a way as to inhibit the operation of the valve or gate.

4. Buried valve tags shall be secured to concrete s with the specified valve or gate number.
5. Submit 2 samples of the type of tag proposed and the manufacturer's standard color chart and letter styles to the Engineer for review.
6. Manufacturer: The following or equal:
   a. Seton Name Plate Company, Branford, CT.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01600.

3.02 PREPARATION

A. Prepare and coat surfaces as specified in Section 09960.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 ABOVE GROUND AND IN-CHASE PIPING IDENTIFICATION

A. Identify exposed piping, valves, and accessories and piping, valves, and accessories in accessible chases with lettering or tags designating service of each piping system with flow directional arrows and color code.

B. Color code:
   1. Paint all piping with colors as scheduled in Piping Color Code and Marker Schedule.

C. Lettering and flow direction arrows:
   1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4 inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.
   2. Provide lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.

D. Where scheduled, space 6-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.

E. Label chemical tank fill pipelines at locations which are visible from chemical fill stations.

F. Metal tags:
   1. Where outside diameter of pipe or pipe covering is 5/8 inch or smaller, provide metal pipe identification tags instead of lettering.
   2. Fasten pipe identification tags to pipe with chain.
   3. Where tags are used, color code pipe as scheduled.

3.04 BURIED PIPING IDENTIFICATION

A. Underground warning tape:
   1. Place continuous run of warning tape in pipe trench, 12 inches above the pipe.

B. Tracer wire:
   1. Install on all non-metallic pipe.
   2. Install an electrically continuous run of tracer wire along the entire length of the pipe with wire terminations in valve boxes, vaults, or structures.
   3. Install tracer wire on top of the pipe and secure to pipe with tape a minimum of every 10 feet.
   4. Where approved by the Engineer, splice sections of wire together using approved direct bury wire nuts:
      a. Twisting the wires together is not acceptable.

C. Witness markers:
   1. Install over pipe in unpaved open-space areas at intervals not greater than 200 feet.
   2. Place markers at appurtenances located in unpaved areas.
   3. Embed markers at least 18 inches into the soil.

3.05 APPLICATION

A. Identify piping with legend markers, directional arrow markers, and number markers; use self-adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

B. Provide legend markers, directional arrow markers, and number markers where piping passes through walls or floors, at piping intersections and at maximum 15 foot spacing on piping runs.

C. Provide piping marker letters and colors as scheduled.

D. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.

3.06 PIPING COLOR CODE AND MARKER SCHEDULE

Service Fluid	Pipe Color	Marker Legend
Aeration Air	Green	AERATION AIR
Drain	Charcoal	DRAIN
Chlorine Solution	Yellow	CHLORINE SOLUTION
Mixed Liquor	Brown	MIXED LIQUOR
Pumped Drain	Charcoal	PUMPED DRAIN
3W	Purple	3W
Return Activated Sludge	Brown	RAS
Sample	Green	FLUID BEING SAMPLED

Service Fluid	Pipe Color	Marker Legend
Secondary Effluent	Green	SECONDARY EFFLUENT
Service Air	Green	SERVICE AIR
Tank Drain	Charcoal	TANK DRAIN
Vent Pipe	Yellow	VENT PIPE
Secondary Scum	Brown	SECONDARY SCUM
Waste Activated Sludge	Brown	WAS
Non-Potable Water	Purple	2W

Letters	Color of Pipe	Color of Bands	Color of Letters
Finished or Potable (cold)	Light blue	None	Black
Nonpotable or Raw	Light blue	Dark Gray	Black
Service Water (lines downstream from backflow prevention unit	Dark Blue	White	Red
Sample	Dark Blue	Black	White
Fire Protection	Red	None	Black
Hydrants	Aluminum	None	Black
Filter-to-Waste	Light Brown	None	Black
Sewage	Light Gray	None	Black
Solids	Dark Brown	None	White
Scum	Dark Brown	None	White
Drain	Dark Gray	None	White
Sump Pump Pipe Line	Dark Gray	Red	White
Chlorine (solution)	Yellow	Red	Black
Service Air/Instrument Air	Light Green	Dark Green	Black
Natural Gas	Red	Yellow	White

END OF SECTION

SECTION 15110

COMMON WORK RESULTS FOR VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic requirements for valves.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 01782 - Operation and Maintenance Data.
   4. Section 09960 - High-Performance Coatings.
   5. Section 15211 - Ductile Iron Pipe: AWWA C151.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C111/A21.11 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe Fittings.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   2. A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   3. A536 - Standard Specification for Ductile Iron Castings.

C. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

D. Society for Protective Coatings (SSPC):
   1. SP 7 - Brush-Off Blast Cleaning.
   2. SP 10 - Near-White Blast Cleaning.

1.03 DESIGN REQUIREMENTS

A. Pressure rating:
   1. Suitable for service under minimum working pressures of 150 pounds per square inch gauge.
   2. When a piping system is specified in the Piping Schedule to be tested at a pressure greater than 150 pounds per square inch gauge, provide valves for that piping system with design working pressure which is sufficient to withstand the test pressure.

B. Valve to piping connections, unless noted otherwise:
   1. Valves 3 inch nominal size and larger: Flanged ends.
   2. Valves less than 3 inch nominal size: Screwed ends.

3. Plastic valves in plastic piping:
    a. Up to 2.5 inches: Provide solvent or heat welded unions.
    b. 3 inches and above: Provide solvent or heat welded flanges.

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Product data:
1. Submit the following information for each valve:
    a. Valve type, size, pressure rating, Cv factor.
    b. Coatings.
    c. Power valve actuators:
        1) Information on valve actuator including size, manufacturer, model number, limit switches, mounting; and motor enclosure, seating and unseating torque coefficient, dynamic torque, and bearing friction for calculation of maximum operating torque.
        2) Complete wiring diagrams and control system schematics.
    d. Manual valve actuators:
        1) Information on valve actuator including size, manufacturer, model number.
    e. Certified drawings with description of component parts, dimensions, weights, and materials of construction.
    f. Certifications of reference standard compliance:
        1) Submit certification that the valves and coatings are suitable in potable water applications in accordance with NSF 61.
    g. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
    h. Factory test data.

C. Provide vendor operation and maintenance manual as specified in Section 01782:
1. Furnish bound sets of installation, operation, and maintenance instructions for each type of manual valve 4 inch in nominal size and larger, and all non-manual valves. Include information on valve operators.

D. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756.

E. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications:
1. Valves manufactured by manufacturers whose valves have had successful operational experience in comparable service.

1.06 DELIVERY STORAGE AND HANDLING

A. Protect valves and protective coatings from damage during handling and installation; repair coating where damaged.

PART 2 PRODUCTS

2.01 MATERIALS

A. Stainless steel: In accordance with ASTM A167, Type 316, or Type 304, UNS Alloy S31600 or S30400.

B. Valve and operator bolts and nuts:
   1. Fabricated of stainless steel for the following installation conditions:
      a. Submerged in sewage or water.
      b. In an enclosed space above sewage or water.
      c. In structures containing sewage or water, below top of walls.
      d. At openings in concrete or metal decks.
   2. Where dissimilar metals are being bolted, use stainless steel bolts with isolation bushings and washers.
   3. Underground bolts: Low-alloy steel in accordance with AWWA C111/A21.11.

C. Bronze and brass alloys: Use bronze and brass alloys with not more than 6 percent zinc and not more than 2 percent aluminum in the manufacture of valve parts; UNS Alloy C83600 or C92200 unless specified otherwise.

D. Valve bodies: Cast iron in accordance with ASTM A126, Class 30 minimum or ductile iron in accordance with ASTM A536, Grade 65-45-12 minimum unless specified otherwise.

2.02 INTERIOR PROTECTIVE LINING

A. When specified in the particular valve specification, provide valves with type of protective lining specified in the particular valve Specification.

B. Apply protective lining to interior, non-working surfaces, except stainless steel surfaces.

C. Lining types:
   1. Fusion bonded epoxy:
      a. Manufacturers: One of the following or equal:
         1) 3-M Company, ScotchKote 134; certified to NSF 61 for drinking water use.
      b. Clean surfaces in accordance with SSPC SP 7 or SP 10, as recommended by epoxy manufacturer.
      c. Apply in accordance with manufacturer's published instructions.
      d. Lining thickness: 0.010 to 0.012 inches except that:
         1) Lining thickness in grooves for gaskets: 0.005 inches.
         2) Do not coat seat grooves in valves with bonded seat.
      e. Quality control:
         1) Lining thickness: Measured with a non-destructive magnetic type thickness gauge.
         2) Verify lining integrity with a wet sponge-testing unit operating at approximately 60 volts, or as recommended by the lining manufacturer.
         3) Consider tests successful when lining thickness meets specified requirements and when no pinholes are found.

4) Correct defective lining disclosed by unsuccessful tests, and repeat test.
5) Repair pinholes with liquid epoxy recommended by manufacturer of the epoxy used for lining.

2. High solids epoxy:
   a. Product equivalent to high solids epoxy specified in Section 09960:
      1) Certified in accordance with NSF 61 for drinking water use.
      2) Interior: Coat valve interior with manufacturer's equivalent high performance high solids epoxy coating system with a certifiable performance history for the service conditions and as approved by the Engineer. Manufacturer shall provide for approval, coating information sufficient to allow Engineer to assess equivalence to the specified high solids epoxy coating specified in Section 09960.
   b. Clean surfaces to meet SP-7 or SP-10, or as recommended by coating manufacturer.
   c. Quality control: After coating is cured, check coated surface for porosity with a holiday detector set at 1,800 volts, or as recommended by coating manufacturer:
      1) Repair holidays and other irregularities and retest coating.
      2) Repeat procedure until holidays and other irregularities are corrected.

2.03 UNDERGROUND VALVES

A. Provide underground valves with flanged, mechanical, or other type of joint required for the type of pipe to which the valve is to be connected.

B. Coating and wrapping:
   1. Prior to installation, coat buried valves with 2 coats of protective coal tar as specified in Section 09960.
   2. After installation, encase valves in 2 layers of polyethylene wrap as specified for ductile iron piping in Section 15211:
      a. Ascertain that polyethylene wrapping does not affect operation of valve.

2.04 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.05 STEAM VALVES

A. Valves in steam or steam condensate piping: Ductile iron body in accordance with ASTM A536, Grade 65-45-12 minimum or cast steel or forged steel.

2.06 VALVE BOXES

A. Provide cast-iron valve boxes at each buried valve to access valve and valve operators.

B. Do not support boxes on valve, valve operator, or pipe.

C. Boxes:
   1. 2-piece, fabricated of cast iron; provide cover, with asphalt varnish or enamel protective coating.
   2. Adjustable to grade, install centered around the upper portions of the valve and valve operator.

D. Manufacturers: One of the following or equal:
   1. Tyler Pipe Industries, Inc.
   2. Neenah Foundry Company.

2.07 VALVE OPERATORS

A. Valve operator "Open" direction: Open counterclockwise.

B. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels.

C. Provide manually operated valves located not more than 6 feet above the operating level with tee handles, wrenches, or handwheels:
   1. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
   2. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.

D. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels:
   1. Chains: Sufficient length to reach approximately 4 feet above the operating level.
   2. Where chains constitute a nuisance or hazard to operating personnel, provide holdbacks or other means for keeping the chains out of the way.

E. Provide an operator shaft extension from valve or valve operator to finished grade or deck level when buried valves, and other valves located below the operating deck or level, are specified or indicated on the Drawings to be key operated; provide 2 inch square AWWA operating nut, and box and cover as specified, or a cover where a box is not required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Preparation prior to installation:
   1. Install valves after the required submittal on installation has been accepted.
   2. Determine after flanged valves and flanged check valves are selected, the face-to-face dimensions of flanged valves and flanged check valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

3.02 INSTALLATION

A. Provide incidental work and materials necessary for installation of valves including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

B. Where needed, furnish and install additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
   1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by Contractor.
   2. Where such additional valves are required as a result of a substitution or change initiated by Contractor.

C. Install valves with their stems in vertical position above the pipe, except as follows:
   1. Butterfly valves, gate valves aboveground, globe valves, ball valves, and angle valves may be installed with their stems in the horizontal position.
   2. Install buried plug valves with geared operators with their stems in a horizontal position.

D. Install valves so that handles clear obstructions when the valves are operated from fully open to fully closed.

E. Place top of valve boxes flush with finished grade or as otherwise indicated on the Drawings.

F. Valves with threaded connections:
   1. Install valves by applying wrench on end of valve nearest the joint to prevent distortion of the valve body.
   2. Apply pipe joint compound or Teflon tape on external (male) threads to prevent forcing compound into valve seat area.

G. Valves with flanged connections:
   1. Align flanges and gasket carefully before tightening flange bolts.
   2. When flanges are aligned, install bolts and hand tighten.
   3. Tighten nuts opposite each other with equal tension before moving to next pair of nuts.

H. Valves with soldered connections:
   1. Do not overheat connection to prevent damage to resilient seats and metal seat rings.

2. Position valves in full open position before starting soldering procedure.
3. Apply heat to piping rather than to valve body.

3.03 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

C. As specified elsewhere for specific valve types, sizes or actuators:
   1. Source testing.
   2. Manufacturers on site services for Owner Training, Installation Testing, Functional Testing, and during the Process Operational Period.

END OF SECTION

SECTION 15111

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Metal body ball valves and plastic body ball valves.

B. Related sections:
   1. Section 01756 - Commissioning.
   2. Section 13447 - Electric Motor Actuators.
   3. Section 15052 - Common Work Results for General Piping.
   4. Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

B. American Water Works Association (AWWA):
   1. C507 - Standard for Ball Valves 6 Inch Through 48 Inch.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
   3. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

1.03 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:
   1. Metal body ball valves on metallic pipelines.
   2. Plastic body ball valves on plastic pipelines.

B. Do not use metal body ball valves in sodium hypochlorite or sodium bisulfite systems.

1.04 SUBMITTALS

A. As specified in Section 15110.

B. Metal body ball valves: 6 inches and larger only. Submit affidavit of compliance in accordance with AWWA C507.

C. Operation and maintenance manual.

PART 2 PRODUCTS

2.01 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.02 METAL BODY BALL VALVES, 6 INCH SIZE AND LARGER

A. Manufacturers: One of the following or equal:
   1. DeZURIK/APCO: Metal seated valve.
   2. Crane ChemPharma Energy: Resilient seated valve.
   3. Henry Pratt Co.: Resilient seated valve.

B. General:
   1. Type: Non-lubricated, resilient seated or metal seated and capable of sealing in either flow direction.
   2. In accordance with AWWA C507.
   3. Stem packing: Manually adjustable while valve is under pressure.
   4. ASME B16.1, Class 125 flanged ends.

C. Materials:
   1. Body: ASTM A48 cast iron with 400 series Monel seats (metal seated valves only) and integrally cast bronze bushed trunnions.
   2. Ball: Type 304 or Type 316 stainless steel.
   3. Seats: PTFE (resilient seated valves) and 300 series stainless steel (metal seated valves).
   4. Stem seals: PTFE or Viton.

D. Valve actuator:
   1. Manually operated valves: Self-locking worm gear type actuator with position indicator. Permanently lubricate gearing. Provide adjustable screws to stop travel at both open and closed positions.
   2. Electric motor operated valves: Provide electric motor operator as specified in Section 13447.

2.03 METAL BODY BALL VALVES, LESS THAN 6 INCH SIZE

A. Manufacturers: One of the following, or equal:
   1. Apollo Valves as manufactured by Conbraco Industries, Inc.
   2. Metso Automation/Jamesbury.
   3. NIBCO, Inc.
   4. Flow-Tek, Inc.

B. General:
   1. Type: Non-lubricated, full port and capable of sealing in either direction.
   2. End connections:
      a. Threaded or solder ends for sizes 3-inch and smaller.
      b. Class 150 flanged for sizes larger than 3 inch:
         1) Flanges: In accordance with ASME B16.1 standards.
   3. Stem packing: Manually adjustable while valve is under pressure.
   4. Shafts:
      a. Rigidly connected to the ball by a positive means:
         1) Design connection to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
   5. Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
   6. Temperature limits: Suitable for operation between minus 20 and 350 degrees Fahrenheit.

C. Materials:
   1. Valves in copper lines: Bronze body.
   2. Valves in steel and ductile iron piping: Ductile iron or cast steel body.
   3. Valves in stainless steel piping: Stainless steel body, material type to match piping material as specified in Section 15052.
   4. Ball: Type 304 or 316 stainless steel, Type 316 in digester gas applications.
   5. Seats: PTFE.
   6. Stem seals: PTFE or Viton.
   7. Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.
   8. Valves for combustible fluid applications (digester gas, natural gas, fuel oil, etc.) must be of fire safe design.

2.04 PLASTIC BODY BALL VALVES

A. Manufacturers: One of the following or equal:
   1. Asahi America.
   2. Chemtrol Division, NIBCO, Inc.
   3. Plast-O-Matic Valves, Inc.
   4. Georg Fisher Piping Systems.

B. General:
   1. Type: Non-lubricated and capable of sealing in either flow direction.
   2. End connections: True union; solvent or heat welded to piping.
   3. Operator handle: Lever.

C. Materials:
   1. Body: Polyvinyl chloride (PVC).
   2. Ball: Polyvinyl chloride (PVC).
   3. Seats: PTFE (Teflon).
   4. O-rings: EPDM.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

B. Special techniques:
   1. PVC ball valves for hypochlorite service:
      a. Provide valve with factory drilled 0.125-inch hole in the upstream side of the ball.
      b. Provide an engraved plastic tag permanently attached to the valve stem stating "One side of ball drilled for hypochlorite service".

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. As specified in Section 15110.
   2. Source testing.

END OF SECTION

SECTION 15112

BUTTERFLY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Butterfly valves.

B. Related sections:
1. Section 01756 - Commissioning.
2. Section 09960 - High-Performance Coatings.
3. Section 15211 - Ductile Iron Pipe: AWWA C151.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125 and 250.
2. B16.5 - Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24.

B. American Water Works Association (AWWA):
1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
2. C504 - Rubber-Seated Butterfly Valves.
3. C540 - Standard for Power-Actuating Devices for Valves and Sluice Gates.
4. C550 - Protective Interior Coatings for Valves & Hydrants.
5. C606 - Standard for Grooved and Shouldered Joints.

C. ASTM International (ASTM):
1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for Higher-Temperature Service.
3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
4. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
5. A395 - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
6. A479 - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
7. A515 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate - and Higher-Temperature Service.
8. A516 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower-Temperature Service.
9. A536 - Standard Specification for Ductile Iron Castings.
10. A564 - Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

11. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
12. A890 - Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application.
13. B462 - Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
14. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
15. B691 – Standard Specification for Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Rod, Bar, and Wire.
16. D429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrate.

D. Compressed Gas Association (CGA):
   1. Standard G-4.1 - Cleaning Equipment for Oxygen Service.

E. NSF International (NSF):
   1. Standard 61 - Drinking Water System Components - Health Effects.

F. United States Code of Federal Regulations (CFR):
   1. 21 - Food and Drugs.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. General purpose AWWA butterfly valves:
      a. Design standard: Provide valves designed and manufactured in accordance with AWWA C504.
      b. Class:
         1) Provide butterfly valves in accordance with AWWA Class 150B, unless otherwise specified.
         2) Provide butterfly valves in accordance with AWWA Class 250B in piping systems with test pressure greater than 150 pounds per square inch and less than 250 pounds per square inch.
   2. High pressure butterfly valves:
      a. Piping systems designed for operating pressures greater than 250 pounds per square inch and less than 450 pounds per square inch: Provide ASME B16.5, Class 300 high pressure valves.
   3. Industrial class butterfly valves:
      a. Industrial class butterfly valves capable of 150 pounds per square inch leak tight shut off.
   4. Stainless steel butterfly valves:
      a. Stainless steel butterfly valves capable of a minimum of 100 pounds per square inch leak tight shut off and with special cleaning, packaging, and handling.

B. Usage:
   1. Provide and install butterfly valve types as outlined in the Butterfly Valve Application Schedule at the end of this Section.

C. Performance requirements:
   1. Tight shutoff at the pressure rating of the valve with pressure applied in either direction.
   2. Suitable for the following service conditions:
      a. Throttling.
      b. Frequent operation.
      c. Operation after long periods of inactivity.
      d. Installation in any position and flow in either direction.

1.04 SUBMITTALS

A. As specified in Section 15110:
   1. Product data:
      a. For general purpose AWWA butterfly valves, include description of the method of attachment of the disc edge to the valve disc.

B. Certificates:
   1. Interior epoxy coatings: Affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves comply with all provisions in accordance with AWWA C550.
   2. Certification, for all valves and coatings in contact with potable water, that the products used are suitable for contact with drinking water in accordance with NSF Standard 61.

PART 2 PRODUCTS

2.01 GENERAL PURPOSE AWWA BUTTERFLY VALVES

A. Manufacturers: One of the following or equal:
   1. DeZurik/Sartell Model BAW.
   2. Henry Pratt Company.

B. Valve body:
   1. Material: Cast iron, ASTM A126, Grade B, or ductile iron, ASTM A536, Grade 65-45-12.
   2. Body design:
      a. Flanged body valves:
         1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.
         2) Flanges: In accordance with ASME B16.1 Class 125 flanges for Class 150B valves, in accordance with ASME B16.1 Class 250 flanges for Class 250B valves.
      b. Mechanical joint body valves:
         1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.
         2) Mechanical joint design: In accordance with AWWA C110.

3) When mechanical joint body valves are used, incorporate valve into thrust restraint analysis as specified in Section 15211. Utilize test pressure on one side of valve and zero pressure on the opposite side of the valve. Restrain pipe joints on both sides of valve as determined by thrust analysis calculations.

c. Grooved end body valves:

1) Usage: Butterfly valves with grooved ends may be used in piping systems specified in the Piping Schedule to have grooved end joints. Comply with additional limitations specified in the Butterfly Valve Application Schedule.

2) Grooved end joint design: In accordance with AWWA C606.

C. Disc:

1. Material: Cast iron or ductile iron with Type 316 stainless steel edge that matches seat in valve body.
2. Secure valve disc to shaft by means of smooth-sided, taper or dowel pins, Type 316 stainless steel, or Monel.
3. Extend pins through shaft and mechanically secure in place.

D. Shaft and bearings:

1. Shaft design:
   a. Valves 20-inch and less: 1 piece, through disc design.
   b. Valves greater than 20-inch size: 2 piece, stub shaft design.
2. Shaft seal: Vee type, chevron design.
3. Shaft material for Class 150B valves: Type 316 stainless steel, ASTM A276.
4. Shaft material for Class 250B valves: Type 17-4 pH stainless steel, ASTM A564.
5. Shaft bearings: Self-lubricating sleeve type:
   a. Valves 20-inch and less: Nylatron.
   b. Valves greater than 20-inch size: Teflon with stainless steel or fiberglass backing.

E. Seats:

1. Seat materials:
   a. In low-pressure air applications: EPDM.
   b. In all other applications: NBR or natural rubber or EPDM.
2. For valves 20 inches in nominal size and smaller, bond or vulcanize seat into the valve body.
3. For valves 24 inches in nominal size and larger, retain seats mechanically or by adhesive:
   a. Mechanical retainage: Retain seat by a clamping ring with segmented clamping ring locks with adjusting locking screws:
      1) Clamping ring, ring locks, and adjusting locking screws: Type 316 stainless steel.
      2) Provide means to prevent ring locks and screws used to retain seats from loosening due to vibration or cavitation.
   b. Adhesive retainage: Inset the seat within a groove in the valve body and retain in place with epoxy injected behind the seat so that the seat expands into the body.
   c. Do not provide valves with seats retained by snap rings or spring-loaded retainer rings.

4. Resilient seat: Withstand 75 pound per inch pull when tested in accordance with ASTM D429, Method B.

F. Valve packing:
   1. Valves 4 inch to 48 inch nominal size: Self-adjusting V-type packing or chevron-type packing. NBR or EPDM to match seat material.
   2. Valves 54 inch nominal size and larger: Adjustable V-type packing with bronze packing gland or self-adjusting V-type packing. NBR or EPDM to match seat material.

2.02 INDUSTRIAL CLASS BUTTERFLY VALVES

A. Manufacturers: One of the following or equal:
   1. SPX/DeZurik Style BOS.
   2. Tyco-Keystone Figure AR2.

B. Valve body:
   1. Pressure rating: 150 pounds per square inch, minimum.
   2. Material: Cast iron, ASTM A126, Class B or Ductile Iron, ASTM A395, Grade 60/40/18.
   3. Body design: Lugged style body with drilled and tapped boltholes in accordance with ASME B16.1, Class 125 and Class 150 flange drilling dimensions.

C. Disc:
   1. Materials:
      a. Air and water service: Cast iron, ASTM A126, Class B or Ductile Iron, ASTM A536, Grade 65/45/12 or Type 316 stainless steel, ASTM A351, Grade CF8M.
      b. Natural gas and digester gas service: Type 316 stainless steel, ASTM A351, Grade CF8M.
   2. Disc edge: Nickel-plated when cast iron or ductile iron disc is used.

D. Shaft and bearings:
   1. Shaft: Type 316 stainless steel, ASTM A276.
   2. Shaft bearings: Self-lubricating sleeve type, Teflon with stainless steel or fiberglass backing.

E. Disc pins: Secure valve disc to shaft by means of solid, smooth-sided, taper or dowel pins, Type 316 stainless steel:
   1. Extend pins through shaft and mechanically secure in place.

F. Seats:
   1. Material:
      a. Natural gas and digester gas applications: Neoprene or Buna N.
      b. All other applications: EPDM.
   2. Seat retention ring, if used on larger sizes: Type 316 stainless steel or bronze, ASTM B584, with stainless steel fasteners. For all such valves, bond the seat to the retention ring.

G. Valve shaft packing:
   1. Natural gas and digester applications: Neoprene or Buna N.
   2. All other applications: EPDM or Teflon.

2.03 COATING

A. Shop coat interior and exterior metal surfaces of valves, except as follows:
   1. Interior machined surfaces.
   2. Surfaces of gaskets and elastomeric seats and stem seals.
   3. Bearing surfaces.
   4. Stainless steel surfaces and components.

B. Coating material for potable water applications:
   1. Formulate interior coating material from materials in accordance with CFR 21, AWWA C550, and NSF 61.
   2. Submit affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves in accordance with CFR 21, AWWA C550, and NSF 61.

C. Interior surfaces:
   1. Interior surfaces, except for valves used in low-pressure air service: High solids epoxy.
   2. Interior surfaces of valves used in low-pressure air service: High temperature coating for range of 150 to 350 degrees Fahrenheit.

D. Exterior surfaces:
   1. Exterior surfaces of valves, actuators, and accessories coating in accordance with Section 09960 with the following coating types:
      a. Submerged valves: High solids epoxy.
      b. Buried valves: Coal tar epoxy.
      c. Other valves: High solids epoxy with polyurethane topcoat.
   2. Polished and machined surfaces: Apply rust-preventive compound:
      a. Manufacturers: One of the following or equal:
         1) Houghton, Rust Veto 344.
         2) Rust-Oleum, R-9.

E. Coating materials:
   1. High solids epoxy and coal tar epoxy:
      a. Products: As specified in Section 09960:
         1) Coating product in contact with potable water must be in accordance with AWWA C550 and NSF 61.
   2. High temperature coating: As specified in Section 09960 and in accordance with AWWA C550.
   3. Rust-preventive compound:
      a. Manufacturers: One of the following or equal:
         1) Houghton, Rust Veto 344.
         2) Rust-Oleum, R-9.

F. Field applied coatings of valve exterior:
   1. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960:
      a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
      b. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that

requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves with valve shafts horizontal, unless a vertical shaft is required to suit a particular installation, and unless a vertical shaft is indicated on the Drawings.

B. Install pipe spools or valve spacers in locations where butterfly valve disc travel may be impaired by adjacent pipe lining, pipe fittings, valves, or other equipment.

3.02 BUTTERFLY VALVE APPLICATION SCHEDULE

A. Acceptable butterfly valve types and body styles are listed in the Butterfly Valve Application Schedule provided at the end of this Section. Furnish and install butterfly valves in accordance with this Schedule.

3.03 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. As specified in Section 01756 and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. As specified in Section 15110.
   2. Source testing.

BUTTERFLY VALVE APPLICATION SCHEDULE	
Valve Type and Style	**Acceptable Applications**
General Purpose AWWA Butterfly Valves – Flanged Body Design	Aboveground or submerged in the following service applications only: - Acceptable in all service applications except oxygen and ozone service and high-pressure service. - May be used in buried applications when required by the specified piping system.
General Purpose AWWA Butterfly Valves – Mechanical Joint Body Design	Buried in the following service applications only: - Acceptable in all service applications except oxygen and ozone service and high-pressure service.
General Purpose AWWA Butterfly Valves – Lugged Body Design	Aboveground in the following service applications only: - Aeration Air Systems
General Purpose AWWA Butterfly Valves – Wafer (not lugged) Body Design	Not allowed.
General Purpose AWWA Butterfly Valves – Grooved End Body Design	Aboveground, in sizes 20-inch and less, with piping system test pressure less than 100 psi, and in the following service applications only:

BUTTERFLY VALVE APPLICATION SCHEDULE	
Valve Type and Style	**Acceptable Applications**
	- Acceptable in all service applications, except oxygen and ozone service, where piping for that service is specified in the Piping Schedule to have grooved end joints.
Industrial Class Butterfly Valves – Lugged Body Design	Aboveground in the following service applications only: - Aeration Air Systems - Natural Gas Systems - Digester Gas Systems - Chilled and Hot Water Systems
Industrial Class Butterfly Valves – Wafer (not lugged) Body Design	Not allowed.

END OF SECTION

SECTION 15114

CHECK VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Center guide (silent).
   2. Swing.
   3. Plastic ball check valves.

B. Related sections:
   1. Section 01756 - Commissioning.
   2. Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: PS 1/2 through NPS 24 Inch Standard.

B. American Water Works Association (AWWA):
   1. C508 - Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch (50-mm Through 600-mm) NPS.

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A313 - Standard Specification for Stainless Steel Spring Wire.
   3. A536 - Standard Specification for Ductile Iron Castings.
   4. B582 - Standard Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet, and Strip.
   5. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Check valves: When not otherwise specified as indicated on the Drawings, provide check valves suitable for service as follows:
      a. In either horizontal or vertical position.
      b. Suitable for service working pressures up to 150 pounds per square inch gauge.

1.04 SUBMITTALS

A. As specified in Section 15110.

PART 2 PRODUCTS

2.01 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.02 CENTER GUIDE (SILENT) CHECK VALVES

A. Manufacturers: One of the following or equal:
   1. APCO, Model Number 600.
   2. Crispin, Series GC.

B. Valve design:
   1. Center guided, spring-loaded plug.
   2. Replaceable seat and plug.
   3. Shaft guide bushing.
   4. Non-slam, silent shut-off.
   5. Flanged body.

C. Materials:
   1. Body: Cast iron, ASTM A126 Grade B, or Type 316 stainless steel, ASTM A313.
   2. Plug and seat: Bronze, ASTM B584 C83600.
   3. Spring: Stainless steel, ASTM A313 Type 316.
   4. Shaft and bushing: Bronze, ASTM B584 C83600.
   5. Seat: Buna-N or EPDM.

2.03 SWING CHECK VALVES

A. Valves 1/4 inch through 3 inch:
   1. Manufacturers: One of the following or equal:
      a. Crane Valve Company, Number 36.
      b. Lunkenheimer Company, Figure 554Y.
   2. Valve design:
      a. Threaded joints.
      b. Y-pattern body with integral seat.
      c. Hinged disc.
      d. Access to valve seat for regrinding without disassembly of piping.
   3. Materials:
      a. Body, cap, hinge, and disc: Bronze.

B. Valves 4 inch through 24 inch:
   1. Manufacturers: One of the following or equal:
      a. Kennedy, Figure 106LW or M&H, Model 159.

b. Mueller Company, Model A-2600.
c. APCO Model 250.
d. Crispin SWL Series.

2. Valve design:
   a. In accordance with AWWA C508.
   b. Constructed to permit top entry and removal of internal components without removing the valve.
   c. Equipped with outside lever and weight.
3. Materials:
   a. Body: Cast iron, ASTM A126 Class B or ASTM A536 Gr. 65-45-12 Ductile Iron.
   b. Disc:
      1) Valve disc shall be ASTM A126 cast iron, ASTM A536 ductile iron or ASTM B584 bronze.
      2) 4-inch valves: Bronze or stainless steel rings and seats.
      3) 6 inches and larger valves: Bronze faced or stainless steel rings and seats.
      4) Rubber seat Buna-N or EPDM.
   c. Hinge pins: Stainless steel.

2.04 PLASTIC BALL CHECK VALVES

A. Manufacturers: One of the following or equal:
   1. Chemtrol Division of Nibco.
   2. Georg Fischer Piping Systems.
   3. Plast-O-Matic Valves, Inc.

B. Valves: Ball type:
   1. Material: Polyvinyl chloride.
   2. End connection: Double or single union-type.
   3. Seals: Viton.

C. Valve body material:
   1. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), Polypropylene (PP) or polyvinylidene fluoride (PVDF), as best suited for each individual service condition.

D. Union connections material:
   1. NPT or socket ends conforming to ASME B16.5 pipe flanges and flange fittings, class 150.

E. Seats and seals material:
   1. EPDM, Buna-N, or Viton.

F. Maximum inlet pressure rating.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves as specified in Section 15110 and the manufacturer’s instructions.

B. Flapper type check valves:
   1. Install with proper orientation of flow direction arrow on valve body.
   2. When installed in horizontal pipelines, mount with shaft on vertical locations.
   3. When mounted in a vertical pipeline, directly downstream of an elbow, mount with the shaft perpendicular to the outermost portion of the elbow.
   4. Mount on downstream side of discharge silencer when used on positive displacement and centrifugal blowers.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. As specified in Section 15110.
   2. Source testing.

3.03 ADJUSTING

A. Adjust cushioned swing check valves in the field by means of external adjustment devices to minimize pressure surges.

B. Adjust weight on swing check valves to affect proper closing action on equipment shutdown.

END OF SECTION

SECTION 15115

GATE, GLOBE, AND ANGLE VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Gate, globe, angle, and plug disc and plain hose valves.

B. As specified in Section 15110.

C. Related sections:
1. Section 01330 - Submittal Procedures.
2. Section 01756 - Commissioning.
3. Section 01783 - Warranties and Bonds.
4. Section 09960 - High-Performance Coatings.
5. Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
1. C515 - Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Services.
2. C 550 - Protective Interior Coatings for Valves and Hydrants.

B. ASTM International (ASTM):
1. B98 - Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

1.03 SUBMITTALS

A. Submit as specified in Section 01330.

B. Product data: As specified in Section 15110.

C. Commissioning submittals: For valves larger than 16-inch:
1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.04 WARRANTY

A. Provide warranty as specified in Section 01783.

B. Interior epoxy coatings: Affidavit of compliance attesting that epoxy coatings applied to interior surfaces of valves comply in accordance with all provisions of AWWA C550.

PART 2 PRODUCTS

2.01 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.02 GATE VALVES

A. Gate valves aboveground:
   1. Valves less than 3 inches in size for clean water and air service:
      a. Manufacturers: One of the following or equal:
         1) Crane, Figure 431.
         2) Jenkins, Figure 47.
         3) Lunkenheimer Company, Figure 2151.
      b. Design:
         1) Size and configuration: Indicated on the Drawings.
         2) Manufacturer's standard bronze, solid wedge disc, rising stem, screwed end, Class 150 pounds.
   2. Valves 3 inches in size and larger:
      a. Manufacturers: One of the following or equal:
         1) M&H/Kennedy Valve Company.
         2) Mueller.
         3) American Flow Control, Series 2500.
      b. Design:
         1) Size, material, configuration: Indicated on the Drawings.
         2) Resilient wedge type in accordance with AWWA C515.
         3) Flange, iron body, and bonnet rated for 200 pound working pressure.
            a) Provide O-ring seal between valve body and bonnet.
         4) Ductile or cast iron wedge encapsulated in nitrile rubber and capable of sealing in either flow direction.
         5) Bronze stem with double or triple O-ring or braided packing stem seals.
         6) Rising stem configuration with handwheel diameter sized to allow opening of valve with no more than a 40-pound pull.
         7) Coat interior and exterior surfaces of valve body and bonnet with fusion-bonded epoxy in accordance with AWWA C550.

B. Gate valves underground:
   1. Manufacturers: One of the following or equal:
      a. M&H/Kennedy Valve Company.
      b. Mueller Company.
      c. American Flow Control.

2. Design:
    a. Size, material, configuration: Indicated on the Drawings.
    b. Resilient wedge type in accordance with AWWA C515.
    c. Stem:
        1) Iron body, resilient seat, non-rising stem, double O-ring stem seal.
        2) Rising stem configuration with handwheel diameter sized to allow opening of valve with no more than a 40-pound pull.
    d. Ductile or cast iron wedge encapsulated in nitrile rubber and capable of sealing in either flow direction.
    e. Bronze stem with double or triple O-ring or braided packing stem seals.
    f. Coat interior and exterior surfaces of valve body and bonnet with fusion-bonded epoxy in accordance with AWWA C550.
    g. Valve operator: Provide standard AWWA 2-inch operating nut, matching valve key, and valve box for operating stem.

C. Knife gate valves:
1. Manufacturers: One of the following or equal:
    a. DeZurick SPX, KGL.
    b. ITT Fabri-Valve, C37.
2. Design:
    a. Size and configuration: Indicated on the Drawings.
    b. Suitable for service under pressures equal to and less than 150 pounds per square inch gauge.
    c. Full round port, metal seated, raised face design.
    d. Flanged wafer design drilled and tapped to ASME Class 125/150 standard.
    e. Rounded gate with beveled edge, finish-ground to 32 RMS, maximum, on both sides.
    f. Body to incorporate guides and jams to assist in seating.
    g. Materials:
        1) Body: Cast or ductile iron or cast steel, with Type 316 stainless steel lining or cast Type 316 stainless steel.
        2) Wetted components (including gate): Type 316 stainless steel.
        3) Yoke sleeve: Acid resisting bronze or aluminum bronze.
        4) Packing: PTFE.
    h. Outside screw and yoke (OS&Y) with handwheel operator.

2.03 GLOBE AND ANGLE VALVES

A. General purpose globe and angle valves:
1. Valves 3 inches and smaller:
    a. Manufacturers: One of the following or equal:
        1) Except in welded steel piping:
            a) Crane, No. 1 Globe or No. 2 Angle.
            b) Lunkenheimer Company Figure No. 2140 Globe or No. 2141 Angle.
        2) In Welded steel piping:
            a) Crane, No. 351.
            b) Lunkenheimer Company, Figure No. 1123; or equal with flanged ends.

b. Design:
1) Size and configuration: Indicated on the Drawings.
2) Valve: Class 125 threaded ends, rated for 250 degrees Fahrenheit at pressure of 170 pounds per square inch.

2. Valves larger than 3 inches:
a. Manufacturers: One of the following or equal:
1) Crane, No. 351.
2) Lunkenheimer Company, Figure No. 1123.
b. Design:
1) Size and configuration: Indicated on the Drawings.

3. Plug disc globe valves: for throttling or for severe service.
a. Manufacturers: One of the following or equal:
1) Crane, No. 212P or No. 384P.
2) Lunkenheimer Company, 72-PS or 73-PS1.
b. Design:
1) Size and configuration: Indicated on the Drawings.
2) Material: Iron body stainless steel trimmed plug type seat and disc.

2.04 NEEDLE VALVES

A. Manufacturers: One of the following or equal:
1. Powell, Figure No. 180.
2. Lunkenheimer Company, Figure No. 906-BS or No. 907-BS.
3. Crane No. 88 or No. 89.

B. Design:
1. Size and configuration: Indicated on the Drawings.

2.05 HOSE VALVES

A. Hose valves:
1. Manufacturers:
a. Globe threaded valve: One of the following or equal:
1) Crane, No. 7TF.
2) Stockham, Figure No. B22T.
b. Angle threaded valve: One of the following or equal:
1) Crane, No. 17TF.
2) Stockham, Figure No. B222T.
2. Design:
a. Size and configuration: Indicated on the Drawings.
b. Valve: Globe or angle valve with threaded ends.
c. Disc: Renewable, made of Teflon or Buna-N.
d. Threaded ends rated for a pressure of 200 pounds per square inch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves as specified in Section 15110 and manufacturer’s instructions.

B. Mount yard hydrants on minimum 1 inch supply pipe or size indicated on the Drawings.

C. Mount Post hydrants on minimum 2 inches supply pipe or size indicated on the Drawings.

D. Set yard and post hydrants in 4 cubic feet of 3/4 inches minimum crushed stone surrounding valve body to allow for proper drainage:
   1. Install in accordance with AWWA recommendations for hydrants.

END OF SECTION

SECTION 15116

PLUG VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Non-lubricated plug valves.

B. Related sections:
   1. Section 01756 - Commissioning and Process Start-Up.
   2. Section 09960 - High-Performance Coatings.
   3. Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C606 - Grooved and Shouldered Joints.
   2. C517 - Resilient-Seated Cast Iron Eccentric Plug Valves.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A536 - Standard Specification for Ductile Iron Castings.

1.03 SUBMITTALS

A. As specified in Section 15110.

PART 2 PRODUCTS

2.01 NON-LUBRICATED PLUG VALVES

A. Manufacturers: One of the following or equal:
   1. DeZurik, "PEC".
   2. Clow Valve.

B. Design:
   1. Type: Non-lubricated eccentric type, in accordance with AWWA C517.
   2. Plug face: Resilient material that operates satisfactorily at a temperature of 180 degrees Fahrenheit continuous and 215 degrees Fahrenheit intermittent, except for valves in compressed air or digester gas service:
      a. Valves in compressed air service: Resilient material suitable for continuous duty at 250 degrees Fahrenheit.
      b. Valves in digester gas service: Resilient material suitable for petroleum or digester gas at continuous duty at 180 degrees Fahrenheit.

3. Compression washer: Provide flat compression washer made of Teflon, or of a material having equal physical characteristics on valve stem between plug and bonnet.
4. Stem seals: Provide stem seals serviceable without unbolting the valve bonnet assembly.
5. Grit excluders: Provide PTFE grit excluders at upper plug journals to prevent entry of foreign solids in bearing area.
6. Clearly mark valves to indicate their open and closed positions.
7. Provide valves with ends as required by piping details indicated on the Drawings.
8. Grooved end body valves:
    a. Usage: Plug valves with grooved ends may be used in piping systems specified in the Piping Schedule to have grooved end joints and as indicated on the Drawings.
    b. Grooved end joint design: In accordance with AWWA C606.

C. Materials:
1. Body and plug: ASTM A126, Class B, cast-iron, with plug face of Buna N material suitable for the intended service as specified under paragraph "Design" above.
2. Body seats in valves 3 inch size and larger: Provide with overlay of not less than 90-percent nickel and minimum thickness of 1/8 inch on surfaces contacting the plug face.
3. Stem bearing and bottom bearing: Type 316 stainless steel.
4. Internal parts, except the body and plug: Type 316 stainless.
5. Exposed nuts, bolts, and washers: Zinc plated. Exception: Exposed nuts, bolts, and washers for buried service: Stainless steel.

2.02 VALVE OPERATORS

A. Furnish valves with an operating wrench or worm gear operator:
1. Equip valves 4 inch nominal size and smaller with a lever operator.
2. Equip valves 6 inch nominal size and larger with a worm gear operator.

2.03 COATING

A. Coat interior metal surfaces as specified in Section 15110.

B. Coat exterior metal surfaces as specified in Section 09960.

C. Field applied coating of valve exterior:
1. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960:
    a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
    b. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves as specified in Section 15110 and the manufacturer's instructions.

B. Install valves so that in the closed position the pressure in the pipeline applies a seating head on the valves.

C. Lubrication: Lubricate plug valves and fill extended lubricant pipes with lubricant suitable for service intended.

D. Install valves so that in the open position the plug is located in the top half of the valve body.

3.02 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. As specified in Section 01756 and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. As specified in Section 15110.
   2. Source testing.

END OF SECTION

SECTION 15117

SPECIALTY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Backflow preventers.
   2. Mud valves.
   3. Surge preventer valves.
   4. Solenoid valves.
   5. Plastic body diaphragm valves.
   6. Tubing valves.
   7. Corporation stops.
   8. Curb stops.
   9. Cocks.

B. Related sections:
   1. Section 01756 - Commissioning.
   2. Section 15082 - Piping Insulation.
   3. Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 25 - Earthquake-Actuated Automatic Gas Shutoff Devices.

B. American Society of Mechanical Engineers (ASME):
   1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. American Water Works Association (AWWA):
   1. C511 - Standard for Reduced Pressure-Principle Backflow-Prevention Assembly.
   2. C800 - Underground Service Line Valves & Fittings (Also Included: Collected Standards For Service Line Materials).

D. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A536 - Standard Specification for Ductile Iron Castings.
   5. B584 - Standard Specification for Copper Alloy Sand Castings for General Application.

E. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA Type 4 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. As specified in Section 15110.

B. Certificates:
   1. Recertification of all new backflow preventers after installation, start-up and testing.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufactured by manufacturers whose valves have had successful operational experience in comparable service.

1.06 DELIVERY STORAGE AND HANDLING

A. Protect valves from damage during handling and installation.

PART 2 PRODUCTS

2.01 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.02 BACKFLOW PREVENTERS

A. Manufacturers: One of the following or equal:
   1. Febco backflow prevention:
      a. Model 860 all sizes.
   2. Zurn/Wilkins:
      a. Model 975XL for 1/2-inch through 2-inch.
      b. Model 375AST for sizes 2 1/2 inch, 3 inch, 8 inch, and 10 inch.
      c. Model 375 and 375DA for sizes 4 inch and 6 inch.
   3. Watts regulator: Series LF909.

B. Design: Reduced pressure chamber type in accordance with AWWA C511.

C. Lead-Free: For potable water installations not more than a weighted average of 0.25 percent lead when used with respect to the wetted surfaces.

D. Include shutoff valves at each end of backflow preventer with properly located test cocks.

E. Shutoff valves:
   1. Backflow preventers 2-inch and smaller: Provide with full-port, quarter turn, resilient seated ball valves.
   2. Backflow preventers larger than 2-inch: Provide with resilient seated, outside stem and yoke gate valves.

2.03 MUD VALVES

A. Manufacturers: One of the following or equal:
   1. Clow Corporation, Series F-3075T.
   2. Waterman Industries, Inc., Model MV-11.

B. Design:
   1. Provide mud valves with non-rising stem.
   2. Provide standard AWWA 2-inch valve nut on stainless steel stem extension to height required.

C. Materials:
   1. Body, cover, and yoke: Cast-iron.
   2. Disc plug: Cast-iron.
   3. Seat rings: Bronze.
   4. Stem and stem nut: Bronze.
   5. Cap screws to bolt valve to cast-iron pipe flange: Type 316 stainless steel.

2.04 SOLENOID VALVES

A. 2-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Company, Series 8210.
      b. Skinner Electric Valve Division, Series C.

B. 3-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Company, Series 8320.
      b. Skinner Electric Valve Division, Type A4.

C. 4-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Company, Bulletin 8344.
      b. Skinner Electric Valve Division, Series V9.

D. Design:
   1. Valves: Suitable for service under the following conditions:
      a. Fluid: 3W (Utility Water).
      b. Temperature of fluid: 70 degrees Fahrenheit.
      c. Piping test pressure: 180 pounds per square inch gauge.
   2. Unless otherwise indicated on the Drawings, provide valves that:
      a. Minimum NEMA Type 4 enclosure.
      b. 120 VAC operation.

c. Suitable for use as indicated on the Drawings.
d. Minimum Class F coil insulation.

3. 2-way valves: Furnish with openings of size equal to or larger than the nominal size designation of the valve.
4. Furnish with manual/bypass operators.

E. Materials:
1. Body: Brass or bronze.
2. Seats: Resilient material.

2.05 TUBING VALVES

A. Manufacturers: One of the following or equal:
1. Stockham, Figure S-127.
2. Jenkins, 1336.
3. Crane, 950 TF.

B. Valves: 1 piece bar stock ball valve.

C. Materials:
1. Body: Type 316 stainless steel.
2. Bull: Type 316 stainless steel.
3. Insert: Type 316 stainless steel.
4. Seat: Reinforced Teflon®.
5. Stem seal: Reinforced Teflon®.
6. Stem: Type 316 stainless steel.
7. Jam nut: Steel.

2.06 CORPORATION STOPS

A. Type: In accordance with AWWA C800:
1. Manufacturers: One of the following or equal:
a. Ford.
b. Mueller Company.

2.07 CURB STOPS

A. Manufacturers: One of the following or equal:
1. Ford.
2. Mueller Company.

B. Description: Round way solid tee head stops.

2.08 COCKS

A. Gauge cock:
1. Manufacturers: One of the following or equal:
a. Lunkenheimer Company, Figure 1178 or Figure 1180.
b. Whitney.

B. Air cock:
   1. Manufacturers: One of the following or equal:
      a. Whitey Research Tool Company, Model B-42S4.
      b. Hoke, Inc., 7122G4B.

C. Plug cock:
   1. Manufacturers: One of the following or equal:
      a. Lunkenheimer Company, Figure 454.
      b. Whitney.
   2. Design: Plug cocks: Bronze, straightway pattern complete with lever.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 in accordance with manufacturer's published instructions.

B. Install sensing line insulation as specified in Section 15082.

C. Backflow preventers:
   1. Install with a minimum clearance of 12 inches and with maximum clearance of 30 inches between the relief port and the floor or finished grade.
   2. Install with sufficient side clearance for access for testing and maintenance.

D. Plastic body diaphragm valves for sodium hypochlorite service:
   1. When valves are installed horizontally, install valves with valve stem position rotated as necessary such that no internal valve obstruction prevents the passage of vapors traveling along the top of adjacent piping from traveling through the valve.

END OF SECTION

SECTION 15118

PRESSURE REDUCING AND PRESSURE RELIEF VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pressure reducing and pressure relief valves for water, air, sludge and chemical service.

B. Related sections:
   1. Section 01756 - Commissioning.
   2. Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

B. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A536 - Standard Specification for Ductile Iron Castings.

C. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. As specified in Section 15110.

PART 2 PRODUCTS

2.01 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.02 WATER PRESSURE REDUCING VALVES

A. Water pressure reducing valves, 2 1/2 inches and smaller:
   1. Manufacturers: One of the following or equal:
      a. Watts Regulator, Series LF223.
      b. Wilkins, 500 Series.
   2. Direct operated, single seat type pressure reducing valve.
   3. Materials:
      a. Body and spring cover: Bronze.
      b. Valve seat: Series 300 stainless steel.
      c. Diaphragm: Buna Nitrile or EPDM.
      d. Disk: Buna Nitrile or EPDM.

B. Water pressure reducing valves, 3 inches and larger:
   1. Manufacturers: One of the following, or equal:
      a. Watts ACV Series 115.
      b. Cla-Val Model 90-01.
   2. Design:
      a. Pilot controlled, hydraulically operated, diaphragm actuated, globe patterned valve.
      b. Rated for 125 pounds per square inch gauge.
      c. Pilot line: Equipped with a strainer.
      d. Flanges: 150 pound rating, in accordance with ASME B16.42.
   3. Materials:
      a. Body and cover: Cast iron ASTM A48 or Ductile Iron ASTM A536.
      b. Valve trim: Bronze.
      c. Pilot control: Cast bronze with Series 303 stainless steel trim.
      d. Diaphragm: Nylon reinforced Buna N.

2.03 WATER PRESSURE RELIEF VALVES

A. Water pressure relief valves:
   1. Manufacturers: One of the following, or equal:
      a. Watts ACV Series 116.
      b. Cla-Val Model 50-01.
   2. Design:
      a. Pilot controlled, hydraulically operated, diaphragm actuated, globe patterned valve.
      b. Rated for 125 pounds per square inch gauge.
      c. Pilot line: Equipped with a strainer.
      d. End connections:
         1) 2 1/2 inch and smaller: Screwed.
         2) 3 inch and larger: 150 pound rated flanges in accordance with ASME B16.42.
   3. Materials:
      a. Body and cover: Cast iron ASTM A48 or Ductile Iron ASTM A536.
      b. Valve trim: Bronze.
      c. Pilot control: Cast bronze with Series 303 stainless steel trim.
      d. Diaphragm: Nylon reinforced Buna N.

2.04 SLUDGE PRESSURE RELIEF VALVES

A. Sludge pressure relief valves:
   1. Manufacturers: One of the following or equal:
      a. GA Industries, Inc., Figure Number 525-RD.
      b. Valve and Primer Corporation.
   2. Component elements: Include body, disc, seating face, shaft, attached counterweight arms and lever, and cushion chamber.
   3. Design:
      a. Provide valves that open immediately when the system pressure exceeds the load setting of the counterweights, and close slowly at an adjustable speed upon return of system pressure to normal.
      b. Set counterweights to open and relieve at a pressure 10 pounds per square inch greater than the pressure developed by the pump under normal operating conditions.
      c. Cushion chamber: Attached externally to the side of the valve body and constructed with a piston operating in a chamber with valve operation without hammering action:
         1) Cushioning:
            a) By oil stored in an oil reservoir attached by piping and fittings to the cushion chamber.
            b) Provide anti-freeze hydraulic oil as required.
         2) Design cushion chamber to allow adjustment of closing speed.
   4. Materials:
      a. Body: Heavy cast iron or cast steel.
      b. Disc: Welded steel.
      c. Seating face: EPDM.
      d. Shaft and cushion chamber: Bronze or steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with Section 15110.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services from each manufacturer for all valves supplied,
   1. As specified in Section 15110.
   2. On site services.

END OF SECTION

SECTION 15119

AIR AND VACUUM RELIEF VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Air release valves, air and vacuum valves, and air vents.

B. Related sections:
   1. Section 01756 - Commissioning.
   2. Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

B. American Water Works Association (AWWA).

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   3. A270 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing.
   4. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

D. SSPC: The Society for Protective Coatings (SSPC):
   1. SP 5 - White Metal Blast Cleaning.
   2. SP 10 - Near-White Metal Blast Cleaning.

1.03 SUBMITTALS

A. As specified in Section 15110.

PART 2 PRODUCTS

2.01 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, remove existing coating by abrasive blast cleaning and apply the coating system used for coating adjacent piping in accordance with Section 09960 (09_96_01):
      a. Submerged valves: SP-5 White Metal Blast cleaning.
      b. Other valves: SP-10 Near-white blast cleaning.

2.02 AIR RELEASE VALVES, WATER SERVICE

A. Manufacturers: One of the following or equal:
   1. Valve and Primer Corporation, DeZurik/APCO Series 200.
   2. Multiplex Manufacturing Company, Crispin PL Series.

B. Design:
   1. Pressure rating: 150 pounds per square inch gauge.
   2. Inlet: Screwed, 2-inch.
   3. Orifice size: 1/4 inch diameter.

C. Materials:
   1. Valve body: Cast iron.
   2. Float and internal trim: Type 316 stainless steel.
   3. Seat or valve plunger: Buna-N.

2.03 AIR RELEASE VALVES, SEWAGE SERVICE

A. Manufacturers: One of the following or equal:
   1. Valve and Primer Corporation, DeZurik/APCO, Series 400.
   2. Multiplex Manufacturing Company, Crispin Series S.

B. Design:
   1. Operation: Release accumulated air in sewage pipelines operating under pressure. After entrained air escapes through the orifice, the orifice is plugged by a needle mounted on a compound lever mechanism.
   2. Internal components removable through top cover without removing valve from pipeline.
   3. Pressure rating: 150 pounds per square inch.
   4. Orifice size: 1/4 inch diameter.
   5. Connections: Threaded, 2-inch diameter inlet and threaded, 1/2-inch diameter outlet.

C. Accessories:
   1. Inlet shutoff valve. Utilize eccentric plug valve.
   2. 2 blowoff valves for backflushing.
   3. 10 feet of hose with quick disconnect couplings.

D. Materials:
   1. Body: Cast iron.
   2. Float: Type 316 stainless steel.
   3. Needle: Buna-N.

2.04 AIR AND VACUUM VALVES, SEWAGE SERVICE

A. Select type of sewage-service air and vacuum release valve from the 2 options provided. Furnish only 1 style of air and vacuum release valve for the entire project:
   1. Option 1: Float activated air and vacuum release valve.
   2. Option 2: Anti-surge type air and vacuum release valve.

B. Option 1: Float activated air and vacuum release valves:
   1. Manufacturers: One of the following or equal:
      a. Multiplex Manufacturing Company, Crispin SA Series.
      b. Valve and Primer Corporation, DeZurik/APCO, Series 401.
   2. Design:
      a. Operation: Release air from pipeline as pipeline is filled and allow air to enter pipeline as pipeline is drained.
      b. Internal components removable through top cover without removing valve from pipeline.
      c. Pressure rating: 150 pounds per square inch.
   3. Accessories:
      a. Inlet shutoff valve. Utilize eccentric plug valve.
      b. 2 blowoff valves for backflushing.
      c. 10 feet of hose with quick disconnect couplings.
   4. Connections: 2-inch threaded inlet and 1-inch threaded outlet.
   5. Materials:
      a. Body: Cast iron.
      b. Float: Type 316 stainless steel.
      c. Seat: Buna-N.

C. Option 2: Anti-surge type air and vacuum release valve:
   1. Manufacturers: One of the following or equal:
      a. International Valve Marketing Company, Vent-O-Mat series RGX.
   2. Design:
      a. Operation: Release air from pipeline as pipeline is filled and allow air to enter pipeline as pipeline is drained. Design valve to react immediately to break vacuum upon pipeline drainage or liquid column separation by the full opening of the orifice.
      b. Design: Consisting of a tubular chamber with a hollow, direct acting float, solid cylindrical orifice control float, woven dirt inhibitor screen, and rubber seats.
      c. Surge alleviation: Integral surge alleviation mechanism that operates automatically to limit transient pressure rise or shock. Induce operation of anti-surge mechanism by closure due to high velocity air discharge or the subsequent rejoining of separated liquid columns.

d. Control discharge of pressurized air by the seating and unseating of a small orifice on a seal affixed to the control float. Provide a nozzle with a flat seating land surrounding the orifice to prevent damage to the seal.
e. Internal components removable through top cover without removing valve from pipeline.

3. Connections: Flanged connections conforming to ASME B16.1 Class 250 and ASME B16.5 Class 300 standards.
4. Performance: Leaktight past the orifice seal at operating pressures to 200 pounds per square inch gauge.
5. Materials:
   a. Body: Type 316 stainless steel.
   b. Float: HDPE.
   c. Seats: EPDM.

2.05 COMBINATION AIR VALVES - SEWAGE SERVICE

A. Manufacturers: One of the following or equal:
   1. Valve and Primer Corporation, DeZurik/APCO, Series 440.
   2. Multiplex Manufacturing Company, Crispin Series US.

B. Design:
   1. Operation: Automatic exhaust and intake of large quantities of air during filling and draining of pipelines, respectively, and release of accumulated air while pipeline is under pressure.
   2. Design: Utilize compound lever system in conjunction with large and small orifices.
   3. Internal parts removable through top cover without removing valve from pipeline.
   4. Pressure rating: 150 pounds per square inch.
   5. Connections: 2-inch threaded inlet and 1-inch threaded outlet.
   6. Accessories:
      a. Inlet shutoff valve.
      b. 2 blowoff valves for backflushing.
      c. 10 feet of hose with quick disconnect couplings.

C. Materials:
   1. Body: Cast iron.
   2. Float: Type 316 stainless steel.
   3. Needle: EPDM.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 and manufacturer’s instructions.

B. Install air release valves and air and vacuum valves with suitable discharge lines to nearest drainage system.

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Piping specialties including:
   1. Flexible rubber connections.
   2. Bellows type expansion joints.
   3. Rubber expansion joints.
   4. Vibration control joints.
   5. Transition fittings.
   6. Pipe saddles.
   7. Tapping sleeves.
   8. Spray nozzles.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 01782 - Operation and Maintenance Data.
   4. Section 15052 - Common Work Results for General Piping.
   5. Section 15956 - Piping Systems Testing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24.

B. American Water Works Association (AWWA):
   1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   2. C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.

C. ASTM International (ASTM):
   1. A148 - Standard Specification for Steel Castings, High-Strength, for Structural Purposes.
   2. A536 - Standard Specification for Ductile Iron Castings.

1.03 SUBMITTALS

A. Submit as specified in Section 01330.

B. Product data:
   1. Submit for each piping specialty:
      a. Shop drawings detailing dimensions and materials.
      b. Manufacturer's published installation instructions.

C. Provide vendor operation and maintenance manual as specified in Section 01782.

D. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756.

E. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Bellows type expansion joints and vibration control joints:
   1. Protect joints against damage during packing, shipping, and installation, and also during pressure test.
   2. Lock expansion joints against movement until pressure tests are completed.
   3. Replace damaged expansion joints with new and undamaged expansion joints.

B. Washdown monitors:
   1. Protect washdown monitors and protective coatings from damage during handling and installation; repair coating where damaged.

PART 2 PRODUCTS

2.01 FLEXIBLE RUBBER CONNECTIONS

A. Manufacturers: One of the following or equal:
   1. Mercer Rubber Company, Type 150 Vibraflex.
   2. Red Valve Company, Inc., Part Number P-5.

B. Provide flexible rubber connections with 3/8 inch thick EPDM rubber tube with full-faced flanged ends suitable to withstand a pressure of 150 pounds per square inch gauge.

C. Provide complete flexible rubber connections, including galvanized retaining rings and control rods.

2.02 BELLOWS TYPE EXPANSION JOINTS

A. Expansion joints for general service:
   1. Expansion joints: Flexible bellows type with equalizing rings, or as otherwise specified or indicated on the Drawings.
   2. Manufacturers:
      a. Expansion joints: One of the following or equal:
         1) Senior Flexonics Pathway, Inc., Controlled Flexing Expansion Joint.
         2) Flex-Weld, Inc., Keflex, Series 308.
         3) Victaulic Depend-o-Lok, Omniflex stainless bellows expansion joint.
      b. Pipe alignment guides: One of the following or equal:
         1) Senior Flexonics Pathway, Inc.
         2) Flex-Weld, Inc.
      c. Intermediate supports: Provide with protective saddles. One of the following or equal:
         1) Unistrut Corporation, Roller-type.
         2) Bergen-Paterson Pipe Support Corp.

3. Design:
    a. Expansion joint rating: 150 pounds per square inch gauge, at 300 degrees Fahrenheit.
    b. Bellows: Multi-ply stainless steel, equipped with a self-draining liner guide.
    c. Axial travel of expansion joints: Not less than 1.50 inches.
    d. Ends: 150 pound ASME flanges, Victaulic Depend-o-Lok Airmaster/Fluidmaster coupled ends, or plain suitable for welding connections, as required for piping in which installed.

B. Expansion joints for steam and hot water:
1. Manufacturers: One of the following or equal:
    a. Flex-Weld, Inc., Keflex, Series 308-1215.
    b. Senior Flexonics Pathway, Inc., Controlled Flexing Expansion Joint.
    c. Victaulic Depend-o-Lok Omniflex Expansion Join.
2. Design:
    a. Single reinforced bellows type or Victaulic mechanical couplings.
    b. Pressure and temperature ratings: 150 pounds per square inch gauge, and 500 degrees Fahrenheit service.
    c. Bellows: Multi-ply Type 321 stainless steel, equipped with a Type 321 stainless steel liner.
    d. Axial travel of expansion joints: 3 inches minimum.
    e. Ends: 150 pound ASME flanges.

C. Copper piping expansion joints:
1. Expansion joints for copper pipe: As specified before, except externally guided, without equalizing rings, and provide for 3-1/4 inch expansion per 100 feet of piping.

D. Roof drain expansion joints:
1. Neoprene bellows between roof drain fitting and drain piping.
2. Up to 12-inch static head.
3. Complete with Type 316 stainless steel clamps.
4. Manufacturer: The following or equal:
    a. Watts, Model RD-900.
    b. Flexicraft Industries, DWV.

2.03 RUBBER EXPANSION JOINTS

A. Manufacturers: One of the following or equal:
1. Mercer Rubber Company, Style 500 or 700.
2. Red Valve Company, Inc., Type J-1.

B. Provide rubber expansion joints complete with control units and split retaining rings.

C. Design:
1. Material: Neoprene rubber, reinforced with embedded steel rings, and a strong synthetic fabric.
2. Expansion rings, suitable for pressures of at least 125 pounds per square inch gauge, except as follows:
    a. Expansion joints in pump suction piping and where indicated on the Drawings suitable for minimum 90 pounds per square inch gauge pressure, and minimum 30 inches mercury vacuum.

b. Split retaining rings, galvanized.
c. Ends of expansion joints, 150 pound ASME flanges with drilling to match that of the piping.

D. Rubber expansion joints for blowers: Butyl type rubber formulated for service application and for maximum temperature of 250 degrees Fahrenheit, suitable for minimum 40 pounds per square inch gauge pressure, and minimum 15 inches mercury vacuum.

2.04 PIPE COUPLINGS FOR STAINLESS STEEL PIPING

A. Flexible hose:
1. Manufacturers: One of the following or equal.
2. General:
a. Type: Flexible stainless steel hose:
1) Unbraided for pressures up to 150 pounds per square inch.
2) Single braided for pressures up to 225 pounds per square inch.
3) Double braided for pressures up to 360 pounds per square inch.
b. End connections: Flanged, or as needed to comply with the specified type of joint:
1) Sizes 2 1/2-inches and smaller may have threaded nipples.
2) Sizes 2-inches through 12-inches may have grooved ends.
3. Design:
a. Open pitch spacing of corrugation.
b. 1 fixed and 1 floating raised face flanged end connection.
c. Able to withstand up to 1-inch offset motion from centerline.
4. Materials:
a. Hose: Type 304 stainless steel.
b. Flanges: Carbon steel.

2.05 VIBRATION CONTROL JOINTS

A. Manufacturers:
1. Braided bronze flexible vibration joints 2 inches and less in size: One of the following or equal:
a. Senior Flexonics Canada, Inc., Type BRC bronze connectors.
b. Flex-Weld, Inc., Keflex, Type KFCB.
2. Flexible vibration joints larger than 2 inches: One of the following or equal:
a. Senior Flexonics Canada, Inc., Type TCS.
b. Flex-Weld, Inc., Keflex, Series 151-TR-1215.
3. Corrugated stainless steel with stainless steel braid flexible vibration joints: One of the following or equal:
a. Senior Flexonics Canada, Inc., Type BSFS stainless steel connectors.
b. Flex-Weld, Inc., Keflex, Type USFNSS-31.

B. Design:
1. Flexible vibration joints 2 inches and smaller: Braided bronze, suitable for pressures of not less than 250 pounds per square inch gauge.

2. Flexible vibration joints larger than 2 inches: Flexible bellows type, suitable for pressures of not less than 150 pounds per square inch gauge, at 70 degrees Fahrenheit, except as follows:
    a. Provide vibration joints in piping subject to test pressures higher than 150 pounds per square inch gauge, suitable for such higher pressures.
    b. Bellows: Stainless steel, equipped with a stainless steel liner.
    c. Ends: ASME Class 150 flanges.
3. Vibration joints in high-pressure air piping and in digester gas piping: Corrugated Type 316 stainless steel with stainless steel braid, suitable for pressures of not less than 150 pounds per square inch gauge:
    a. Ends: ASME Class 150 flanges.

C. Protection: Protect vibration absorbers against end loading and torsional stresses by anchoring attached piping.

2.06 TRANSITION FITTINGS

A. Manufacturers: One of the following or equal:
1. Spears.

B. Materials:
1. Slip socket: Schedule 80 PVC.
2. Collar: Type 316 stainless steel.
3. Threaded insert: Type 316 stainless steel.

2.07 PIPE SADDLES

A. Manufacturers: One of the following or equal:
1. BTR Inc./Smith-Blair, Inc., Style 317.
2. Romac Industries, Inc., Style 202S.

B. Materials:
1. Pipe saddles: Ductile iron.
2. Straps, bolts, and nuts: Type 304 stainless steel with Teflon coating on nuts.
3. Gaskets: EPDM.

2.08 TAPPING SLEEVES

A. Manufacturers: One of the following or equal:
1. BTR, Inc./Smith-Blair, Inc., Style 622.
2. Romac Industries, Inc., Style FTS 420.

B. Materials:
1. Tapping sleeves: Steel construction.
2. Bolts and nuts: Type 304 stainless steel.
3. Nuts: Teflon coated.
4. Gaskets: Rubber.
5. Size of tapped boss: As indicated on the Drawings.

2.09 SPRAY NOZZLES

A. Manufacturers: One of the following, or equal:
   1. Spaying Systems Co.; Wheaton, Illinois; FlatJet Model 3/8P-SS1540, with adjustable ball fitting Model 36725-1/2X3/8-SS.

B. Design:
   1. Operating pressure 40 pounds per square inch gauge, at which pressure each nozzle discharges not less than 3 gallons per minute, nor more than 5 gallons per minute:
      a. Spray: Flat fan with uniform distribution.
      b. Fan width at the water surface not less than 6 feet with 3.8 ft. of vertical distance at 40 pounds per square inch gauge.
      c. Spray Angle: 80 degrees minimum.
   2. The spray nozzles shall be equipped with an adjustable ball fittings.
   3. The spray nozzles shall be mounted to the spray header with a split-eyelet connector.
   4. Spray nozzles structurally suitable for pressure up to 150 pounds per square inch gauge.

C. Materials:
   1. Spray nozzles: 316 Stainless steel.
   2. Nozzles provided with 1/4 inch national pipe thread, and the orifice diameter not less than 0.153 inch.
   3. Adjustable ball fittings: 316 Stainless Steel.
   4. Split-eyelet connectors: 316 Stainless Steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Expansion control joints:
   1. Install bellows type expansion control joints at piping connections to mechanical equipment to prevent damaging stresses due to normal expansion and contraction with temperature changes in piping and connected equipment.
   2. Install bellows type expansion joints so as to allow 2-1/4 inch expansion per 100 linear feet of piping.
   3. Install expansion joints adjacent to an anchor, and provide 1 concentric guide on piping within 12 pipe diameters, but not more than 5 feet, from the end of the joint opposite the anchor:
      a. Locate a similar guide approximately 30 diameters but not more than 10 feet from the first.
   4. For expansion joints not installed adjacent to an anchor provide 2 concentric guides similarly located at each end of the joint.
   5. Provide control rods and additional guides where indicated on the Drawings, but at no greater intervals than recommended by the joint manufacturer in published instructions.
   6. Space intermediate supports a minimum of 10 feet, and tack weld the protective saddles to the pipe.

B. Expansion joints for steam cleaned piping:
   1. Install no less than 1 expansion joint in a run of steam cleaned piping which exceeds 20 feet in length:
      a. Do not exceed 200 feet in spacing of expansion joints.
   2. Install expansion joints in steam cleaned piping between anchors.

C. Bellows type expansion joints for steam and hot water:
   1. Install not less than 1 expansion joint in a run of steam or hot water piping which exceeds 20 feet in length:
      a. Do not exceed 150 feet spacing of expansion for steam piping and 200 feet for hot water piping.
   2. Where possible, install expansion joints adjacent to an anchor; provide piping with 2 concentric guides, the first being within 2 feet of the end of the joint opposite the anchor.
   3. At expansion joints not installed adjacent to an anchor, provide 2 concentric guides on piping within 2 feet off both ends of the expansion joint.
   4. Lock expansion joint against movement until pressure test is completed.

D. Vibration control joints:
   1. Install vibration control joints at piping connections to or from mechanical equipment to prevent transmitting equipment vibration through the piping system.

E. Transition couplings:
   1. Application:
      a. Use transition couplings with function and design similar to flexible couplings and flanged coupling adapters for connecting piping having different outside diameters.
   2. Install transition-coupling products specifically designed and manufactured for that application.

F. Pipe saddles:
   1. Coat threads on bolts with anti-gall coating prior to installation.

G. Tapping sleeves:
   1. Verify existing pipe material and outer diameter prior to ordering materials.
   2. Coat threads on bolts with anti-gall coating prior to installation.

H. Spray nozzles:
   1. Install spray nozzles so that elevation of the nozzles is 18 inches above the water surface.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer(each) services for each type of piping specialty:
   1. Provide Manufacturer’s Certificate of Source Testing.

C. Functional Testing:
   1. Pressure testing as specified in Sections 15052 and 15956.

END OF SECTION

SECTION 15121

PIPE COUPLINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pipe couplings for ductile iron piping.
   2. Pipe couplings for steel piping.
   3. Pipe couplings for stainless steel piping.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 01782 - Operation and Maintenance Data.
   4. Section 09960 - High-Performance Coatings.
   5. Section 15052 - Common Work Results for General Piping.
   6. Section 15956 - Piping Systems Testing.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.9 - Building Services Piping.

C. American Water Works Association (AWWA):
   1. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   2. C207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In.
   3. C606 – Standard for Grooved and Shouldered Joints.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   4. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   6. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

7. A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/9 ksi Minimum Tensile Strength, General Use.
8. A536 - Standard Specification for Ductile Iron Castings.
9. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
10. A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
11. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
12. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
13. F594 - Standard Specification for Stainless Steel Nuts.

E. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. Submit as specified in Section 01330.

B. Product data:
1. Shop drawings, detailing dimensions, and materials.
2. Piping layout drawings: Coordinate preparation of required piping layout drawings to show coupling sizes.

C. Provide vendor operation and maintenance manual as specified in Section 01782:
1. Furnish bound sets of installation, operation, and maintenance instructions for each type of manual valve 4 inch in nominal size and larger, and all non-manual valves. Include information on valve operators.

D. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756.

E. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756.

PART 2 PRODUCTS

2.01 GENERAL

A. Known acceptable manufacturers are listed by specific products.

B. Provide references as specified in this Section by specific product.

C. Manufacturer’s representatives requirements as specified in Section 01756 and this Section by specific product.

D. Gaskets for flexible couplings and flanged coupling adapters:
1. Provide gasket materials for piping applications as follows:
a. Low-pressure and high-pressure air, steam, hot water: EPDM.
b. All other piping applications: EPDM.

E. Exterior coatings for underground and submerged applications:
   1. Manufacturers: One of the following or equal:
      a. Tapecoat Company, Inc., T.C. Mastic.
      b. Kop-Coat Company, Inc., Bitumastic Number 50.
   2. Thickness: Minimum 0.040 inch.

2.02 PIPE COUPLINGS FOR DUCTILE IRON PIPING

A. Dismantling joints:
   1. Manufacturers: One of the following or equal:
      a. Romac Industries, Inc., Style DJ400.
      b. Smith-Blair, Inc., Series 975.
   2. Materials:
      a. Flanged spool: AWWA C207 steel pipe:
         a) ASTM A53 for sizes 3 inches to 12 inches.
         b) ASTM A36 for sizes 14 inches to 72 inches.
      b. End ring and body:
         1) For sizes 3 inches to 12 inches, ductile iron in accordance with ASTM A536.
         2) For sizes 14 inches to 72 inches, steel in accordance with ASTM A36 or A53.
      c. Follower ring: Ductile iron in accordance with ASTM A536.
      d. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
      e. Tie rods: High tensile steel in accordance with ASTM A193 Grade B7.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

B. Flanged coupling adapters: 12-inch size and smaller:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 227.
      b. Romac Industries, Inc., Style FCA501.
      c. Smith-Blair, Inc., Series 912.
   2. Materials:
      a. Flanged body: Ductile iron in accordance with ASTM A536.
      b. Follower ring: Ductile iron in accordance with ASTM A536.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

C. Flanged coupling adapters: Greater than 12-inch size:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 128-W.
      b. Romac Industries, Inc., Style FC400.
      c. Smith-Blair, Inc., Series 913.
   2. Materials:
      a. Flange and flanged body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      b. Follower ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

D. Flexible couplings:
   1. Manufacturers: One of the following or equal:
      a. Dresser, Inc., Style 253.
      b. Romac Industries, Inc., Style 501.
      c. Smith-Blair, Inc., Series 441.
   2. Materials:
      a. Center rings: Ductile iron in accordance with ASTM A536.
      b. Follower rings: Ductile iron in accordance with ASTM A536.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel in accordance with ASTM F593.
   3. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
   4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with following table:

Nominal Pipe Size	Sleeve Length
3 inch and smaller	Manufacturer's standard
4 inch through 8 inch	7 inches
10 inch through 14 inch	12 inches
Greater than 16 inch	Use steel flexible coupling per Pipe Couplings for Steel Piping

E. Restrained flange coupling adapter:
   1. Manufacturers: One of the following or equal:
      a. Romac Industries, Inc., Style RFCA.
      b. Star Pipe Products, 3200 StarFlange.

2. Materials:
    a. Flange and flanged body: Ductile iron in accordance with ASTM A536.
    b. Follower ring: Lug type restraint system:
        1) Follower ring: Ductile iron in accordance with ASTM A536.
        2) Restraining lugs: Ductile iron in accordance with ASTM A536:
            a) Designed to contact the pipe and apply forces evenly.
        3) Restraining bolts:
            a) Ductile iron in accordance with ASTM A536.
            b) Bolt heads shall be designed to twist off when the proper torque has been applied.
    c. Bolts and hex nuts:
        1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
        2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
5. Angular deflection: Restrained flange coupling adapter must allow angular deflection after assembly.

F. Grooved joint couplings:
1. Manufacturers:
    a. Victaulic Company, Series 31 or equal.
2. Materials:
    a. Housings: Ductile iron in accordance with ASTM A536.
    b. Gasket:
        1) FlushSeal® type, or equal. Elastomer in accordance with ASTM D2000.
        2) EPDM.
    c. Bolts and nuts: Electroplated steel in accordance with ASTM A449.
    d. Coating: As specified in Section 09960.
3. For use with rigid or flexible radius grooved components in accordance with AWWA C606.
4. For connection to IPS steel pipe sizes, Victaulic Style 307.

2.03 PIPE COUPLINGS FOR STEEL PIPING

A. Dismantling joints:
1. Manufacturers: One of the following or equal:
    a. Romac Industries, Inc., Style DJ400.
    b. Smith-Blair, Inc., Series 975.
2. Materials:
    a. Flanged spool:
        1) C207 Schedule 40 pipe in accordance with ASTM A53 for sizes 3 inches to 12 inches.
        2) Steel for pipe in accordance with ASTM A36 or A53 for sizes 14 inches to 72 inches.

b. End ring and body:
    1) For sizes 3 inches to 12 inches, ductile iron in accordance with ASTM A536.
    2) For sizes 14 inches to 72 inches, steel in accordance with ASTM A36.
c. Follower ring: Ductile iron in accordance with ASTM A536 or steel in accordance with ASTM A36 or A576.
d. Bolts and hex nuts:
    1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
    2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
e. Tie rods: High tensile steel in accordance with ASTM A193 grade B7.

3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Fusion bonded epoxy certified in accordance with NSF 61.

B. Flanged coupling adapters:
1. Manufacturers: One of the following or equal:
    a. Dresser, Inc., Style 128-W.
    b. Romac Industries, Inc., Style FCA501 (10 inch and smaller) or Style FC400 (12 inch and larger).
    c. Smith-Blair, Inc., Series 913.
2. Materials:
    a. Flange and flanged body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
    b. Follower ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
    c. Bolts and hex nuts:
        1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.
        2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer’s standard fusion bonded epoxy, NSF 61 certified.

C. Flexible couplings:
1. Manufacturers: One of the following or equal:
    a. Dresser, Inc., Style 38.
    b. Smith-Blair, Inc., Series 411.
    c. Romac Industries, Inc., Style 511 or Style 400.
2. Materials:
    a. Center sleeve and follower flanges: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
    b. Bolts and hex nuts:
        1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
        2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.

3. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with following table:

Nominal Pipe Diameter	Sleeve Length
2-1/2 inch and smaller	Manufacturer's standard
3 inch through 6 inch	7 inch
8 inch through 14 inch	7 inch
Greater than 14 inches	10 inch

D. Restrained flange coupling adapters:
1. Manufacturers: One of the following or equal:
   a. Romac Industries, Inc., Style RFCA.
   b. Star Pipe Products, 3200 StarFlange.
2. Materials:
   a. Flange and flanged body: Ductile iron in accordance with ASTM A536.
   b. Follower ring: Lug type restraint system:
      1) Follower ring: Ductile iron in accordance with ASTM A536.
      2) Restraining lugs: Ductile iron in accordance with ASTM A536:
         a) Designed to contact the pipe an apply forces evenly.
      3) Restraining bolts: Ductile iron in accordance with ASTM A536. Bolt heads shall be designed to twist off when the proper torque has been applied.
   c. Bolts and hex nuts:
      1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.
      2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy certified in accordance with NSF 61.

E. Grooved joint couplings:
1. Model numbers from one manufacturer are shown to indicate type only. Equivalent products of other manufacturers may be submitted for approval.
2. Coating: As specified in Section 09960.
3. Sizes through 12 inch:
   a. Rigid type:
      1) Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ASME B31.1 and B31.9.
      2) 2 inch through 6 inch: Installation-ready, for direct stab installation without field disassembly, with grade EHP gasket rated to plus 250 degrees Fahrenheit.
      3) Manufacturer: One of the following or equal:
         a) Victaulic Style 107.
         b) Victaulic Zero-Flex Style 07.

b. Flexible type:
1) For use in locations where vibration attenuation and stress relief are required.
2) Three flexible couplings may be used in lieu of a flexible connector.
3) The couplings shall be placed in close proximity to the source of the vibration.
4) Manufacturer: The following or equal:
a) Victaulic Style 77.
c. Flange adapter:
1) Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.
2) Manufacturer: The following or equal:
a) Victaulic Style 741.

4. Sizes 14 inch through 24 inch:
a. Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.
b. Rigid type:
1) Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ASME B31.1 and B31.9.
2) Manufacturer: The following or equal:
a) Victaulic Style W07.
c. Flexible type:
1) Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement.
2) Manufacturer: The following or equal:
a) Victaulic Style W77.
d. Flange adapter:
1) Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.
2) Manufacturer: The following or equal:
a) Victaulic Style W741.

5. For sizes 30 inch and larger:
a. Manufacturer: The following or equal:
1) Victaulic Style AGS multiple-segment housing may be used.

2.04 PIPE COUPLINGS FOR STAINLESS STEEL PIPING

A. Flexible couplings:
1. Manufacturers: One of the following or equal:
a. Dresser, Inc., Style 38.

B. Grooved joint couplings:
1. Manufacturers: One of the following or equal:
a. Victaulic Company.
2. Materials:
a. Housings:
1) Ductile iron in accordance with ASTM A536.
2) Stainless steel in accordance with ASTM A351.

b. Gasket: Elastomer in accordance with ASTM D2000.
c. Bolts and nuts:
1) Electroplated steel in accordance with ASTM A449.
2) Stainless steel in accordance with ASTM F593.

3. Rigid type:
a. Victaulic Style 89 and W89 (ductile iron housings).
b. Victaulic Style 489 (stainless steel housings).

4. Flexible type: Victaulic Style 77S.

PART 3 EXECUTION

3.01 INSTALLATION

A. In underground and underwater installations, coat the exterior of coupling with a protective coating in accordance with manufacturer's instructions.

B. Joints and flexible connections shall be installed centered with no angular deflection unless otherwise indicated on the Drawings.

C. Flexible couplings and flange coupling adapters: Install with gap between pipe ends in accordance with the following table unless a greater gap is indicated on the Drawings. Maximum gap tolerance shall be within 1/8 inch:
1. Install flexible coupling with pipe gap located in middle of center sleeve.
2. Install flanged coupling adapter with end of plain end pipe in middle of flanged coupling body.

Center Ring Length	Gap Dimension and Tolerance
4 inch through 6 inch	3/8 inch
7 inch	5/8 inch
10 inch and greater	7/8 inch

D. Provide harnesses (tie-downs) for flexible couplings unless otherwise indicated on the Drawings with a written note:
1. Design harnesses (tie-downs) for the test pressures as specified in the Piping Schedule in Section 15052.

E. Grooved joint couplings:
1. Grooved ends: Clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
2. Gaskets: Elastomer grade suitable for the intended service, and molded and produced by the coupling manufacturer.
3. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756.

3.02 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer(each) services for each type of pipe coupling:
1. Provide Manufacturer’s Certificate of Source Testing.

2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

			Manufacturer Rep Onsite					
	Training Requirements		Installation Testing		Functional Testing		Process Operational Period	
Source Testing (Witnessed or Non-witnessed)	**Maintenance (hrs per session)**	**Operation (hrs per session)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**
Non-Witnessed	4	2	1	2	1	1	Not Required	

C. Functional Testing:
1. Pressure testing as specified in Sections 15052 and 15956.

END OF SECTION

SECTION 15122

FIRE HYDRANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Barrel type fire hydrants.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C 502 - Standard for Dry-Barrel Fire Hydrants.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: One of the following or equal:
   1. Mueller Company, Number A-421.
   2. Kennedy, Model K81D.
   3. Clow Valve Company, Medallion Hydrant.

2.02 MATERIALS

A. Fire hydrants:
   1. Dry barrel in accordance with type AWWA C 502, as complemented and modified in this Section.
   2. Provide hydrants with ground level break-off feature and manufactured such that the valve stem will not be bent when the hydrant is damaged or broken at or near the ground level.
   3. When shut, provide valves that remain reasonably tight when the upper portion of the barrel is broken off.
   4. Diameter of the main valve opening: Not less than 4 inches.
   5. Inlet connection: 6-inch diameter mechanical joint for ductile iron pipe.
   6. Provide two 2-1/2-inch hose nozzles and one 4-inch pumper nozzle facing the street.
      a. Provide nozzles with hose caps chained to the hydrant barrel.
      b. Nozzle threads: National standard hose thread.
   7. Hydrants: Furnish with drain valve.
   8. Color of hydrant above ground.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install hydrants with proper extension so that branch pipe to hydrant and supply main are at the same elevation.

B. Attach auxiliary 6-inch gate valves by mechanical joint at 18 inches from the hydrant joint, and attach piping ductile-iron to the supply.

C. Firmly set hydrants on a bed of coarse gravel.

END OF SECTION

SECTION 15211

DUCTILE IRON PIPE: AWWA C151

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Ductile iron pipe, joints, fittings, gaskets, and pipe linings and coatings.

B. Related sections:
1. Section 01330 - Submittal Procedures.
2. Section 01756 - Commissioning.
3. Section 02318 - Trenching.
4. Section 09960 - High-Performance Coatings.
5. Section 15052 - Common Work Results for General Process Piping.
6. Section 15057 - Fusion Bonded Epoxy Lining.
7. Section 15121 - Pipe Couplings and External Joint Restraints.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. American Water Works Association (AWWA):
1. C104 - Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
2. C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
4. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. C115 - Flanged Ductile Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. C150 - Standard for Thickness Design of Ductile-Iron Pipe.
7. C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.
8. C153 - Standard for Ductile-Iron Compact Fittings for Water Service.
9. C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.
10. C606 - Standard for Grooved and Shouldered Joints.

C. American Welding Society (AWS):
1. D11.2 - Guide for Welding Iron Castings.

D. ASTM International (ASTM):
1. A47 - Standard Specifications for Ferritic Malleable Iron Castings.
2. A183 - Standard Specifications for Carbon Steel Track Bolts and Nuts.
3. A536 - Standard Specifications for Ductile Iron Castings.
4. C283 - Standard Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
5. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

E. Ductile Iron Pipe Research Association (DIPRA):
   1. Thrust Restraint Design Manual.

F. NACE International (NACE):
   1. SP0188 - Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.

G. National Association of Pipe Fabricators, Inc. (NAPF):
   1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings.

H. Society for Protective Coatings (SSPC):
   1. PA-2 - Measurement of Dry Coating Thickness With Magnetic Gages.

1.03 SYSTEM DESCRIPTION

A. Thrust restraint system design:
   1. Design restrained joint thrust restraint system.
   2. Determine the length of pipe that must be restrained on each side of the focus of a thrust load in accordance with the procedures and criteria established by the DIPRA Thrust Restraint Design Manual as specified in Piping Schedule in Section 15052 and the following additional criteria:
      a. Design pressure: Test pressure.
      b. Laying condition: Type 5 in accordance with AWWA C150.
      c. Soil designation: Silt 1 as defined by DIPRA.
      d. Unit friction resistance: Based upon polyethylene encasement of pipe.
      e. Safety factor: 1.5 (for thrust restraint calculations only).

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Shop Drawings:
   1. Detailed layout drawings showing alignment of pipes, location of valves, fittings, and appurtenances, types of joints, connections to structures, and thrust restraint system layouts.
   2. Thrust restraint systems: Calculations and layout for restrained joint thrust restraint systems.
   3. Photographs, drawings, and descriptions of fittings, gaskets, couplings, grooving of pipe and fittings, pipe linings, and coatings.

C. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756:
   1. Manufacturer's test reports for polyurethane, ceramic epoxy, and glass lining certifying successful performance of holiday detection tests:
      a. This documentation shall identify each piece by mark designation, and show the actual test results during the final inspection by the manufacturer prior to shipment.
      b. Acceptance criteria for glass lining shall be as specified under Field Quality Control.
   2. Manufacturer’s test results for glass lined pipe-certifying compliance with specified material requirements for glass lining.
   3. Include Coating Manufacturer’s Technical Representative’s reports.

D. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Lining manufacturers: For piping specified to receive glass or epoxy lining, use only a lining manufacturer having a minimum of 5 years experience supplying this type of product to the wastewater and water industry.
   2. Welded on outlets: The pipe manufacturer shall have a minimum of 5 years experience in the fabrication and testing of outlets of similar size and configuration similar to those used on the Project.

B. Pre-installation meeting:
   1. Arrange for Coating Manufacturer's Technical Representative to attend preconstruction conferences, and to make periodic visits to factory or shop to inspect surface preparation of pipe, fittings, and accessories; and to inspect application of linings to interior and coatings to exterior of pipe, fittings, and accessories.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Block piping and associated fittings for shipment to prevent damage to coatings and linings.

B. Carefully handle piping and associated fittings during loading, unloading, and installation:
   1. Do not drop piping material from cars or trucks.
   2. Lower piping by mechanical means.
   3. Do not drop or pound pipe to fit grade.

C. Ceramic epoxy, Glass, and Polyurethane lined pipe and fittings must be handled only from the outside:
   1. No forks, chains, straps, hooks, or other lifting device shall be placed inside the pipe or fittings for lifting, positioning, or laying.

D. Protect gaskets and polyethylene encasement from long-term exposure to sunlight.

E. Store piping, fittings, and other accessories such that they do not accumulate and hold rainwater, dirt, and debris.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Ductile iron piping:
   1. Typical type:
      a. In accordance with AWWA C150 and AWWA C151.
      b. Pressure class or special thickness class as indicated in the Piping Schedule provided in Section 15052.
      c. Manufactured from greater than 90 percent recycled material.

2. Type with screw-on flanges:
    a. In accordance with AWWA C115 with minimum special thickness Class 53 wall thickness as required for screw-on flanges.
    b. Special thickness class as indicated in the Piping Schedule as specified in Section 15052.
    c. Manufactured from greater than 90 percent recycled material.
3. Type with grooved couplings:
    a. Special thickness class as indicated in the Piping Schedule as specified in Section 15052.
    b. Manufactured from greater than 90 percent recycled material.

B. Joints:
1. Flanged joints:
    a. Screw-on flanges: Comply with the diameter, thickness, drilling, and other characteristics in accordance with ASME B16.1. In addition, comply with the following requirements:
        1) Ductile iron.
        2) Long hub, threaded, and specially designed for ductile iron pipe.
        3) After attaching to pipe, machine flange face to make pipe end and flange even and perpendicular to the axis of the pipe.
    b. Bolt holes on flanges: 2-holed and aligned at both ends of pipe.
    c. Cap screw or stud bolt holes: Tapped.
    d. Bolts and nuts: As specified in Section 15052.
    e. Gaskets: Standard styrene butadiene copolymer (SBR) unless specified otherwise in Section 15052.
2. Grooved joints: In accordance with AWWA C606, as complemented and modified below, radius-cut type, with following components:
    a. Couplings: Rigid type, cast from ductile iron in accordance with ASTM A536, Grade 65-45-12, or malleable iron in accordance with ASTM A47, Grade 32510.
    b. Bolts and nuts: In accordance with ASTM A183, Grade 2.
    c. Gaskets: Capable of being applied on surface of piping with cavities to provide for an improved seal with the internal piping pressure. Material to be used for following services:
        1) For liquid service: Halogenated butyl.
        2) For air service: Fluoroelastomer.
        3) For hot water service: EPDM.
    d. Fittings: In accordance with AWWA C606, rigid radius-cut groove:
        1) Center-to-center dimensions: In accordance with AWWA C110.
        2) Wall thickness and other characteristics: In accordance with AWWA C606.
    e. Flanged unit connections: Flanged to grooved joint adapters or a long enough spool with one end flanged and the other end grooved to prevent interference with the operation of adjacent valves, pumps, or other items.
3. Mechanical joints: In accordance with AWWA C111.
4. Push-on rubber gasket joints: In accordance with AWWA C111.
5. Integrally restrained mechanical joints:
    a. Application:
        1) Where designation Mech Rest.
        2) MJ is specified in the Piping Schedule provided in Section 15052, supply a restrained mechanical joint piping system, which includes

restrained mechanical joints where necessary based upon thrust calculations.
3) Standard mechanical joints as specified above can be used where thrust calculations demonstrate restraint is not required.

b. Design:
1) Integral retainer weldment type or lugged type joint with Type 304 stainless steel rods and nuts.
2) Restrained mechanical joints of the configuration which utilizes a gripping or friction force for restraint will not be acceptable.

c. Manufacturers: Where restrained mechanical joints are required, use one of the following or equal:
1) American Cast Iron Pipe Company, MJ Coupled Joint.
2) Pacific States Cast Iron Pipe Company, Lock Mechanical Joint.
3) U.S. Pipe, Bolt-Lok.

6. Integrally restrained push-on joints:
a. Application:
1) Where designation restrained push-on is specified in the Piping Schedule provided in Section 15052, supply a restrained push-on joint piping system, which includes restrained push-on joints where necessary based upon thrust calculations.
2) Standard push-on rubber gasket joints as specified above can be used where thrust calculations demonstrate restraint is not required.

b. Design:
1) Restrained push-on joints of the configuration which utilizes a gripping or friction force for restraint will not be acceptable.
2) Suitable for the following working pressures:
a) For 4- through 24-inch pipe: 350 pounds per square inch gauge.
b) For 30- through 54-inch pipe: 250 pounds per square inch gauge.

c. Manufacturers: One of the following or equal:
1) U.S. Pipe, TR Flex.
2) McWane Ductile, TR Flex.
3) American Cast Iron Pipe Company, Flex Ring or Lok-Ring.

d. Limit buried joints to half the manufacturer's published allowable angular joint deflection for purposes of pipeline alignment and elimination of fittings.

C. Fittings:
1. Ductile iron in accordance with AWWA C110.
2. Joint type: Same as that of the associated piping as specified in Section 15052.
3. Plain end-to-flanged joint connectors using setscrews are not acceptable.

D. Pipe linings:
1. Cement-mortar lining:
a. In accordance with AWWA C104, apply cement-mortar on clean bare metal surfaces. Extend to faces of flanges, ends of spigots, and shoulders of hubs.
b. Minimum lining thickness: Standard in accordance with AWWA C104.
c. Type of cement: Type II.

2. Asphaltic seal coat:
    a. Apply over cement mortar linings and to outside surface of pipes that will not receive another coating. Apply in accordance with AWWA C151.
3. Elastomeric polyurethane (100 percent solids) lining:
    a. As specified in Section 09960.
4. Ceramic epoxy lining:
    a. Manufacturers: One of the following or equal:
        1) PROTECTO 401.
        2) SP-2000W.
    b. Material: Amine cured Novolac epoxy containing at least 20 percent by volume of ceramic quartz pigment.
    c. Minimum dry film thickness (DFT): 40 mills.
    d. Application:
        1) The lining shall only be applied by a manufacturer-authorized representative with no less than 5 years of experience in applying the specified material.
        2) The application of the lining shall be performed in accordance with manufacturer's published specifications.
        3) Pipe and fittings shall be delivered to application facility with no interior lining.
        4) Interior of pipe shall be abrasive blasted per manufacturer's specifications.
    e. Coverage:
        1) Gasket and spigot ends-on joints: Provide 6 mils minimum and 10 mils maximum coverage using joint compound as specified by the manufacturer for the gasket area and spigot ends.
        2) Mechanical joints: Extend lining from spigot end to edge of gauging ring.
        3) Number of coats: As recommended by the lining manufacturer.
    f. Source quality control:
        1) Test pipe and fitting lining with a magnetic film thickness gauge. Perform testing in accordance with the method outlined in SSPC PA-2 Film Thickness Rating.
        2) Test lining integrity of pipes using a holiday detection testing instrument set at the voltage as specified by the coating manufacturer:
            a) Repair all holidays with joint compound in accordance with the recommendations of the coating manufacturer, and re-test.
        3) Discard piping or reline piping when pinholes or discontinuities are found.
5. Glass lining:
    a. Manufacturers: One of the following or equal:
        1) Water Works Manufacturing, Ferrock MEH-32 Lining.
        2) Vitco Corporation, SG-14 Lining.
    b. Material: Special glasses and inorganic materials suited for lining of sewage, sludge, and scum piping with the following characteristics:
        1) Thickness: 0.008 to 0.012 inch.
        2) Hardness: 5 to 6 on the Mohs Scale.
        3) Density: 2.5 to 3.0 grams per cubic centimeter, measured in accordance with ASTM D792.

4) Thermal shock resistance: Capable of withstanding 350 degrees Fahrenheit change from 430 degrees Fahrenheit to 80 degrees Fahrenheit without crazing, blistering, or spalling.
5) Gloss retention: Capable of retaining gloss after immersion in an 8 percent sulfuric acid solution at 148 degrees Fahrenheit for 10 minutes.
6) Weight loss: Maximum 3 milligrams per square inch when tested in accordance with ASTM C283.

c. Fabrication:
1) Use piping that is suitable for glass lining with minimum Class 53 wall thickness after application of glass lining.
2) Machine interior of pipe. Bore or grit blast in accordance with NAPF 500-03 prior to application of glass lining.
3) Screw factory assembled flanges on pipe, align boltholes, and flange faces, unless otherwise specified.
4) Apply lining to surfaces free of chemicals.
5) Place piping in furnaces specially designed for heating piping until glass melts and fuses with an integral molecular bond to the base metal.

2.02 POLYETHYLENE ENCASEMENT

A. General:
1. Polyethylene encasement shall be supplied by the pipe manufacturer.

B. Materials: Supply one of the following polyethylene encasements:
1. 2 layers of linear low-density polyethylene (LLDPE) film, minimum thickness of 8 mils in accordance with AWWA C105.
2. Single layer of high-density, cross-laminated polyethylene (HDCLPE) film, minimum thickness of 4 mils in accordance with AWWA C105.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Install ductile iron piping in accordance with AWWA C600, modified as specified in Section 15052.
2. For underground piping, the trenching, backfill, and compaction: As specified in Section 02318.

B. Polyethylene encasement:
1. Wrap all buried ductile iron pipe and fittings in 2 layers of loose low density polyethylene wrap or a single layer of high-density polyethylene wrap in accordance with AWWA C105.
2. Polyethylene encasement shall be continuous and terminated neatly at connections to below grade equipment or structures.
3. At wall penetrations, extend encasement to the wall and neatly terminate.
4. At slab penetrations, extend encasement to 2 inches below the top of slab and neatly terminate.

5. When rising vertically in unimproved areas, extend encasement 6 inches above existing grade and neatly terminate.
6. Repair tears and make joints with 2 layers of plastic tape.
7. All work shall be inspected prior to backfilling of pipe and associated items.

C. Joints:
1. Install types of joints as specified in the piping schedule provided in Section 15052.
2. Mechanical joints are not acceptable in above ground applications.
3. Field closure for restrained push-on pipe:
   a. Locate field closures in areas where thrust calculations demonstrate restraint is not required.
4. Grooved joints:
   a. Install piping with grooved joints where specified in the piping schedule as specified in Section 15052 or indicated on the Drawings.
   b. Assemble grooved joints in accordance with manufacturer's published instructions.
   c. Support grooved-end pipe in accordance with manufacturer's published instructions:
      1) Install at least 1 support between consecutive couplings.

D. Tapping ductile iron pipe:
1. Direct tapping of ductile iron pipe may be performed but is limited to the following conditions:
   a. Maximum allowable tap diameter by pipe diameter and pressure class:

Pipe Size (inches)	**Pressure Class**				
	150	**200**	**250**	**300**	**350**
	Maximum Allowable Direct Tap Size (inches)				
3	-	-	-	-	3/4
4	-	-	-	-	3/4
6	-	-	-	-	1
8	-	-	-	-	1
10	-	-	-	-	1
12	-	-	-	-	1-1/4
14	-	-	1-1/4	1-1/2	1-1/2
16	-	-	1-1/2	2	2
18	-	-	2	2	2
20	-	-	2	2	2
24	-	2	2	2	2

   b. The maximum allowable tap diameter for pipelines greater than 24 inches is 2 inches.
   c. Two layers of 3-mil thread sealant are required to minimize the torque required to effect a watertight connection.
2. Direct tapping of glass lined ductile iron pipe may be performed only when approved in writing by the Engineer. Direct tapping of glass lined pipe shall be

performed in accordance with the above conditions for tapping ductile iron pipe in addition to the following conditions:

a. Drilling and tapping shall be performed using a hole saw:
   1) Use of a large drill bit is not acceptable.
b. As the hole saw approaches the glass lining, lessen the inward pressure to avoid excess chipping or cracking of the lining.
c. Minor chipping or spalling of the glass lining shall be repaired using an epoxy resin "glass repair kit" provided by the fabricator:
   1) Manufacturers: One of the following or equal:
      a) Devoe - Devran 224 HS.
      b) Sherwin-Williams Co. – Sher-Tile High Solids Epoxy.
   2) Repair kit use is only allowed for areas of damage less than 1/2 inch in diameter:
      a) Larger areas of damage will require replacement.
   3) Surface shall be prepared and repair kit shall be applied in accordance with manufacturer and/or fabricator's instructions.

3.02 FIELD QUALITY CONTROL

A. Testing ductile iron piping:
   1. Test as specified in Section 15052.
   2. Do not test sections longer than 1/2 mile in total pipe length.

B. Repair damaged cement mortar lining to match quality, thickness, and bonding of original lining in accordance with AWWA C104:
   1. When lining cannot be repaired or repairs are defective, replace defective piping with undamaged piping.

C. Verify that interior surfaces of glass lined pipe and fittings have continuous coverage:
   1. Verify with low voltage wet sponge holiday detector in accordance with NACE SP0188.
   2. Discard glass lined ductile iron piping and fittings with voids or casting anomalies. that exceed the maximum non-visible pinholes allowances below:

Diameter	Maximum Pinholes	
	Fittings	Pipe (per 20-foot length of pipe)
4- to 8-inch	3-5	10-12
10- to 18-inch	5-8	18-20
20-inch and Larger	8-10	25-28

   3. Discard lined piping and fittings found to have pinholes, crazing, or fish scales, which expose the metal substrate.

3.03 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

			Manufacturer Rep Onsite					
Source Testing (Witnessed or Non-witnessed)	**Training Requirements**		**Installation Testing**		**Functional Testing**		**Process Operational Period**	
	Maintenance (hrs per session)	**Operation (hrs per session)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**
Non-witnessed	Not required		Not required		Not required		Not required	

END OF SECTION

SECTION 15223

REINFORCED CONCRETE LOW-HEAD PRESSURE PIPE: ASTM C361

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Reinforced concrete low-head pressure pipe, joints, fittings, and specials.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 09960 - High-Performance Coatings.
   4. Section 15052 - Common Work Results for General Piping
      Section 15058 - Plastic Liner for Concrete Pipe.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Water Works Association (AWWA):
   1. C207 – Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 Inches Through 144 Inches.
   2. C 302 - Reinforced Concrete Pressure Pipe, Noncylinder Type.
   3. M11 - Steel Pipe: A Guide for Design and Installation.

C. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
   3. C33 - Standard Specifications for Concrete Aggregates.
   4. C150 - Standard Specifications for Portland Cement.
   5. C302 - Standard Test Method for Density and Dimensions of Preformed Pipe-Covering-Type Thermal Insulation.
   6. C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   7. D297 - Standard Test Methods for Rubber Products - Chemical Analysis.
   8. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   9. D2240 - Standard Test Method for Rubber Property-Durometer Hardness

1.03 SYSTEM DESCRIPTION

A. Design requirements: Design pipe and fittings in accordance with ASTM C361 and the following:
   1. Pressure: The difference between pipe centerline and a hydraulic grade line elevation corresponding to the ground surface elevation or the test pressure scheduled in Section 15052, whichever is higher.

2. Earth load: The cover over the piping plus H-20 loading in accordance with AASHTO standard specifications for highway bridges.
3. Piping class: As calculated or as scheduled in Section 15052, whichever is higher.
4. Design fittings and specials: In accordance with AWWA C 302, fabricated steel piping; reinforced with cement-mortar lining and coating in accordance with AWWA M11 as complemented and modified below:
    a. Design pressure: As specified.
    b. Wall thickness of steel fittings and specials: As calculated, or 3/8 inch, whichever is thicker.
    c. Interior steel cover: Minimum 1-1/4 inches.

1.04 SUBMITTAL

A. Submit as specified in Section 01330.

B. Shop Drawings:
1. Layout drawings.
2. Joints.
3. Fittings and specials.
4. Curves and beveled pipe.
5. Structure and pipe connections.
6. Curing methods.
7. Gaskets.

C. Test results.

D. Design calculations.

E. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756.

F. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete materials for pipe manufacture:
1. Cement: ASTM C150, Type II, low alkali.
2. Aggregates: ASTM C33 except that total deleterious materials shall not exceed 3 percent.

B. Materials for gaskets: ASTM C361, O-ring synthetic neoprene rubber gaskets, except as follows:
1. Tensile strength: Minimum 1,900 pounds per square inch when tested in accordance with ASTM D412.
2. Type A shore durometer hardness: 55 within 3 when tested in accordance with ASTM D2240.
3. Specific gravity: Between 1.29 and 1.30 when tested in accordance with ASTM D297.
4. Basic polymer: Minimum 50 percent by volume of neoprene stock.

C. Joints: Neoprene rubber gasket type, capable of sealing joints from either internal or external hydrostatic pressure:
   1. Do not use plastic or fiberglass bell rings or collars.
   2. Do not use flush type joints which utilize embedded steel bell rings and spigots.

D. Fittings and specials:
   1. Fitting flanges: AWWA C 207, Class B.
   2. Structure and pipe connections:
      a. Concrete pipe to steel pipe or fittings: Welded steel bell ring of size and shape to fit pipe and fitting ends.
      b. Concrete pipe to structure: Steel bell ring cast in structure with gasket for flexible joint as indicated on the Drawings.
      c. Typical connections: With Carnegie type joint using O-ring gaskets.
      d. Steel bell rings: ASTM A36 or ASTM A283.
      e. Bell ring coating: High solids polyamine epoxy as specified in Section 09960.

E. Provide plastic liner as specified in Section 15058.

2.02 SOURCE QUALITY CONTROL

A. Perform at least 1 hydrostatic test for each size pipe.

B. Perform at least 1 hydrostatic test on 2 pipes joined together to test a joint. When straight pipe joints are deflected to form curves, test a joint with the maximum deflection.

C. Dye check welds in fittings.

2.03 FABRICATION

A. Manufacture pipe by the centrifugally spun process or by vertical casting between stationary inner and outer metal forms:
   1. Do not use packer-head type pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install pipe as specified in Section 15052 and this Section.

B. Laying pipe:
   1. Assemble and join joints in accordance with the manufacturer's published instructions for the type of joint.
   2. When assembled, check the position of each rubber gasket with a feeler gauge.
   3. Capture neoprene rubber gaskets so gaskets cannot be forced out of intended position because of hydrostatic pressure or forced in when making joints during pipe laying.

C. Installation of curves:
   1. In general, make horizontal and/or vertical curves using pipe with beveled joints or by slight deflections in the joints of straight pipe:
      a. Do not exceed 5 degrees total angular deflection at a joint for beveled pipe.
      b. Maximum joint opening: Do not exceed 3/4 inch for 36-inch pipe and smaller and 1 inch for pipe larger than 36 inch.
   2. Where necessary, make short length pipes for curves of shorter radius than can be made with beveled pipe of usual length.

3.02 REPAIR

A. Repair damaged pipe in accordance with ASTM C361 except use epoxy bonding agent to bond mortar to concrete.

3.03 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

			Manufacturer Rep Onsite					
Source Testing (Witnessed or Non-witnessed)	**Training Requirements**		**Installation Testing**		**Functional Testing**		**Process Operational Period**	
	Maintenance (hrs per session)	**Operation (hrs per session)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**
Non-witnessed	Not required		Not required		Not required		Not required	

END OF SECTION

SECTION 15230

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Plastic pipe, tubing, and fittings.

B. Related sections:
1. Section 01330 - Submittal Procedures.
2. Section 01756 - Commissioning.
3. Section 15052 - Common Work Results for General Piping.
4. Section 15211 - Ductile Iron Pipe: AWWA C159.
5. Section 15956- Piping Systems Testing.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
1. B16.12 - Cast Iron Threaded Drainage Fittings.

B. ASTM International (ASTM):
1. D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.
2. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
3. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
4. D1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
5. D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
6. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
7. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
8. D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
9. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
10. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
11. D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride)(PVC) Pipe and Fittings.
12. D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
13. D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
14. D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

15. D3350 - Standard Specification for Polyethylene Plastic Pipes and Fittings Materials.
16. D4101 – Standard Specification for Polypropylene Injection and Extrusion Materials.
17. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
18. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.
19. F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
20. F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
1. C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches to 12 Inches (100 mm Through 300 mm), for Water Transmission Distribution.

D. NSF International (NSF).

E. Plastics Pipe Institute (PPI):
1. TR 31 - Underground Installation of Polyolefin Piping.

1.03 ABBREVIATIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. CPVC: Chlorinated polyvinyl chloride.

C. DR: Dimension ratio.

D. DWV: Drain, waste, and vent.

E. ID: Inside diameter of piping or tubing.

F. NPS: Nominal pipe size followed by the size designation.

G. NS: Nominal SIZE of piping or tubing.

H. PE: Polyethylene.

I. PP: Polypropylene.

J. PVC: Polyvinyl chloride.

K. SDR: Standard dimension ratio; the outside diameter divided by the pipe wall thickness.

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Shop Drawings:
   1. Describe materials, pipe, fittings, gaskets, and solvent cement.
   2. Installation instructions.
   3. Polyethylene pipe submittals: Include:
      a. Installation equipment including details on fusion machine used to join polyethylene pipe sections.
      b. Qualifications of installation crew for use of the fusion machine used for joining polyethylene pipe.

C. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756. Include as applicable:
   1. Date of manufacture of plastic pipe and tubing for each lot delivered.
   2. Solvent cement manufacturer's report and certification.

D. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.05 QUALITY ASSURANCE

A. Fusion machine technician qualifications: 1-year experience in the installation of similar PE piping systems from the same manufacturer.

B. Plastic pipe in potable water applications: Provide pipe and tubing bearing NSF seal.

C. Mark plastic pipe with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required in accordance with ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring, and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

C. Store and handle PE pipe and fittings as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except that fittings used in drain, waste, and vent piping systems need not be pressure rated.

C. Unions 2-1/2 inches and smaller: Socket end screwed unions. Make unions 3 inches and larger of socket flanges with 1/8-inch full-face soft neoprene or Viton gasket. Use Viton gaskets for chlorine solution.

2.02 PVC PIPING, SCHEDULE TYPE

A. Materials:
   1. PVC Pipe: Designation PVC 1120 in accordance with ASTM D1785 and appendices:
      a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454-B material in accordance with ASTM D1784.
      b. PVC Pipe: Schedule 80 unless otherwise indicated on the Drawings or Section 15052 Pipe Schedule.
   2. Fittings:
      a. Supplied by pipe manufacturer.
      b. Pressure fittings: In accordance with ASTM D2466 or ASTM D2467.
      c. DWV fittings: In accordance with ASTM D2665.
   3. Solvent cement: In accordance with ASTM D2564:
      a. Chemical service: For CPVC or PVC pipe in chemical service, provide the following primer and cement, or equal:
         1) Primer: IPS Corp Type P70.
         2) Cement: IPS Corp Type 724 cement or another cement certified by the manufacturer for chemical service.

2.03 PVC PIPING, CLASS TYPE

A. Fittings: Ductile iron with transition gasket sized to accommodate the outside pipe diameter.

B. PVC pipe, Class Type: In accordance with AWWA C900:
   1. Pressure Class: as scheduled in Section 15052 with a maximum DR of 18.
   2. Fittings: Cast or ductile iron fittings as specified in Section 15211, sized for the dimensions of the pipe being used.
   3. Joint design: Push-on or mechanical joint type as identified in Piping Schedule.
   4. Gaskets: Neoprene, EPDM, or Viton in accordance with ASTM D1869 or ASTM F477.

2.04 PVC GRAVITY DRAIN PIPING

A. Materials:
   1. Polyvinyl chloride (PVC) gravity sewer pipe and fittings: In accordance with ASTM D3034 for piping NPS 15 and smaller diameter, and to ASTM F679 for piping NPS 18 and larger diameter:
      a. Referenced standards apply as complemented and modified in this Section.
      b. Fittings: Supplied by the pipe manufacturer.
   2. PVC compounds: Class Number 12454-C, in accordance with ASTM D1784:

a. Stabilizers, antioxidants, lubricants, colorants, and other additives and fillers: Not to exceed 10 parts by weight per 100 of PVC resin in the compound.

3. Pipe NPS 15 and smaller diameter: Wall thickness SDR 26:
   a. Joints: Push-on joints in accordance with ASTM D3212.
4. Fittings, including wyes, tees, elbow caps, plug adapters, and manhole waterstops: Same wall thickness as the pipe:
   a. Fittings: Factory molded with joints and gaskets equal to those of the pipe.
5. Gasket: Neoprene in accordance with ASTM D3212 or ASTM F477:
   a. Keep rubber gasket in place during pipe joining.
6. Gasket for connection to manhole: Stainless steel clamp with gasket or similar device to seal the penetration.

2.05 POLYETHYLENE PIPING FOR DRAIN, WASTE, AND VENT PIPING SYSTEMS

A. General:
   1. Pipe and fittings: High-density polyethylene.
   2. Dimensions of pipe and fittings: Based on controlled outside diameter in accordance with ASTM F714:
      a. SDR: Maximum of 11.

B. Manufacturers: One of the following or equal:
   1. DuPont, Sclairpipe.
   2. Polaris, Duratuff; or equal.

C. Pipe, fittings, and adapters: Furnished by the same manufacturer, and compatible with components in the same system and with components of other systems to which connected.

D. Materials:
   1. Polyethylene: In accordance with ASTM D1248, Type III, Class C, Category 5, Grade P34; listed by the Plastic Pipe Institute under the designation PE 3408; and have a minimum cell classification, in accordance with ASTM D3350.
   2. Pipe and fittings: Manufactured from material with the same cell classification.

2.06 SOURCE QUALITY CONTROL

A. PVC piping, Schedule Type:
   1. Mark pipe and fittings in accordance with ASTM D1785.

B. PVC piping, Class Type:
   1. Hydrostatic proof testing in accordance with AWWA C900: Test pipe and integral bell to withstand, without failure, two times the pressure class of the pipe for a minimum of 5 seconds.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Where not otherwise specified, install piping in accordance with ASTM F645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of PVC piping, Schedule Type:
1. Solvent weld joints in accordance with ASTM D2855:
a. For PVC pipe in chemical service use IPS Corp. Type 724 cement in accordance with manufacturer's instructions.
2. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C900 complemented with manufacturer's published instructions.

D. Installation of PE piping for drain, waste, and vent:
1. Install piping as recommended in manufacturer's published instructions.

3.02 FIELD QUALITY CONTROL

A. Leakage test for PVC piping, Class Type:
1. Polyvinyl chloride (PVC) piping, Class Type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 15956.
2. Pressure test with maximum leakage allowance: Perform test after backfilling:
a. Pressure: 125 pounds per square inch, gauge.
b. Maximum leakage allowance as follows, wherein the value for leakage is in gallons per 100 joints per hour:

NPS, Inches	1-1/2	2	2-1/2	3	4	6	8	10	12
Leakage	0.41	0.52	0.63	0.76	0.98	1.45	1.88	2.35	2.80

B. Leakage test for HDPE piping:
1. Pressure test with maximum leakage allowance: Perform test prior to backfilling (cover pipe at intervals and/or curves if necessary to hold pipe in place during testing):
a. Pressure: As specified in Section 15052 or 125 pounds per square inch, gauge.
b. Test with water as test medium.
c. Remove all free air from test section and raise pressure at steady rate to test pressure.
d. Apply and allow initial test pressure to stand without makeup pressure for 3 hours to allow for diametric expansion or pipe stretching to stabilize.
e. After stabilization period, return to test pressure and hold for 3 hours.
f. Amount of make up water allowable for expansion during pressure test in accordance with PPI Technical Report TR 31-88.
g. No visual leaks or pressure drops allowed during final test period.

3.03 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

			Manufacturer Rep Onsite					
Source Testing (Witnessed or Non-witnessed)	**Training Requirements**		**Installation Testing**		**Functional Testing**		**Process Operational Period**	
	Maintenance (hrs per session)	**Operation (hrs per session)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**
Non-witnessed	Not required		Not required		Not required		Not required	

END OF SECTION

SECTION 15259

CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE: ASTM F 441

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: ASTM F 441 CPVC pipe and fittings.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.
      b. Section 01756 - Commissioning and Process Start-Up.
      c. Section 15052 - Common Work Results for General Piping.
      d. Section 15956 - Piping Systems Testing.

1.02 REFERENCES

A. American Water Works Association (AWWA).

B. ASTM International (ASTM):
   1. D 1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   2. F 438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
   3. F 439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
   4. F 441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
   5. F 493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
   6. F 645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.

C. NSF International (NSF).

1.03 ABBREVIATIONS

A. CPVC: Chlorinated polyvinyl chloride.

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Shop Drawings:
   1. Describe materials, pipe, fittings, gaskets, and solvent cement.
   2. Installation instructions.

C. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756. Include:
   1. Date of manufacture of pipe for each lot delivered.
   2. Solvent cement manufacturer's report and certification.

D. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756.

1.05 QUALITY ASSURANCE

A. Pipe in potable water applications: Provide pipe bearing NSF seal.

B. Mark pipe with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required in accordance with ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect from sunlight, scoring, and distortion.

B. Do not allow surface temperatures to exceed 120 degrees Fahrenheit.

C. Store and handle as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Pipe:
   1. In accordance with ASTM F 441 and Appendix, CPVC 4120.
   2. Extruded from Type IV, Grade 1, Class 23447 material in accordance with ASTM D 1784.
   3. Schedule 80, unless otherwise indicated on the Drawings or specified in the Piping Schedule in Section 15052.
   4. Manufacturers: One of the following or equal:
      a. Charlotte Pipe and Foundry Company.
      b. Eslon Thermoplastics, Inc.
      c. GF Harvel.
      d. Spears Manufacturing Company.
      e. Chemtrol.

C. Fittings:
   1. In accordance with ASTM F 438 or ASTM F 439 for pressure fittings, as appropriate to the service and pressure requirement.
   2. Same material as the pipe and of equal or greater pressure rating.
   3. Supplied by pipe manufacturer.

D. Solvent cement:
   1. In accordance with ASTM F 493.
   2. Manufacturers: The following or equal:
      a. IPS Corporation.
   3. Certified by the manufacturer for the service of the pipe.
   4. Primer: As recommended by the solvent cement manufacturer.

E. Unions 2-1/2 inches and smaller:
   1. Socket end screwed unions.

F. Unions 3 inches and larger:
   1. Socket flanges with 1/8-inch full-face soft neoprene gasket.

2.02 SOURCE QUALITY CONTROL

A. Mark pipe and fittings in accordance with ASTM F 441.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
   2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe:
      a. Do not thread pipe.
   3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
   4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of piping:
   1. Clean dirt and moisture from pipe and fittings.
   2. Bevel pipe ends in accordance with manufacturer's instructions with chamfering tool or file:
      a. Remove burrs.
   3. Use solvent cement and primer formulated for CPVC.
   4. Use primer on pressure and non-pressure joints.
   5. Do not solvent weld joints when ambient temperatures are below 40 degrees Fahrenheit or above 90 degrees Fahrenheit unless solvent cements specially formulated for these conditions are utilized.

3.02 FIELD QUALITY CONTROL

A. Test as specified in Section 15052 and Section 15956.

3.03 COMMISSIONING AND PROCESS START-UP REQUIREMENTS

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

			Manufacturer Rep Onsite					
Source Testing (Witnessed or Non-witnessed)	**Training Requirements**		**Installation Testing**		**Functional Testing**		**Process Operational Period**	
	Maintenance (hrs per session)	**Operation (hrs per session)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**
Non-witnessed	Not required		Not required		Not required		Not required	

END OF SECTION

SECTION 15270

STEEL PIPE: GALVANIZED AND BLACK, ASTM A53

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel pipe: Galvanized and black, ASTM A 53.

B. Related sections:
1. Section 01330 - Submittal Procedures.
2. Section 01756 - Commissioning.
3. Section 09960 - High-Performance Coatings.
4. Section 15052 - Common Work Results for General Piping.
5. Section 15057 - Fusion Bonded Epoxy Lining.
6. Section 15274 - Plastic Tape Wrap for Pipe.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
1. B16.3 - Malleable-Iron Threaded Fittings: Classes 150 and 300.
2. B16.5 - Pipe Flanges and Flanged Fittings.
3. B16.9 - Factory-Made Wrought Buttwelding Fittings.
4. B16.11 – Forged Fittings, Socket-Welding and Threaded.

B. American Water Works Association (AWWA):
1. C200 – Steel Water Pipe- 6 Inches and Larger.
2. C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied.
3. C205 - Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4 Inches and Larger-Shop Applied.
4. C206 - Field Welding of Steel Water Pipe.
5. C207 - Standard for Steel Pipe Flanges for Waterworks Service-Sizes 4 inches Through 144 inches.
6. C602 - Standard for Cement-Mortar Lining of Water Pipelines in Place-4 inches and Larger.
7. C606 - Standard for Grooved and Shouldered Joints.

C. ASTM International (ASTM):
1. A47 - Standard Specification for Ferritic Malleable Iron Casting.
2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
6. A536 - Standard Specification for Ductile Iron Castings.

7. C150 - Standard Specification for Portland Cement.
8. D429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
9. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

1.03 SUBMITTALS

A. Submit as specified in Section 01330.

B. Shop Drawings, as appropriate include:
   1. Details of fittings and specials showing thickness and dimensions of plates.
   2. Detail of welds and materials.
   3. Listing of proposed services and locations for use of grooved joint type piping.
   4. Tabulated layout schedules for cement-mortar lined and coated steel pipe.
   5. Grooved joint piping fittings, gaskets, couplings.
   6. Grooving of pipe and fittings.
   7. Pipe lining and coating.

C. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756. Include:
   1. Mill certificates.
   2. Test reports on gaskets.

D. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland cement: In accordance with ASTM C150, Type II, low alkali.

2.02 MANUFACTURED UNITS

A. Steel pipe:
   1. General:
      a. In accordance with ASTM A53:
         1) Type: Type E - electric-resistance welded or Type S - seamless.
         2) Grade: Grade A or B.
      b. Schedule:
         1) As indicated on the Drawings or as specified in Section 15052 pipe schedule.
         2) Minimum Schedule unless otherwise indicated on the Drawings or as specified in Section 15052 pipe schedule:
            a) Pipe 6 inches and smaller: Schedule 40.
            b) Pipe greater than 6 inch to 12 inch: Schedule 20.
            c) Pipe greater than 12-inch: 0.25 inches.

B. Pipe fittings:
   1. Flanged and welding fittings:
      a. Butt -welding fittings in accordance with ASME B16.9. Schedule of fittings: same class or thickness as the pipe to which it connects.
   2. Screwed fittings:
      a. Malleable iron:
         1) Class 150 or Class 300 in accordance with ASME B16.3, as specified in Section 15052 pipe schedule.
         2) Galvanized in accordance with ASTM A153 where used with galvanized pipe.
   3. Grooved joint fittings:
      a. Fittings for grooved joint steel piping: Rigid-grooved type.
      b. Fittings for grooved joint piping:
         1) Manufacturers: One of the following or equal:
            a) Victaulic Company of America.
            b) Grinnell.
            c) Anvil.
         2) Ductile iron fittings:
            a) Larger than 4 inches in diameter: In accordance with ASTM A536, Grade 65-45-12, long radius, per AWWA C110.
            b) Less than 4 inches in diameter: Malleable iron conforming to ASTM A47, Grade 32510.
         3) Where cast fittings are not made, forged steel in accordance with ASME B 16.9, ASTM A105, Grade B with 0.375 inch minimum wall thickness:
            a) Bends: Long radius.
         4) Fittings for grooved joint piping shall be furnished by the manufacturer of the grooved joint coupling.
         5) Fittings for grooved joint piping shall be for rigid-grooved type joints. Connection to flanged units shall be by means of a spool with one end flanged and the other grooved, long enough to prevent interference with adjacent valves, pumps, or other items, minimum length, 4 inches.

C. Pipe joints:
   1. General:
      a. Use type of pipe joints as indicated on the Drawings or as specified in Section 15052 pipe schedule.
      b. In addition to the type of pipe joints indicated on the Drawings or as specified in Section 15052 pipe schedule, use flexible couplings, unions or flanged joints to allow ready assembly and disassembly of the piping.
   2. Flanged joints:
      a. In accordance with ASME B16.5, steel, 150 pounds, slip-on or weld neck, galvanized in accordance with ASTM A153 where used with galvanized pipe.
      b. Companion flanges:
         1) In accordance with ASME B16.5, steel.
         2) Class 150 pounds, slip-on or welding neck.
      c. Weld flanges to pipe or fittings before applying lining.
      d. Machine flanges or provide tapered filler for changes in grade or to slope lines for drainage.

e. Match pipe flanges to the valve flanges.
f. Flange bolts: As specified in Section 15052.
g. Gaskets: As specified in Section 15052.

3. Grooved joints:
   a. Grooves: Cut grooves. Rolled grooves are not acceptable.
   b. Couplings housing: Cast in 2 or more segments of ductile iron in accordance with ASTM A536, Grade 65-45-12 or malleable iron in accordance with ASTM A47, Grade 32510.
   c. Bolts and nuts: In accordance with ASTM A183, Grade 2.
   d. Gaskets: Composition water sealing designed so that the internal piping pressure serves to increase the seal's watertightness:
      1) Gaskets for water service and oil-free air systems at temperatures less than 230 degrees Fahrenheit shall be made of ethylene propylene diene monomers (EPDM) in accordance with ASTM D2000 Line Call Out 2CA615A25B24.
      2) Gaskets for use with cement-mortar lined steel piping shall be captured between the ends of the pipe to protect exposed metal from corrosion, and shall be made of nitrile in accordance with ASTM D2000, Line Call Out 2CA615A25B24.
   e. Perform grooving of the pipe wall only on standard or heavier schedule weight pipe:
      1) For pipe with wall thickness less than standard weight, weld a shouldered end on the pipe in accordance with AWWA C606.
      2) Shoulder: Type B or D in accordance with AWWA C606.
   f. Couplings and grooving: Manufacturers: One of the following or equal:
      1) Victaulic Company of America.
      2) Grinnell.
      3) Anvil.
   g. Grooved joint piping shall not be used in the following installations:
      1) In underground and underwater installations.
      2) In piping subject to test pressures of 150 pounds per square inch gauge, or more.
      3) In steam and gas piping.
      4) In sludge and scum piping designed to be steam cleaned.
4. Welded joints: Butt welds, 2 pass, full depth with beveled ends and no backing rings.

D. Pipe lining and coating:
1. General:
   a. Lining and coating shall be as indicated on the Drawings or as specified in Section 15052 pipe schedule.
2. Pipe coating:
   a. Extend pipe coating for underground piping 6 inches above finish grade or finish floor, and neatly terminate.
   b. Field paint aboveground steel pipe as specified in Execution of this Section.
   c. Coat exposed piping as specified in Section 09960.
   d. Coat submerged piping as specified in Section 15052 pipe schedule and Section 09960.

e. Cement-mortar coating:
1) Cement-mortar coating: In accordance with AWWA C205, modified as follows:
a) Sand: In accordance with AWWA C205 except that the total percentage of deleterious material shall not exceed 3 percent.
f. Plastic tape wrap: As specified in Section 15274:
1) For buried pipe, wrap fittings, valves, and other odd shaped components in the pipeline with first and finish wrapping over the prime coat, total thickness of tape 80 mils.

3. Pipe lining:
a. Cement-mortar lining:
1) Shop apply cement-mortar lining in accordance with AWWA C205. At the option of Contractor, field apply with a pipe lining machine.
b. Coal-tar enamel lining:
1) Coal-tar enamel lining for interior of steel pipe: In accordance with AWWA C203.
c. Coal-tar epoxy lining:
1) Coal-tar epoxy lining: Epoxy bituminous coating as specified for submerged metal in Section 09960.
d. Fusion epoxy:
1) Fusion bonded epoxy as specified for submerged metal or exposed metal in Section 15057.
e. High solids epoxy:
1) High solids epoxy as specified for submerged metal or exposed metal in Section 09960.
f. Polyurethane lining:
1) Polyurethane as specified for submerged metal in Section 09960.

2.03 FABRICATION

A. Shop coat of primer:
1. Flanges and portions of pipe not covered with cement-mortar shall be given a shop coating of primer.
2. Primer compatible with finish coating system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pipe joints:
1. General:
a. Steel pipe joints shall be screwed, welded, flanged, grooved, or made with flexible joints. The type of joint for piping is as specified in Section 15052 pipe schedule or as indicated on the Drawings.
b. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means necessary to allow ready assembly and disassembly of the piping.
c. Unless otherwise indicated on the Drawings or as specified in Section 15052 pipe schedule, pipe joints shall be as follows:
1) Pipe smaller than 2 inches in nominal diameter shall have screwed joints, welded joints, unions, or flexible couplings.

2) Pipe 2 inches to 4 inches in nominal diameter shall have screwed joints, flanged joints, welded joints, or joints made with flexible couplings.
3) Pipe larger than 4 inches in nominal diameter shall have flanged joints, welded joints, or joints made with flexible couplings.

2. Flanged joints:
   a. Flanges shall come together at the proper orientation with no air gaps between the flanges after the gaskets are in place.
   b. Secure welding neck flanges with full penetration butt welds without backing rings.
   c. Secure slip-on flanges with both internal and external welds.
   d. After welding in place, the faces of flanges shall be perpendicular to the axis of the pipe, or, in the case of fittings, at the proper angle to each other, and bolt holes shall be in proper alignment.
3. Grooved joints:
   a. Assemble in accordance with manufacturer's published instructions.
   b. Support grooved joint pipe in accordance with manufacturer's recommendations. In addition, provide at least 1 support between consecutive couplings.
4. Screwed joints:
   a. Perform threading with clean, sharp dies:
      1) Wavy, rough, or otherwise defective pipe threads are not acceptable.
   b. Make screwed joints tight and clean with an application of Teflon tape or paste compound applied to the male threads only, except as follows:
      1) Make up liquid and liquefied petroleum gas lines, with litharge and glycerin.
   c. Provide railroad type unions with bronze-to-iron seat. Galvanized where used with galvanized pipe:
      1) Flanged joints may be used instead of unions.
5. Welded joints:
   a. Field welded joints: Electric arc welded in accordance with AWWA C206.
   b. Welder’s qualification: Qualified in accordance with AWWA C206:
      1) Welders' testing shall be at the Contractor's expense, including cost of test nipples, welding rods, and equipment.
   c. Do not weld galvanized pipe.

B. Pipe lining and coating:
1. Pipe lining:
   a. Field applied cement-mortar lining shall be of the same density, smoothness, and thickness as shop applied lining, and in accordance with AWWA C602.
2. Pipe Coating:
   a. Plastic tape wrap application:
      1) Wrap fittings, valves, and other odd shaped components in the pipeline with first and finish wrapping over the prime coat.
      2) Wrap joints, fittings, valves, and other irregular shapes of piping with extruded coatings with tape as specified in this subparagraph.
   b. Field coat aboveground steel pipe as specified in Section 09960.

3.02 FIELD QUALITY CONTROL

A. Field test fabricated steel manifolds with the pipe to which they connect.

3.03 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

			Manufacturer Rep Onsite					
Source Testing (Witnessed or Non-witnessed)	**Training Requirements**		**Installation Testing**		**Functional Testing**		**Process Operational Period**	
	Maintenance (hrs per session)	**Operation (hrs per session)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**
Non-witnessed	Not required		Not required		Not required		Not required	

END OF SECTION

SECTION 15278

STEEL PIPE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel piping, joints, fittings, pipe lining and coating, and fabricated steel piping fittings and specials.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 09960 - High-Performance Coatings.
   4. Section 15052 - Common Work Results for General Piping.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard H-20.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.3 - Malleable-Iron Threaded Fittings: Classes 150 and 300.
   3. B16.5 - Pipe Flanges and Flanged Fittings.
   4. B16.9 - Factory-Made Wrought Buttwelding Fittings.
   5. B16.12 - Cast Iron Threaded Drainage Fittings.

C. American Water Works Association (AWWA):
   1. C200 - Steel Water Pipe 6 Inches and Larger.
   2. C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied.
   3. C205 - Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4 Inches and Larger-Shop Applied.
   4. C206 - Field Welding of Steel Water Pipe.
   5. C207 - Standard for Steel Pipe Flanges for Waterworks Service-Sizes 4 inches Through 144 inches.
   6. C208 - Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   7. C209 - Standard for Cold-Applied Tape Coating for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   8. C214 - Standard for Tape-Coating Systems for the Exterior of Steel Water Pipelines.
   9. C602 - Standard for Cement-Mortar Lining of Water Pipelines in Place-4 inches and Larger.
   10. C606 - Standard for Grooved and Shouldered Joints.
   11. M 11 - Steel Pipe: A Guide for Design and Installation.

D. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Casting.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
   4. A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   5. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
   7. A536 - Standard Specification for Ductile Iron Castings.
   8. C150 - Standard Specification for Portland Cement.
   9. D297 - Standard Test Methods for Rubber Products-Chemical Analysis.
   10. D395 - Standard Test Methods for Rubber Property-Compression Set.
   11. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
   12. D429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
   13. D471 - Standard Test Methods for Rubber Property-Effect of Liquids.
   14. D573 - Standard Test Methods for Rubber -Deterioration in an Air Oven.
   15. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
   16. D2240 - Standard Test Method for Rubber Property-Durometer Hardness.

E. NACE International (NACE):
   1. RP0274-74 - Standard Recommended Practice.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Design criteria for pipe and pipe fittings: In accordance with AWWA Manual M11 with the following modifications:
      a. Wall thickness: As designed or minimum 1/4 inch for pipe from 12 inches in diameter to, and including, 72 inches in diameter or minimum 5/16 inch for pipe larger than 72 inches in diameter, whichever is thicker.
      b. Inside diameter of unlined pipe: Nominal.
      c. Inside diameter of lined pipe: As measured from face to face of liner, but not less than nominal.
      d. Deflection of underground pipe inside diameter: Maximum 2 percent under trench load of H-20 live load in accordance with AASHTO specifications.
      e. Working stress of steel: Maximum 50 percent of yield stress.

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Shop Drawings.
   1. Details of fittings and specials showing thickness and dimensions of plates.
   2. Detail of welds and materials.

3. Listing of proposed services and locations for use of grooved joint type piping.
4. Tabulated layout schedules for cement-mortar lined and coated steel pipe.
5. Details of fittings and specials showing thickness and dimensions of plates.
6. Grooved joint piping fittings, gaskets, and couplings.
7. Grooving of pipe and fittings.
8. Design calculations:
    a. Wall thicknesses for external loading, special loading, and internal pressure.

C. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756. Include:
    1. Mill certificates.
    2. Test reports on rubber gaskets.

D. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

E. Calculations shall be prepared and stamped by a professional engineer licensed in the State of California.

1.05 QUALITY ASSURANCE

A. Applicable standards:
    1. Cement-mortar lined and coated steel pipe shall conform to the following standards, as complemented and modified in this Section:
        a. Steel pipe: AWWA C200.
        b. Cement-mortar lining and coating: AWWA C205.
        c. Fittings and specials: AWWA C208.
        d. Reinforcement of fittings and specials: AWWA M 11.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel pipe:
    1. Type, pipe 6 inches and smaller: ASTM A53, black or galvanized, seamless or straight seam electric resistance welded. Minimum Schedule 40.
    2. Type, from 6 to 12 inches: ASTM A53, black or galvanized pipe, seamless or straight seam electric resistance welded. Minimum Schedule 20.
    3. Type, larger than 12 inches: AWWA C200, without butt strap, riveted, or swaged joints; wall thickness as specified.
    4. Type, 24 inches and larger, with grooved type couplings and wall thickness less than 1/2 inch: Provided with stub ends, sized as follows, for grooves:
        a. Thickness: As recommended by coupling manufacturer, but not less than 1/2 inch.
        b. Length: Width of coupling plus 1 inch, but not less than 6 inches.
    5. Type for liquid or gaseous dry chlorine: ASTM A106, Grade A, Schedule 80, assembled with 300 pounds per square inch malleable iron fittings and ammonia type flanges.

B. Steel pipe fittings:
   1. Screwed fittings:
      a. Malleable iron: ASME B16.3, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe.
      b. Cast iron drainage: ASME B16.12, galvanized in accordance with ASTM A153 where used with galvanized pipe.
   2. Flanged fittings:
      a. Type for 12-inch and smaller pipe: ASME B16.1, cast iron or ductile iron, 125 pounds; or ASME B16.5, steel, 150 pounds, galvanized in accordance with ASTM A153 where used with galvanized pipe.
      b. Type for larger than 12-inch pipe: ASME B16.5, steel, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe; or AWWA C207 and AWWA C208, fabricated from flanges and steel pipe, respectively.
      c. Companion flanges for 4 inches and smaller pipe: ASME B16.1, cast iron or ductile iron, 125 pounds; ASME B16.5, steel, 150 pounds, slip-on or welding neck; or ammonia type for use on chlorine liquid or gas piping.
      d. Companion flanges for larger than 4 inch to and including 12-inch pipe: ASME B16.5, slip-on or welding neck type.
      e. Companion flanges for larger than 12-inch pipe: ASME B16.5, steel, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe; or AWWA C207, steel plate or raised hub type.
      f. Weld flanges to pipe or fittings before applying lining.
      g. Machine flanges or provide tapered filler for changes in grade or to slope lines for drainage.
      h. Flange bolts: As specified in Section 15052.
      i. Gaskets: As specified in Section 15052.
   3. Welding fittings:
      a. Welding fittings for piping 8 inches and less in nominal diameter: Butt-welding fittings in accordance with ASME B16.9, standard wall, or standard weight.
      b. Welding fittings for piping larger than 8 inches in nominal diameter: Butt-welding fittings in accordance with ASME B16.9, or, at the option of the Contractor, made up out of sections of pipe welded together, except where smooth bends are indicated for air lines.
      c. Fittings made up of sections of pipe welded together shall be made of pipe of at least the same wall thickness as the pipe with which used, and bends shall be miter bends, fabricated in accordance with AWWA C208 and as supplemented by AWWA Manual M 11. Welding of these made-up fittings shall be in accordance with AWWA C206:
         1) Design and fabricate outlets and 4 branch fittings in accordance with AWWA Manual M 11.
         2) Bends may be welded to adjacent pipe sections:
            a) Bends shall be manufactured of the following number of pieces:
               (1) Bends from 0 to 30 degrees angle, 2 pieces.
               (2) Bends from 30 to 45 degrees angle, 3 pieces.
               (3) Bends from 45 to 67-1/2 degrees angle, 4 pieces.
               (4) Bends from 67-1/2 to 90 degrees angle, 5 pieces.

4. Grooved joint fittings:
    a. Fittings for grooved joint steel piping: Rigid-grooved type, and as follows:
        1) Grooves: Cut; rolled grooves are not acceptable.
        2) Couplings: Cast in 2 or more segments of ductile iron in accordance with ASTM A536, Grade 65-45-12 or malleable iron in accordance with ASTM A47, Grade 32510.
        3) Bolts and nuts: ASTM A183, Grade 2.
        4) Gaskets: Composition water sealing designed so that the internal piping pressure serves to increase the seal's watertightness:
            a) Gaskets for water service and oil-free air systems at temperatures less than 230 degrees Fahrenheit shall be made of ethylene propylene diene monomers (EPDM) in accordance with ASTM D2000 Line Call Out 2CA615A25B24.
            b) Gaskets for use with cement-mortar lined steel piping shall be captured between the ends of the pipe to protect exposed metal from corrosion, and shall be made of nitrile in accordance with ASTM D2000, Line Call Out 2CA615A25B24.
        5) Perform grooving of the pipe wall only on standard or heavier schedule weight pipe:
            a) For pipe with wall thickness less than standard weight, weld a shouldered end on the pipe in accordance with AWWA C606.
            b) Fabricated pipe, pipe in accordance with AWWA C200, shall have shouldered ends welded onto the pipe.
            c) Shoulder: Type B or D in accordance with AWWA C606.
        6) Couplings and grooving: As manufactured by Gustin-Bacon Piping Products, Victaulic Company of America, or equal.
    b. Fittings for grooved joint piping: Ductile iron in accordance with ASTM A536, Grade 65-45-12, or malleable iron in accordance with ASTM A47, Grade 32510, and as follows:
        1) Where cast fittings are not made, standard fittings including large diameter elbows shall be made of forged steel in accordance with ASTM A105, Grade B with 0.375 inch wall thickness, or shall be standard segmentally welded fittings fabricated of Schedule 40 carbon steel pipe:
            a) Grooves: As manufactured by Gustin-Bacon Piping Products, Victaulic Company of America, or equal.
        2) Fittings for grooved joint piping shall be furnished by the manufacturer of the grooved joint material.
        3) Fittings for grooved joint piping shall be for rigid-grooved type joints.
        4) Connection to flanged units shall be by means of flange to grooved joint adapters:
            a) Where the flanged to grooved joint adapters interfere with the operation of adjacent valves, pumps, or other items, the connection shall be by means of a spool with one end flanged and the other grooved, long enough to prevent interference with adjacent valves, pumps, or other items.

C. Steel pipe lining and coating:
    1. General:
        a. Except where otherwise specified in the Specifications and indicated on the Drawings, lining and coating for steel pipe shall be as specified.

b. Pipe coating:
    1) Except as otherwise specified or indicated on the Drawings, provide underground steel piping with one of the coatings specified.
    2) Extend pipe coating for underground piping 6 inches above finish grade or finish floor, and neatly terminate.
    3) Field paint aboveground steel pipe as specified in Execution of this Section.

2. Cement-mortar lining and coating:
    a. Lining:
        1) Shop apply cement-mortar lining for steel pipe, interior, in accordance with AWWA C205; or, at the option of Contractor, field apply with a pipe lining machine.
    b. Coating:
        1) Cement-mortar coating for steel pipe exterior: In accordance with AWWA C205, modified as follows:
            a) Portland cement: ASTM C150, Type II, low alkali.
            b) Sand: AWWA C205 except that the total percentage of deleterious material shall not exceed 3 percent.
3. Coal-tar enamel lining:
    a. Coal-tar enamel lining for interior of steel pipe: In accordance with AWWA C203.
4. Coal-tar epoxy lining:
    a. Coal-tar epoxy lining for interior of steel pipe: Epoxy bituminous coating as specified for submerged metal in Section 09960.
    b. Polyurethane lining for interior of steel pipe: Polyurethane as specified for submerged metal in Section 09960.
5. Plastic tape wrap:
    a. Plastic tape wrap for exterior of steel piping shall consist of a prime coat followed with spirally applied tape layers to a minimum system thickness of 80 mils.
    b. Plastic tape wrap coating: Plastic tape wrap for exterior of steel pipe, fittings and specials, in accordance with AWWA C209 and AWWA C214 as applicable.
6. General: The tape coating system shall consist of primer, 1 layer of 20 mil inner wrap, 1 layer of 30 mil outer wrap and a second layer of 30 mil outer wrap, for a total coating thickness of 80 mils. All materials shall be of products of the same manufacturer:
    a. Primer: As manufactured by one of the following or equal:
        1) Polyken Pipeline Coatings, Number 1029 or 1039 Primer.
        2) The Tapecoat Company, TC Omniprime Primer.
    b. Pipe wrap:
        1) First wrap: As manufactured by one of the following or equal:
            a) Polyken Pipeline Coatings, Number 989-20 (932-50 for fittings).
            b) The Tapecoat Company, Tapecoat 1020B.
        2) Middle wrap: As manufactured by one of the following or equal:
            a) Polyken Pipeline Coatings, Number 955-30.
            b) The Tapecoat Company, Tapecoat 2030B.
        3) Finish wrap: As manufactured by one of the following or equal:
            a) Polyken Pipeline Coatings, Number 956-30 White.
            b) The Tapecoat Company, Tapecoat CT 2030B.

7. Filler tape:
    a. Polyken 939.
    b. Or equal.
8. Joint wrap:
    a. Polyken 932-50, white Hi-Tack Joint Wrap tape.
    b. Tapecoat Company, Joint Tape.
9. Application on welded joints:
    a. Remove sharp edges of weld spatter and slag with a file or ball peen hammer before wrapping joints.
    b. Apply plastic tape wrap in accordance with AWWA C209:
        1) Clean and prime all surfaces, then apply a wrap of 0.125 thick by 2-inch wide filler tape centered on the weld. Push and knead the tape into all voids.
    c. Apply 2 wraps of 50 mil joint tape; or the tape may be half lapped to obtain the double thickness.
    d. Finish wrap: Apply final wrapping in same manner.
    e. Wrap fittings, valves, and other odd shaped components in the pipeline with first and finish wrapping over the prime coat, total thickness of tape 80 mils.
10. Extruded coatings:
    a. Coat pipe with a film of high-density polyethylene, plant extruded onto the pipe over a thermoplastic adhesive primer:
        1) Coating thickness: In accordance with the extruder's standards but not less than 6 pounds per diameter inch per 100 feet of pipe.
        2) Coating: Manufacturers: One of the following or equal:
            a) Plexco (Pipe Line Service Co.).
            b) Extrucoat.

D. Fabricated steel piping fittings and specials:
1. General: Specified in this Section are the design and fabrication of fabricated steel piping fittings and specials, which include elbows, branches, nozzles, manifolds, headers, heads, collars, stiffeners, reinforcements, and other steel fabrications relating to steel piping, but shall not include steel pipe.
2. Design:
    a. Contractor shall design and detail fittings and specials:
        1) Design: In accordance with the recommended procedures in AWWA Manual M 11, as complemented and modified in this Section.
        2) Nozzles: Reinforced in accordance with recommended practice in AWWA M 11, Steel Pipe Manual.
        3) Design reinforcing for fittings and specials for the specified test pressure.
        4) Fittings shall conform in dimension to AWWA C208, complemented with the provisions specified in this Section.
        5) The working stress for steel used for fabrication of pipe shall not exceed 50 percent of the yield stress.
    b. The thickness of pipe, large elbows, and headers, except header nozzles, shall be the thicker of:
        1) The thickness designed in accordance with the design methods specified in the preceding paragraph “Fabricated Steel Piping Fittings and Specials.”
        2) The thickness indicated on the Drawings.

3) The following thicknesses:
a) For pipes smaller than 72 inches in diameter: Minimum 1/4 inch.
b) For pipes 72 inches in diameter and larger: Minimum 5/16 inch.

c. Elbows shall be of the number of pieces specified under paragraph Steel Pipe Fittings, “Welding and Fittings”, and thickness of material shall conform to thickness of pipe or manifold shells specified.
d. Ends of fittings to be welded to pipe shall be beveled for welding.

3. Fabrication:
a. Shop fabricate steel piping fittings and specials in units as long as practicable for safe hauling and installation. Minimize number of field welds.
b. Fabricate fittings and specials to uniform lengths with proper end clearance for the specified types of joint or attachment.
c. Fabricate fittings and specials to allow field assembly without cutting or special work.
d. Where specified in the Piping Schedule in Section 15052 or indicated on the Drawings, the inside of fabricated steel manifolds and other fittings and specials shall receive a cement-mortar lining in accordance with AWWA C205:
1) Reinforce lining for piping 24 inches in diameter and larger with wire fabric.
e. Do not weld flanges to nozzles until the nozzles and reinforcements are completely welded to the header:
1) Accurately space and align flanges so that when connections have been made there will be no stress on the header, piping, or equipment. Properly locate and align equipment.

4. Dished heads:
a. Dished heads on 84 inch diameter and smaller manifolds: 1 piece (seamless) spherically dished (torispherical) heads:
1) Larger heads may be seamed.
b. Dish radius: Same dimension as the outside diameter of the head measured at skirt.
c. Skirt face length: Not less than 3 inches.
d. Design heads in accordance with recommended practice in AWWA M 11, Steel Pipe Manual.

5. Testing: No shop testing will be required for manifolds or piping connected thereto.

E. Steel pipe, cement-mortar lined and coated:
1. General:
a. Applicable standards: Cement-mortar lined and coated steel pipe shall conform to the standards specified in General of this Section.
b. Identification marks: Provide identification marks in accordance with AWWA C200. These marks shall be stenciled or otherwise shown at the top of the piping items exterior, including the following information:
1) Name or trademark of the manufacturer.
2) Date of manufacture of the item.
3) Internal diameter in inches.
4) Number of the item, sequential from initial to end station.

c. Diameter designation: The pipe diameter specified in the Specifications and indicated on the Drawings shall be the clear inside diameter after application of the cement-mortar lining with a tolerance of plus 0 inch and minus 1/4 inch.

2. Design:
   a. Pipe and fittings shall be designed by Contractor.
   b. Design: In accordance with the recommended procedures in AWWA Manual M 11, as complemented and modified in this Section.
   c. Thicknesses of Pipe, Fittings and Specials Shall Be the Thicker Of:
      1) The thickness designed in accordance with the design methods specified in the preceding subparagraph below.
      2) The thickness indicated on the Drawings.
      3) The following thicknesses:
         a) For pipes 26 inches and less in nominal diameter, not less than 1/4 inch.
         b) For pipes more than 26 inches and less than 38 inches in nominal diameter, not less than 5/16 inch.
         c) For pipes 38 inches to and including 54 inches in nominal diameter, not less than 3/8 inch.
   d. The working stress for steel used for fabrication of pipe shall not exceed 50 percent of the yield stress.
   e. Break longitudinal and girth seams for straight seam pipe shall be no greater in number than would be required for the fabrication of pipe with 96-inch by 120-inch steel plates:
      1) Break longitudinal seams at the girth seams.
   f. Calculate earth loads using the following formula:

$$W = 192 \times H \times B$$

      wherein the various terms shall have the following meaning:

      W: Earth load, pounds per linear foot of pipe.
      H: Height of fill over the pipe, feet.
      B: Outside diameter of the pipe, feet.
      x: Mathematical symbol for multiplication.

   g. Add AASHTO's H-20 loading to earth loads.
   h. Design pipe, fittings and specials for a deflection, under external loads, not to exceed 2 percent of the diameter:
      1) Stiffness computations shall not consider the effect of the cement-mortar lining and coating.
      2) Calculate deflection using the Spangler formula and the following values:
         a) Bedding constant K = 0.100.
         b) Modulus of soil reaction E' = 700 pounds per square inch.
         c) Deflection lag constant D_1 = 1.00.
   i. Where piping is designated to be flanged or welded in order to restrain thrust, the design of the cylinder and flange or welded joint shall take into account the effect of stresses caused by thrust loads.
   j. Steel cylinder shall be subject to no more than the lesser of 15,000 pounds per square inch or 50 percent of the steel yield stress.

3. Materials:
    a. Cement: ASTM C150, Type II, low alkali.
    b. Gaskets shall be as specified in Section 15052 and meet the following requirements:
        1) Minimum tensile strength, tested in accordance with ASTM D412, between 2,000 and 2,700 pounds per square inch.
        2) Minimum elongation, tested in accordance with ASTM D412, between 350 and 400 percent.
        3) Shore A durometer hardness, tested in accordance with ASTM D2240, between 50 and 65.
        4) Specific gravity, tested in accordance with ASTM D297, between 0.90 and 1.50.
        5) Maximum compression set, tested in accordance with Method B of ASTM D395, 20 percent.
        6) Maximum tension strength loss, tested in accordance with ASTM D573 at 96 hours, 70 degrees Centigrade, in air, 20 percent.
        7) Maximum elongation loss, tested in accordance with ASTM D573 at 96 hours, 70 degrees Centigrade, in air, 20 percent.
        8) Maximum absorption, tested in accordance with ASTM D471 at 48 hours, 70 degrees Centigrade, in air, 5 percent.
4. Fabrication:
    a. Joints: Except as otherwise specified or indicated on the Drawings, provide bell and spigot type joints with rubber gaskets:
        1) Bell and spigot rings: Rolled Carnegie shape M-3516.
    b. Flanges: AWWA C207, Class D, steel ring, and as follows:
        1) Match pipe flanges to the valve flanges:
            a) At flanged joints connecting to valves, provide a steel pipe section without rod reinforcing and not less than 24 inches in length.
            b) Apply cement-mortar lining and coating to the steel pipe section.
    c. Shop coat of primer: Flanges and portions of pipe not covered with cement-mortar shall be given a shop coating of primer.
    d. Bend radii of fittings: Not less than 2.5 times the nominal diameter.

PART 3 EXECUTION

3.01 INSTALLATION

A. Joints:
1. Steel pipe joints shall be screwed, welded, flanged, grooved, or made with flexible joints. The type of joint for piping is specified in the Piping Schedule in Section 15052.
2. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means necessary to allow ready assembly and disassembly of the piping.
3. Unless otherwise indicated on the Drawings or specified in the Piping Schedule in Section 15052, pipe joints shall be as follows:
    a. Pipe smaller than 2 inches in nominal diameter shall have screwed joints or flexible couplings.

b. Pipe 2 inches to 4 inches in nominal diameter shall have screwed joints, flanged joints, welded joints, or joints made with flexible couplings.
c. Pipe larger than 4 inches in nominal diameter shall have flanged joints, welded joints, or joints made with flexible couplings.

B. Screwed joints:
1. Perform threading with clean, sharp dies:
a. Wavy, rough, or otherwise defective pipe threads are not acceptable.
2. Make screwed joints tight and clean with an application of Teflon tape or approved paste compound applied to the male threads only, except as follows:
a. Make up liquid and dry chlorine lines, and liquefied petroleum gas lines, with litharge and glycerin.
3. Provide railroad type unions with bronze-to-iron seat, galvanized where used with galvanized pipe:
a. Flanged joints may be used instead of unions.

C. Flanged joints:
1. In flanged joints, flanges shall come together at the proper orientation with no air gaps between the flanges after the gaskets are in place.
2. Attach slip-on flanges to pipe by 2 fillet welds, in accordance with AWWA C207.
3. Secure welding neck flanges with full penetration butt welds without backing rings:
a. After welding in place, the faces of flanges shall be perpendicular to the axis of the pipe, or, in the case of fittings, at the proper angle to each other, and bolt holes shall be in proper alignment.

D. Welded joints:
1. Welded joints shall be electric welded in accordance with AWWA C206.
2. Welders shall be qualified pursuant to the provisions of AWWA C206:
a. Welders' testing shall be at the Contractor's expense, including cost of test nipples, welding rods, and equipment.
3. Do not weld galvanized pipe.

E. Grooved joints:
1. Piping with grooved joints shall be installed where indicated on the Drawings and may be installed in place of flanged piping and screwed piping, except that grooved joint piping shall not be used in the following installations:
a. In underground and underwater installations.
b. In piping subject to test pressures of 150 pounds per square inch gauge, or more.
c. In steam and gas piping.
d. In sludge and scum piping designed to be steam cleaned.
2. Assemble in accordance with manufacturer's published instructions.
3. Support grooved-end pipe in accordance with manufacturer's recommendations. In addition, provide at least 1 support between consecutive couplings.

F. Lining and coating:
   1. Field paint aboveground steel pipe as specified in Section 09960.
   2. Field applied cement-mortar lining shall be of the same density, smoothness, and thickness as shop applied lining, and in accordance to applicable portions of AWWA C602.
   3. Plastic tape wrap application procedures shall be in accordance with manufacturer's published instructions:
      a. Apply primer with brush, without runs and drips.
      b. Lap wrapping not less than 1/2 inch. A single wrap lapped 50 percent or more will not be acceptable.
      c. Application on welded joints:
         1) Remove sharp edges of weld spatter and slag with a file or ball peen hammer before wrapping welded joints.
         2) Apply a single thickness of tape base wrap over the primer, around the weld.
         3) Start first wrapping 4 inches back on the pipe wrap, spiral wrap tape over the joint holding the proper tension and overlap, and finish 4 inches back on the pipe wrap on the other side of the joint.
         4) Apply final wrapping in same manner.
      d. Wrap fittings, valves, and other odd shaped components in the pipeline with first and finish wrapping over the prime coat.
      e. Wrap joints, fittings, valves, and other irregular shapes of piping with extruded coatings with tape as specified in this subparagraph.
   4. Protect lining of fabricated steel piping fittings and specials during hauling, installation, and operation.
   5. Finish joints of fabricated steel piping fittings and specials as specified for pipe lining after field welding is done.
   6. After final field welding of fabricated steel piping fittings and specials, complete the lining and exterior painting at and near the welded connections:
      a. Repair or replace lining damaged as a result of welding heat, handling, or other causes.

3.02 FIELD QUALITY CONTROL

A. Testing: Fabricated steel manifolds shall be field tested with the pipe to which they connect.

B. Holiday detection testing of plastic tape wrap coatings:
   1. Perform a complete high voltage electrical inspection (holiday detection testing) of all steel piping systems and fittings coated with plastic tape wrap prior to burying:
      a. Perform high voltage electrical inspection in strict accordance with NACE RP0274-74.
      b. Test voltage used for the electrical inspection of the piping and fittings shall be in accordance with the recommendations given by the tape coating manufacturer in their published literature.
      c. Repair all holidays and defects found in the coating system through the high voltage electrical inspection in strict accordance with the tape coating manufacturer's recommendations.
      d. Retest repaired areas in the coating prior to burial of the piping to ensure that all holidays and defects in the coating have been properly repaired.

2. Before conducting holiday detection testing on any piping systems, submit to the Engineer for review and approval technical literature and data describing the testing instrumentation, equipment, electrodes, and other accessories that will be used:
    a. The literature and data shall include complete information covering the operation and use of the testing equipment, including operational voltage ranges.
3. All holiday detection testing and coating repair work shall be witnessed, inspected and approved by the Engineer.

C. Holiday detection testing of extruded coatings:
1. Perform a complete high voltage electrical inspection (holiday detection testing) of all steel piping systems and fittings coated with extruded high-density polyethylene prior to burial of the pipe.
2. Perform the high voltage electrical testing as specified under the preceding paragraph “Holiday Detection Testing of Plastic Tape Wrap Coatings.”

3.03 COMMISSIONING

A. As specified in Section 01756 and this Section.

B. Manufacturer services:
1. Provide Manufacturer’s Certificate of Source Testing.
2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance.

			Manufacturer Rep Onsite					
Source Testing (Witnessed or Non-witnessed)	**Training Requirements**		**Installation Testing**		**Functional Testing**		**Process Operational Period**	
	Maintenance (hrs per session)	**Operation (hrs per session)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**	**Trips**	**Days (each trip)**
Non-witnessed	Not required		Not required		Not required		Not required	

END OF SECTION

SECTION 15286

STAINLESS STEEL PIPE AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Stainless steel piping and tubing.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 15052 - Common Work Results for General Piping.
   3. Section 15121 - Pipe Couplings and External Joint Restraints.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.
   3. B16.11 - Forged Fittings, Socket-Welded and Threaded.
   4. B31.3 - Process Piping.
   5. B36.19 - Stainless Steel Pipe.

B. American Welding Society (AWS):
   1. D1.6 - Structural Welding Code - Stainless Steel.

C. ASTM International (ASTM):
   1. A182 - Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A194 - Standard Specification for Carbon and Alloy Steel Nuts and Bolts for High Pressure or High Temperature Service, or Both.
   4. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   5. A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   7. A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   9. A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.

10. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
11. A744 - Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
12. A774 - Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Services at Low and Moderate Temperatures.
13. A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
14. A789 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service.
15. A790 - Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe.
16. A928 - Standard Specification for Ferritic/Austenitic (Duplex) Stainless Steel Pipe Electric Fusion Welded with Addition of Filler Metal.
17. A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
18. B622 - Standard Specification for Seamless Nickel and Nickel-Cobalt Alloy Pipe and Tube.
19. B912 - Standard Specification for Passivation of Stainless Steels Using Electropolishing.
20. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

D. NSF International (NSF):
   1. Standard 61 - Drinking Water System Components - Health Effects.

1.03 DESIGN REQUIREMENTS

A. Piping layout: Lay out and fabricate piping systems with piping sections as long as possible, while still allowing shipment, so that joints are minimized:
   1. Piping design indicated on the Drawings illustrates piping layout and configuration and does not indicate the location of every joint and flexible coupling that may be needed to connect piping sections fabricated in the shop.
   2. Add joints and flexible couplings in a manner that achieves intent of maximizing size of individual piping sections.

B. Shop fabrication: Fabricate piping sections in the shop and pickle and passivate at point of manufacture.

C. Field assembly:
   1. Field welding is prohibited.

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Product data: As specified in Section 15052.

C. Shop drawings:
   1. Detailed layout drawings:
      a. Dimensions and alignment of pipes.
      b. Location of valves, fittings, and appurtenances.
      c. Location of field joints.
      d. Location of pipe hangars and supports.
      e. Connections to equipment and structures.
      f. Location and details of shop welds.
   2. Thickness and dimensions of fittings and gaskets.
   3. Photographs, drawings, and descriptions of pipe, fittings, welding procedures, and pickling and passivating procedures.
   4. Material specifications for pipe, gaskets, fittings, and couplings.
   5. Data on joint types and components used in the system including flanged joints, grooved joint couplings and screwed joints.

PART 2 PRODUCTS

2.01 STAINLESS STEEL PIPE

A. General:
   1. Pipe sizes specified in the Specifications and indicated on the Drawings are nominal.

B. Wall thickness:
   1. As specified in Section 15052.
   2. Piping 3 inches in nominal diameter and greater:
      a. For general service applications with pressures less than 250 pounds per square inch gauge, pipe diameter 24-inches or less, minimum wall thickness corresponding to Schedule 10S.
      b. For pressures exceeding 250 pounds per square gauge, minimum wall thickness corresponding to Schedule 40S.
   3. Piping less than 3 inches in nominal diameter:
      a. Piping with threaded or grooved joints:
         1) Minimum wall thickness corresponding to Schedule 40S.
   4. Piping with threaded or grooved joints:
      a. For general service applications with pressures less than 250 pounds per square inch gauge, minimum wall thickness corresponding to Schedule 40S.
      b. For pressures exceeding 250 pounds per square inch gauge, minimum wall thickness corresponding to Schedule 80S.

C. Piping material and manufacturing:
   1. Comply with the requirements outlined in the following table:

Service	Stainless Steel Grade	Pipe Manufacturing Process
For low chloride water service with chloride concentrates below 200 parts per million and/or free chlorine less than 2 parts per million at ambient temperatures.		
Piping 3 inches in nominal diameter and larger	Type 304L stainless steel in accordance with ASTM A240	In accordance with ASTM A778
Piping less than 3 inches in nominal diameter	Type 304L stainless steel in accordance with ASTM A240	In accordance with ASTM A312

   2. Chemical analysis certificates.

D. Fittings for piping 3 inches in nominal diameter and greater:
   1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
   2. Manufacturing standard: In accordance with ASTM A774.
   3. Wall thickness of fitting: In accordance with ASME B36.19 for the schedule of pipe specified.
   4. End configuration: As needed to comply with specified type of joint.
   5. Dimensional standards:
      a. Fittings with weld ends: In accordance with ASME B16.11.
      b. Fittings with flanged ends: In accordance with ASME B16.5, Class 150.

E. Fittings for piping less than 3 inches in diameter:
   1. Material: In accordance with ASTM A240 stainless steel, grade to match the pipe.
   2. Manufacturing standard: In accordance with ASTM A403, Class WP.
   3. Wall thickness and dimensions of fitting: In accordance with ASME B16.11 and as required for the schedule of pipe specified.
   4. End configuration: As needed to comply with specified type of joint.
   5. Forgings in accordance with ASTM A182, or barstock in accordance with ASTM A276. Match forging or barstock material to the piping materials.

F. Piping joints:
   1. Joint types, piping greater than 2 inches in diameter, general:
      a. Where type of joint is specifically indicated on the Drawings or specified, design and shop-fabricate piping sections utilizing type of joint illustrated or scheduled.
      b. Joints at valves and pipe appurtenances:
         1) Provide flanged valves and flanged pipe appurtenances in stainless steel piping systems with flanged ends.
         2) Design and fabricate piping sections to make connections with flanged valves and pipe appurtenances using flanged coupling adapters or flanged joints:
            a) Flexible couplings and flanged coupling adapters: Provide stainless steel construction with materials matching the piping system, and conforming to requirements as specified in Section 15121.

2. Joints in piping 2 inches in diameter and smaller: Flanged, grooved, welded, or screwed with Teflon tape thread lubricant, as specified in Section 15052.
3. Welded joints:
    a. Pipe 12 inches and larger in diameter: Automatically weld joints using gas tungsten-arc procedures.
    b. Piping 4 inches through 12 inches in diameter: Double butt welded joints.
    c. Piping less than 4 inches in diameter: Single butt-welded joints.
    d. Mark each weld with a symbol that identifies the welder.
4. Flanged joints: Conforming to the requirements in accordance with ASME B16.5, Class 150.
5. Flanges for Schedule 40S and Schedule 80S pipe:
    a. Provide forged stainless steel (type matching piping system) welding neck flanges or slip-on flanges in accordance with ASME B16.5 Class 150.
    b. Material: In accordance with ASTM A182.
6. Grooved joints:
    a. Pressure less than 500 pounds per square inch:
        1) Cut grooves from Schedule 40 or higher.
    b. Heavier schedule pipe sections used for cut groove ends:
        1) Tapered inside diameter to transition from the inside diameter of the lighter schedule pipe.
    c. Butt welds connecting pipes of different schedules that leave an abrupt change in inside diameter are not allowed.
    d. Couplings:
        1) Rigid type, cast from ductile iron, Victaulic Style 07 or equal. High performance coating as specified in Section 09960.

G. Gaskets:
1. Aeration air service: As specified in Section 15052.
2. All other service applications: EPDM, nitrile, or other materials compatible with the process fluid.

H. Bolts for flanges:
1. Bolts and nuts: Type 316 stainless steel in accordance with ASTM A193 heavy hex head:
    a. Bolt length such that after installation, end of bolt projects 1/8-inch to 3/8-inch beyond outer face of nut.
    b. Nuts: In accordance with ASTM A194 heavy hex pattern.

I. Fabrication of pipe sections:
1. Welding: Weld in accordance with ASME B31.3.
2. Weld seams:
    a. Full penetration welds, free of oxidation, crevices, pits and cracks, and without undercuts.
    b. Provide weld crowns of 1/16 inch with tolerance of plus 1/16 inch and minus 1/32 inch.
    c. Where internal weld seams are not accessible, use gas tungsten-arc procedures with internal gas purge.
    d. Where internal weld seams are accessible, weld seams inside and outside using manual shielded metal-arc procedures.

J. Cleaning (pickling) and passivation:
   1. Following shop fabrication of pipe sections, straight spools, fittings, and other piping components, clean (pickle) and passivate fabricated pieces.
   2. Clean (pickle) and passivate in accordance with ASTM A380 or A967:
      a. If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible:
         1) However, these treatments must be followed by inorganic cleaners such as nitric acid/hydrofluoric acid.
      b. Passivation treatments with citric acid are not allowed.
   3. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface:

2.02 STAINLESS STEEL TUBING

A. Stainless steel tubing:
   1. Seamless tubing made of Type 316L stainless steel and in accordance with ASTM A269, wall thickness not less than 0.035 inch.

B. Fittings: Swage ferrule design:
   1. Components made of:
      a. Type 316 stainless steel.
   2. Double acting ferrule design, providing both a primary seal and a secondary bearing force.
   3. Flare type fittings are not acceptable.
   4. Manufacturers: One of the following or equal:
      a. Crawford Fitting Company, Swagelok.
      b. Hoke, Gyrolok.
      c. Parker, CPI.

C. Valves for use with stainless steel tubing:
   1. Ball type valves with swage ends to match tubing diameter.
   2. Constructed from:
      a. Type 316 stainless steel with TFE seats.
   3. Manufacturers: The following or equal:
      a. Crawford Fitting Company, Swagelok.

2.03 SOURCE QUALITY CONTROL

A. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

B. Provide written certification that the pipe as supplied are in accordance with ASTM A778. Supplemental testing is not required.

C. Provide written certification that the fittings as supplied are in accordance with ASTM A774:
   1. Supplementary testing is not required.

D. Thoroughly clean any equipment before use in cleaning or fabrication of stainless steel.

E. Storage: Segregate location of stainless steel piping from fabrication of any other piping materials.

F. Shipment to site:
   1. Protect all flanges and pipe ends by encapsulating in dense foam.
   2. Securely strap all elements to pallets with nylon straps. Use of metallic straps is prohibited.
   3. Cap ends of tube, piping, pipe spools, fittings, and valves with non-metallic plugs.
   4. Load pallets so no tube, piping, pipe spools, fittings, or valves bear the weight of pallets above.
   5. Notify Engineer when deliveries arrive so Engineer may inspect the shipping conditions.
   6. Engineer may reject material due to improper shipping methods or damage during shipment.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping in such a manner as not to impart strain to connected equipment.

B. Slope horizontal lines so that they can be drained completely.

C. Provide valve drains at low points in piping systems.

D. Install eccentric reducers where necessary to facilitate draining of piping system.

E. Provide access for inspection and flushing of piping systems to remove sediment, deposits, and debris.

3.02 FIELD ASSEMBLY OF SHOP-FABRICATED PIPING SECTIONS

A. Join shop-fabricated piping sections together using backing flanges, flexible couplings, flanged coupling adapters, grooved couplings, or flanges.

3.03 FIELD QUALITY CONTROL

A. Test piping to pressure and by method as specified in Section 15052:
   1. If pressure testing is accomplished with water:
      a. Use only potable quality water.
      b. Piping: Thoroughly drained and dried or place immediately into service.

B. Visually inspect pipe for welding defects such as crevices, pits, cracks, protrusions, and oxidation deposits.

3.04 PROTECTION

A. Preserve appearance and finish of stainless steel piping by providing suitable protection during handling and installation and until final acceptance of the Work:
   1. Use handling methods and equipment to prevent damage to the coating, include the use of wide canvas slings and wide padded skids.
   2. Do not use bare cables, chains, hooks, metal bars, or narrow skids.
   3. Store stainless steel piping and fittings away from any other piping or metals. Storage in contact with ground or outside without projection from bad weather is prohibited.
   4. Protect stainless steel piping and fittings from carbon steel projections (when grinding carbon steel assemblies in proximity) and carbon steel contamination (do not contact stainless steel with carbon steel wire brush or other carbon steel tool).

END OF SECTION

SECTION 15294

RUBBER HOSE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hose.

1.02 SUBMITTALS

A. Product data: Manufacturer's data indicating service type, sizes, materials, and required accessories.

PART 2 PRODUCTS

2.01 HOSE

A. Hose material: Neoprene or acceptable oil resistant material suitable for a working pressure of minimum 75 pounds per square inch, gauge.

B. Size as indicated on the Drawings fit ends with appropriate combination clamped nipples and threaded ends as indicated on the Drawings.

C. Hose larger than 1-1/2 inches in size: Industrial fire hose. Provide one 50 foot long hose for each utility station (hose bib and hose rack) provided:
   1. Manufacturers: One of the following or equal:
      a. Goodyear Rubber Products Corp.
      b. Uniroyal, Inc.
      c. Goodall Rubber Company.

D. Hose 1/2 inch through 1-1/2 inch nominal diameter: General purpose hose. Provide one 75 foot long hose for each utility station (hose bib and hose rack) provided:
   1. Manufacturers: One of the following or equal:
      a. Goodyear Rubber Products Corp.
      b. Uniroyal.
      c. Goodall Rubber Company.

E. Equip and fit hose ends with appropriate combination clamped nipples and threaded ends to make up the assembly indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install hose in accordance with manufacturer's published instructions.

END OF SECTION

SECTION 15956

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Test requirements for piping systems.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.
      b. Section 01410 - Regulatory Requirements.
      c. Section 01500 - Temporary Facilities and Controls.
      d. Section 15052 - Common Work Results for General Piping.

1.02 REFERENCES

A. National Fuel Gas Code (NFGC).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.3 - Process Piping.
   3. B31.8 - Gas Transmission and Distribution Piping Systems.

C. Underwriters Laboratories Inc. (UL).

1.03 TESTING REQUIREMENTS

A. General requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052; are specified in the specifications covering the various types of piping; and are specified in this Section.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01410, and UL requirements.

4. Test natural gas or digester gas piping:
    a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01410, or the National Fuel Gas Code, whichever is more stringent.
    b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
5. When testing with water, the specified test pressure is considered to be the pressure at the lowest point of the piping section under test:
    a. Lower test pressure as necessary (based on elevation) if testing is performed at higher point of the pipe section.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for testing, cleaning, and disinfecting:
1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01500.

D. Pipes to be tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful tests:
1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
2. Repeat testing until tests are successful.

F. Test completion: Drain and leave piping clean after successful testing.

G. Test water disposal: Dispose of testing water at the headworks or in plant drain in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site. Coordinate location and testing requirements with the City.

1.04 SUBMITTALS

A. Submit as specified in Section 01330.

B. Schedule and notification of tests:
1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
2. Notification of readiness to test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping.
3. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection test:
   1. Pull a mandrel through the clean piping section under test.
   2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
   3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within 1 percent plus or minus.
   4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.02 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
   1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 15052:
   1. Provide temporary pressure relief valve for piping under test:
      a. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
   2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1, ASME B31.3, ASE B31.8, or the pipe manufacturer's stated maximum working pressure.
   3. Gradually increase test pressure to an initial test pressure equal to the lesser of 1/2 the test pressure or 25 pounds per square inch gauge.
   4. Perform initial check of joints and fittings for leakage.
   5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage at each step increase until test pressure reached.
   6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
   7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.03 TESTING GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with "GR" in the Piping Schedule, as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.
      b. For plastic piping test for deflection.
      c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
   2. Inspect piping for visible leaks before backfilling.
   3. Provide temporary restraints when needed to prevent movement of piping.
   4. Pressure test piping with maximum leakage allowance after backfilling.
   5. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours:
      a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
      b. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
      c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of 4 hours while accurately measuring the volume of water added to maintain the test pressure:
         1) For polyvinyl chloride (PVC) gravity sewer pipe: 25 gallons per day per inch diameter per mile of piping under test:
            a) Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
               (1) For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test:
                  (a) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.

(2) For vitrified clay piping: 500 gallons per day per inch of diameter per mile of piping under test.
(3) For other piping: 80 gallons per day per inch diameter per mile of piping under test.

3.04 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping Schedule.

B. General:
1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
3. Do not include valves, equipment, or piping specialties in test sections if test pressure exceeds the valve, equipment, or piping specialty safe test pressure allowed by the item's manufacturer.
4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
6. When test results indicate failure of selected sections, limit tests to piping:
   a. Between valves.
   b. Between a valve and the end of the piping.
   c. Less than 500 feet long.
7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing procedures:
1. Fill piping section under test slowly with water while venting air:
   a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
3. Raise pressure to the specified test pressure and inspect piping visually for leaks:
   a. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
2. Pressure test piping after completion of visible leaks test.

3. For piping systems using joint designs other than flanged, threaded, or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
   b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
   c. When leakage is allowed, calculate the allowable leakage by the following formula:

      $L = S \times D \times P^{1/2} \times 133{,}200^{-1}$

      wherein the terms shall mean:

      L = Allowable leakage in gallons per hour.

      S = Length of the test section in feet.

      D = Nominal diameter of the piping in inches.

      P = Average observed test pressure in pounds per square inches gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

      x = The multiplication symbol.

3.05 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

B. General:
   1. Test pressures shall be as scheduled in Section 15052.
   2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
   3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
   4. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible leaks test:
   1. Subject piping under test to the specified pressure measured at the lowest end.
   2. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.

3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Pressure test piping after completion of visible leaks test.
   2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours, and no damage to piping and appurtenances has occurred.
      b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

E. Optional joint test:
   1. When joint testing is allowed by note in the Piping Schedule, the procedure shall be as follows:
      a. Joint testing will be allowed only for low head pressure piping.
      b. Joint testing does not replace and is not in lieu of any testing of the piping system or trust restraints.
   2. Joint testing may be performed with water or air.
   3. Joint test piping after completion of backfill and compaction to the top of the trench.
   4. Joint testing with water:
      a. Measure test pressure at the invert of the pipe. Apply pressure of 4 feet plus the inside diameter of the pipe in water column within 0.20 feet in water column.
      b. Maintain test pressure for 1 minute.
      c. Base the allowable leakage per joint on 80 gallons per inch nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
      d. Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
      e. Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.
   5. Joint testing with air:
      a. Apply test pressure of 3 pounds per square inch gauge with a maximum variation of plus 0.20 and minus 0.00 pounds per square inch.
      b. Maintain test pressure for 2 minutes.
      c. Consider the pressure test to be complete when the test pressure does not drop below 2.7 pounds per square inch for the duration of the test.

END OF SECTION

SECTION 15958

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Testing of mechanical equipment and systems.

B. Related sections:
   1. Section 01756 - Commissioning.
   2. Section 02318 - Trenching.
   3. Section 15956 - Piping Systems Testing.
   4. Section 16222 - Low Voltage Motors up to 500 Horsepower.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4 Specification for Sound Level Meters.

B. Hydraulic Institute (HI).

C. National Institute of Standards and Technology (NIST).

1.03 SUBMITTALS

A. Schedule of source (factory) tests, Owner training, installation testing, functional testing, clean water facility testing, closeout documentation, process start-up and process operational period as specified in this Section and in Section 01756 and equipment sections.

B. Test instrumentation calibration data:

C. Operation and maintenance manual:
   1. Include motor rotor bar pass frequencies for motors larger than 500 horsepower.

D. Commissioning and Process Start-up Plan: As specified in Section 01756.

E. Test plan as specified in Section 01756 and equipment sections.

F. Test reports as specified in this Section and in Section 01756 and equipment sections.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL

A. Commissioning and process start-up of equipment as specified in:
   1. This Section.
   2. Section 01756.
   3. Equipment sections:
      a. If testing requirements are not specified, provide Level 1 Tests.

B. Comply with latest version of applicable standards.

C. Test and prepare piping as specified in Sections 02318 and 15956.

D. Operation of related existing equipment: Owner will operate related existing equipment or facilities necessary to accomplish the testing. Schedule and coordinate testing as required by Section 01756.

E. Provide necessary test instrumentation that has been calibrated within 1 year from date of test to recognized test standards traceable to the NIST or approved source:
   1. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for tests.
   2. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

F. Test measurement and result accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments:
      a. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy:
      a. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

G. Report features:
   1. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.
   2. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.
   3. Include appendix with sample calculations for adjustments to raw test data and for calculated results.
   4. Include appendix with the make, model, and last calibration date of instrumentation used for test measurements.
   5. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

H. Provide necessary fluids, utilities, temporary piping, temporary supports, temporary access platforms or access means and other temporary facilities and labor necessary to safely operate the equipment and accomplish the specified testing:
   1. With Owner's permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

I. Prepare and submit test reports as specified.

J. Testing levels:
   1. Level 1 Tests:
      a. Level 1 General Equipment Performance Test:
         1) For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
         2) Operate at rated design load conditions.
         3) Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
      b. Level 1 Pump Performance Test:
         1) Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
         2) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 or the applicable equipment section. Use actual driver for field tests.
         3) Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
      c. Level 1 Vibration Test:
         1) Test requirement:
            a) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
            b) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
         2) Equipment operating condition: Test at specified maximum speed.
      d. Level 1 Noise Test:
         1) Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.
   2. Level 2 Tests:
      a. Level 2 General Performance Test:
         1) For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
         2) Operate at rated design load conditions.

3) Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

b. Level 2 Pump Performance Test:
   1) Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   2) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222. Use actual driver for field tests.
   3) Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.
   4) Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.

c. Level 2 Vibration Test:
   1) Test requirement:
      a) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
      b) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
   2) Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
   3) Natural frequency test of field installed equipment:
      a) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears and supports.
      b) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
      c) Perform with equipment and attached piping full of intended service or process fluid.

d. Level 2 Noise Test:
   1) Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.

3. Level 3 Tests:
    a. Level 3 General Equipment Performance Tests:
        1) For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
        2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
        3) Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.
        4) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
        5) Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.
    b. Level 3 Pump Performance Test:
        1) Test 4 hours minimum for flow and head at or near the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
        2) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222. Use actual driver for field tests.
        3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes; for factory testing, test at other speeds may be omitted if test driver at reduced speeds is used for rated condition testing.
        4) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.
    c. Level 3 Vibration Test:
        1) Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
        2) Perform High Frequency Enveloping Analysis for gears and bearings:
            a) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
            b) Report results in units of acceleration versus frequency in cycles per minute.
        3) Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).

4) Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.

d. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plain view; report results for each of 8 octave band mid-points beginning at 63 hertz.

4. Level 4 Tests:

a. Level 4 General Equipment Performance Test:

1) For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.

2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.

3) Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.

4) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.

5) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

b. Level 4 Pump Performance Test:

1) Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.

2) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration and noise data at each test condition.

3) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.

4) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

5) Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:

a) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.

b) Perform efficiency testing with test fluids at maximum rated speed.
c) Perform priming time testing with test fluids at maximum rated speed.

c. Level 4 Vibration Test: Same as Level 3 vibration test.
d. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

K. Variable speed equipment tests:
1. Establish performance over the entire speed range and at the average operating condition.
2. Establish performance curves for the following speeds:
a. The speed corresponding to the rated maximum capacity.
b. The speed corresponding to the minimum capacity.
c. The speed corresponding to the average operating conditions.

L. Pump tests, all levels of testing:
1. Test in accordance with the following:
a. Applicable HI Standards.
b. This Section.
c. Equipment sections.
2. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
a. From 0 to plus 5 percent of head at the specified flows rated design point flow.
b. From 0 to plus 5 percent of flow at the rated design point head.
c. No negative tolerance for the efficiency at the specified flows rated design point.
d. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

M. Drivers tests:
1. Test motors as specified in Section 16222.
2. Test other drivers as specified in the equipment section.

N. Noise requirements and control:
1. Perform noise tests in conjunction with vibration test analysis.
2. Make measurements in relation to reference pressure of 0.0002 microbar.
3. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.
4. Set sound level meter to slow response.
5. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

O. Pressure testing:
1. Hydrostatically pressure test pressure containing parts at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher.

P. Inspection and balancing:
    1. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits.
    2. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.
    3. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

Q. Critical speed of rotating equipment:
    1. Satisfy the following:
        a. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
        b. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
        c. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

R. Vibration tests:
    1. Definitions:
        a. Root mean square: for pumps operating at speeds greater than 600 rpm, the vibration measurement shall be measured as the overall velocity in inches per second root mean square (RMS).
        b. Peak-to-peak displacement: The root mean squared average of the peak-to-peak displacement multiplied by the square root of 2.
        c. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
        d. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
        e. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency:
            1) Manufacturers: One of the following or equal:
                a) Rockwell Automation, Entek Group, "Spike Energy" analysis.
                b) CSI, "PeakVue."
        f. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
        g. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.
        h. Preferred operating range: Manufacturer's defined preferred operating range (POR) for the equipment.
        i. Allowable operating range: Manufacturer's defined allowable operating range (AOR) for the equipment.

2. Vibration instrumentation requirements:
    a. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12 bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, data output port, circuitry for integration of acceleration data to velocity or double integration to displacement:
        1) Manufacturers: One of the following or equal:
            a) Computational Systems Inc., (CSI) Division of Emerson Process Management, Model 2120A, Data Collector/analyzer with applicable analysis software.
            b) Pruftechnik, VIBXPERT II.
    b. Analyzer settings:
        1) Units: English, inches/second, mils, and gravitational forces.
        2) Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
        3) Sample averages: 4 minimum.
        4) Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
        5) Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
        6) Fast fourier transform windowing: Hanning Window.
        7) High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.
    c. Accelerometers:
        1) For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount:
            a) Manufacturers: One of the following or equal:
                (1) Wilcoxon Research, Model 797L.
                (2) PCB, Model 393C.
        2) For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder:
            a) Manufacturers: One of the following or equal:
                (1) Wilcoxon Research, Model 793.
                (2) Entek-IRD Model 943.
3. Accelerometer mounting:
    a. Use magnetic mounting or stud mounting.
    b. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
    c. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.

4. Vibration acceptance criteria:
    a. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.
    b. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Conditions & Application Data	**Overall Peak-to-Peak Displacement**	
	Field, mils	**Factory, mils**
Operation within the POR	3.0	4.0
Operation within the AOR	4.0	5.0
Additive value when measurement location is greater than 5 feet above foundation.	2.0	2.0
Additive value for solids-handling pumps	2.0	N/A
Additive value for slurry pumps	2.0	N/A

    c. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

HI Pump Type	**Horsepower**	**Field Test**	**Factory Test**
		Overall RMS	**Overall RMS**
Horizontal Solids Handling Centrifugal Pumps	Below 33 hp	0.25	0.28
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type)	Between 33 and 100 hp	0.28	0.31
	100 hp and above	0.31	0.34
Vertical Solids Handling Centrifugal Pumps	Below 33 hp	0.30	0.33
Vertical Turbine, Mixed Flow, and Propeller Pumps	Between 33 and 100 hp	0.32	0.35
	100 hp and above	0.34	0.35
Non-Solids Handling Centrifugal Pumps	Below 268 hp	0.15	0.19
HI Types BB1, BB2, BB3, BB4, BB5, OH1, OH2, OH3, OH4, OH5, and OH7	268 hp and above	0.19	0.22
Vertical Turbine, Mixed Flow, and Propeller Pumps HI Types VS1, VS2, VS3, VS4, VS5, VS6, VS7, and VS8	Below 268 hp	0.13	
Gear Reducers, Radial	268 hp and above	0.17	

HI Pump Type	Horsepower	Field Test	Factory Test
		Overall RMS	Overall RMS
Slurry Pumps		0.25	0.30
Motors		See Applicable Motor Specification	See Applicable Motor Specification
Gear Reducers, Radial		Not to exceed AGMA 6000-B96 limits	Not to exceed AGMA 6000-B96 limits
Other Reducers, Axial		0.1	N/A

d. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.

e. Additional criteria:

1) No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.

2) The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.

3) For motors, the following shall be cause for rejection:

a) Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that are more than 40 percent of the peak at rotational frequency.

b) Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.

c) Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.

d) Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.

4) The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

5. Vibration testing results presentation:

a. Provide equipment drawing with location and orientation of measurement points indicated.

b. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.

c. When Vibration Spectra Data required:
    1) Plot peak vibration velocity versus frequency in cycles per minute.
    2) Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
    3) Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
    4) Plot motor spectra on a log amplitude scale versus frequency.
d. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
e. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.02 PLANNING PHASE

A. Submit test plans as specified in Section 01756 and this Section:
    1. Indicate test start time and duration, equipment to be tested, other equipment involved or required; temporary facilities required, number and skill or trade of personnel involved; safety issues and planned safety contingencies; anticipated effect on Owner's existing equipment and other information relevant to the test.
    2. Provide locations of all instruments to be used for testing. Provide calibration records for all instrumentation.

3.03 COMMISSIONING PHASE

A. Source testing:
    1. Witnessing not required unless specified otherwise in equipment section.
    2. Witnessed tests: Schedule test date and notify Engineer at least 30 days prior to start of test.
    3. Test equipment as specified in Section 01756 and equipment sections.
    4. Test fluids as specified in Section 01756.
    5. Submit reports as specified in Section 01756

B. Installation testing:
    1. Test equipment as specified in Section 01756 and equipment sections.

C. Functional testing:
    1. Witnessing required as specified in Section 01756.
    2. Schedule test date and notify Engineer at least 7 days prior to start of test.
    3. Test equipment as specified in equipment sections. Test fluids as specified in Section 01756.
    4. Submit reports as specified in Section 01756.

D. Clean Water Facility Testing:
    1. Test equipment as specified in Section 01756 and equipment sections.

E. Closeout documentation:
   1. Provide closeout documentation as specified in Section 01756 and equipment sections.

3.04 PROCESS START-UP PHASE

A. Process start-up:
   1. Process start-up equipment as specified in Section 01756 and equipment sections.

B. Process Operational Period:
   1. Operate equipment as specified in Section 01756 and equipment sections.
   2. Test fluids as specified in Section 01756.

END OF SECTION

SECTION 16050

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. General requirements applicable to all Electrical Work.
   2. General requirements for electrical submittals.

B. Related sections:
   1. Document 00200 - Instructions to Bidders.
   2. Document 00700 - General Conditions.
   3. Section 01140 - Work Restrictions.
   4. Section 01292 - Schedule of Values.
   5. Section 01312 - Project Meetings.
   6. Section 01324A - Progress Schedules and Reports.
   7. Section 01329 - Safety Plan.
   8. Section 01330 - Submittal Procedures.
   9. Section 01410 - Regulatory Requirements.
   10. Section 01450 - Quality Control.
   11. Section 01500 - Temporary Facilities and Controls.
   12. Section 01600 - Product Requirements.
   13. Section 01610 - Project Design Criteria.
   14. Section 01612 - Seismic Design Criteria.
   15. Section 01614 - Wind Design Criteria.
   16. Section 01738 - Selective Site Demolition.
   17. Section 01756 - Commissioning.
   18. Section 01770 - Closeout Procedures.
   19. Section 01782 - Operation and Maintenance Data.
   20. Section 16052 - Hazardous Classified Area Construction.
   21. Section 16075 - Identification for Electrical Systems.
   22. Section 16130 - Conduits.
   23. Section 16305 - Electrical System Studies.
   24. Section 16950 - Field Electrical Acceptance Tests.

C. Interfaces to equipment, instruments, and other components:
   1. The Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
   2. Provide all material and labor needed to install the actual equipment furnished, and include all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the Work, which may be necessary to make a complete, functional installation based on the actual equipment furnished:
      a. Make all changes necessary to meet the manufacturer's wiring requirements.

3. Submit all such changes and additions to the Engineer for acceptance as specified in Document 00700.
4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appear on the Drawings or in the Specifications from another discipline in the scope of Work:
    a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
5. Loop drawings:
    a. Provide all electrical information required in the preparation of loop drawings including, but not limited to:
        1) Conduit numbers and associated signal(s) contained within each conduit.
        2) Wire numbers.
        3) Equipment terminal numbers.
        4) Junction boxes and signal(s) contained within each junction box.
        5) Equipment power sources, and associated circuit numbers.
        6) As-built drawings detailing wiring.

D. All electrical equipment and systems for the entire Project must comply with the requirements of the Electrical Specifications, whether referenced in the individual Equipment Specifications or not:
1. The requirements of the Electrical Specifications apply to all Electrical Work specified in other sections.
2. Inform all vendors supplying electrical equipment or systems of the requirements of the Electrical Specifications.
3. The Owner is not responsible for any additional costs due to the failure of the Contractor to notify all subcontractors and suppliers of the Electrical Specifications requirements.

E. Contract Documents:
1. General:
    a. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work.
2. Specifications:
    a. The General and Supplementary Conditions of the Contract Documents govern the Work.
    b. These requirements are in addition to all General Requirements.
3. Contract Drawings:
    a. The Electrical Drawings show desired locations, arrangements, and components of the Electrical Work in a diagrammatic manner.
    b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only; exercise professional judgment in executing the Work to ensure the best possible installation:
        1) The equipment locations and dimensions indicated on the Drawings are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all electrical equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.

2) The Contractor has the freedom to select any of the named manufacturers identified in the individual specification sections; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.

c. Installation details:
   1) The Contract Drawings include typical installation details the Contractor is to use to complete the Electrical Work. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.
   2) Not all typical installation details are referenced within the Drawing set. Apply and use typical details where appropriate.

d. Schematic diagrams:
   1) All controls are shown de-energized.
   2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
   3) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
   4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
   5) Schematic diagrams are to be used in conjunction with the descriptive operating sequences in the Contract Documents. Combine all information and furnish a coordinated and fully functional control system.

F. Alternates/Alternatives:
   1. Coordinate with Document 00700 for substitute item provisions.

G. Changes and change orders:
   1. As specified in Document 00700.

1.02 REFERENCES

A. Code compliance:
   1. As specified in Section 01410.
   2. The publications are referred to in the text by the basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of the bid governs.
   3. The standards listed are hereby incorporated into this Section:
      a. American National Standards Institute (ANSI).
      b. American Society of Civil Engineers (ASCE):
         1) ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
      c. ASTM International (ASTM).
      d. Illuminating Engineering Society (IES). Institute of Electrical and Electronics Engineers (IEEE).

e. Insulated Cable Engineers Association (ICEA).
f. International Code Council (ICC):
    1) International Code Council Evaluation Service (ICC-ES):
        a) AC 156 – Acceptance Criteria for Seismic Certification by Shake Table Testing of Non-Structural Components (ICC-ES AC 156).
g. International Society of Automation (ISA).
h. National Electrical Manufacturers Association (NEMA):
    1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
i. National Fire Protection Association (NFPA):
    1) 70 - National Electrical Code (NEC).
j. National Institute of Standards and Technology (NIST).
k. Underwriters' Laboratories, Inc. (UL).

B. Compliance with laws and regulations:
    1. As specified in Document 00700.

1.03 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth by:
    1. IEEE.
    2. NETA.
    3. IES.
    4. ISA.
    5. NEC.
    6. NEMA.
    7. NFPA.
    8. NIST.

B. Specific definitions:
    1. FAT: Factory acceptance test.
    2. ICSC: Instrumentation and controls subcontractor.
    3. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
    4. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
    5. PCIS: Process control and instrumentation system.
    6. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
    7. Space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment, i.e., provide all standoffs, bus, and hardware, as part of the space.
    8. Spare: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that physically contains a device with no load connections to be made.

9. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
10. Unequipped space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.

1.04 SYSTEM DESCRIPTION

A. General requirements:
1. The Work includes everything necessary for and incidental to executing and completing the Electrical Work indicated on the Drawings and specified in the Specifications and reasonably inferable there from:
   a. The Electrical Drawings are schematic in nature; use the Structural, Architectural, Mechanical, and Civil Drawings for all dimensions and scaling purposes.
2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of equipment furnished by others as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
3. Provide all Electrical Work, including conduit, field wiring, and connections by the electrical subcontractor under the provisions of the Electrical Specifications for all aspects of the Work.
4. Coordinate all aspects of the Work with the electrical subcontractor and other subcontractors before bidding in order to ensure that all costs associated with a complete installation are included. The Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the electrical subcontractor, the other subcontractors or suppliers.
5. Demolition:
   a. Where demolition is specified or indicated on the Drawings, disconnect all associated electrical equipment and render the equipment safe.
   b. Remove and dispose of all conduit, wire, electrical equipment, controls, etc. associated with the items and/or areas to be demolished as indicated on the Drawings unless otherwise indicated.
   c. Salvage electrical equipment as specified in Section 01738.
   d. For each piece of equipment to be removed, remove all ancillary components (e.g., instruments, solenoid valves, disconnect switches, etc.).
   e. Conduit:
      1) Where conduit removal, other than associated with equipment to be removed, is indicated on the Drawings:
         a) Remove exposed conduit to the point of encasement or burial.
         b) Cut conduit flush and plug or cap encased or buried conduit.
      2) Where conduits are to remain in place and removal is not indicated on the Drawings:
         a) Cap conduit open ends.
         b) Re-label empty conduits as spare.

f. Remove all wire back to the source for all conduits to be removed or abandoned in place.
g. Provide new nameplates for modified electrical distribution equipment, motor control centers etc. to identify equipment and circuits that are no longer used as spares.
h. Provide new typewritten schedules for all modified panelboards.

6. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
   a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before starting any Work. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
   b. Provide and document interface with, modifications to, upgrades, or replacement of existing circuits, power systems, controls, and equipment.
7. Provide all trenching, forming, rebar, concrete, back filling, hard surface removal and replacement, for all items associated with the Electrical Work and installation:
   a. As specified in the Contract Documents.
8. Defective work:
   a. As specified in Document 00700.

B. Modified system:
   1. Existing equipment SWGR-7, MCC-7A, MCC-7B, RTU-207, and SWGR-7 Remote Control Panel are located in Electrical Building No. 7. This equipment will be modified to support new electrical and instrumentation for this project.
   2. Existing equipment MCC-2F, MCC-2G, and RTU-30 are located in the Filter Pump Station. This equipment will be modified for support new electrical and instrumentation for this project.

C. New system:
   1. The new electrical and control system shall include, but not be limited to:
      a. Addition of a new pre-fabricated walk-in electrical enclosure including new motor control centers, RTU, manual transfer switch, transformer, panel board and lighting contactor.
      b. New motor control centers and a new RTU in Electrical Building No. 7.
      c. The new and modified system shall provide power to:
         1) New mixers, mixed liquor return pumps, and instruments in 7 existing aeration basins.
         2) New secondary clarifier and RAS pump station.
         3) New motorized gates and instruments at the modified mixed liquor flumes.

D. Operating facility:
   1. As specified in Section 01140.
   2. The Turlock Regional Water Quality Control Facility is an operating facility. Portions of this facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
      a. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction schedule to meet the

requirements of the Owner. All changes in schedule and any needs to reschedule are included in the Work.

b. As weather and water demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.

c. Coordinate the construction and power renovation, bear all costs, so that all existing facilities can continue operation throughout construction.

3. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.

4. The standards of documentation, instrument tagging, cable and conductor ferruling, terminal identification and labeling that apply to the new installation apply equally to the existing installation which forms part of the modified system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 01330 and this Section.

B. General:

1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.

2. Furnish the submittals required by each section in the Electrical Specifications.

3. Adhere to the wiring numbering scheme specified in Section 16075 throughout the Project:

a. Uniquely number each wire.

b. Wire numbers must appear on all Equipment Drawings.

4. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.

C. Seismic requirements:

1. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads based on the seismic design criteria in Section 01612.

2. For equipment installed in structures designated as seismic design category C, D, E or F, prepare and submit the following:

a. Statement of seismic qualification, and special seismic certification:

1) “Statement of seismic qualification:” Provide manufacturer’s statement that the equipment satisfies the seismic design requirements of the building code indicated in Section 01410, including the requirements of ASCE 7, Chapter 13.

2) “Special seismic certification:” Provide manufacturer’s certification that the equipment, when subjected to shake table testing in accordance with ICC-ES AC 156, meets the “Post-Test Functional Compliance Verification” requirements of ICC-ES AC 156 for “Components with Ip = 1.5.” Compliance shall include both operability and containment of hazardous materials as appropriate to the unit being tested.

b. Substantiating test data: With seismic qualification and special seismic certification statements, submit results of testing in accordance with ICC-ES AC 156.

c. Anchoring design calculations and details:
1) Submit project-specific drawings and supporting calculations, prepared and sealed by a professional engineer licensed in the state where the Project is being constructed, and showing details for anchoring electrical equipment to its supports and for anchoring supports provided with the equipment to the structure. Prepare calculations in accordance with the requirements of Section 01612.

3. Exemptions: A “statement of seismic qualification” and a “special seismic certification” are not required for the following equipment:
a. Temporary or moveable equipment.
b. Equipment anchored to the structure and having a total weight of 20 pounds or less.
c. Distribution equipment anchored to the structure and having a total unit weight of 3 pounds per linear foot, or less.

D. Operation and maintenance manuals:
1. As specified in Section 01782.
2. Furnish the Engineer with a complete set of written operation and maintenance manuals 8 weeks before Functional Acceptance Testing.

E. Material and equipment schedules:
1. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
a. Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

F. Schedule of values:
1. In addition to completing all items referred to in the schedule of values, Section 01292, submit per unit material and labor costs used in developing the final bid for the electrical system, for the express purpose of pricing and cost justification for any proposed change orders. In addition to the items shown on the schedule of values, provide per unit material and labor costs for conduit and wire installation for specific types, sizes, and locations as indicated on the Drawings and Conduit Schedule. It is the responsibility of the electrical subcontractor to prove to the Engineer’s satisfaction that said per unit costs were used in the development of the final Bid amount.

G. Roof penetrations:
1. Submit details of all portions of the electrical installation that penetrate the roof. Include details showing support of the penetrating component, and the sealing means to be utilized.

H. Record Documents:
1. Furnish as specified in Section 01770.

I. Test reports:
1. As specified in Section 01330.
2. Additional requirements for field acceptance test reports are specified in Sections 01756 and 16950.

J. Calculations:
    1. Where required by specific Electrical Specifications:
        a. Because these calculations are being provided by a registered professional engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculation means.

1.06 QUALITY ASSURANCE

A. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600.

1.08 PROJECT OR SITE CONDITIONS

A. Site conditions:
    1. Provide an electrical, instrumentation and control system, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
    2. Seismic load resistance:
        a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads as specified in Section 01612.
    3. Wind load resistance:
        a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site wind loads as specified in Section 01614.
    4. Altitude, temperature and humidity:
        a. As specified in Section 01610.
        b. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
        c. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces subject to these ambient temperatures, with a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature, as determined by the equipment manufacturer's guidelines:
            1) Provide all power conduits wiring for these devices (e.g. heaters, fans, etc.) whether indicated on the Drawings or not.
    5. Site security:
        a. Abide by all security and safety rules concerning the Work on the Site, as specified in Sections 01329 and 01500.
    6. Outdoor installations:
        a. Provide electrical, instrumentation and control equipment suitable for operation in the ambient conditions where the equipment is located.

b. Provide heating, cooling, and dehumidifying devices incorporated into and included with electrical equipment, instrumentation and control panels to maintain the enclosures within the rated environmental operating ranges as specified in this Section for the equipment:
    1) Provide all wiring necessary to power these devices.

B. Provide enclosures for electrical, instrumentation and control equipment, regardless of supplier or subcontractor furnishing the equipment, that meet the requirements outlined in NEMA Standard 250 for the following types of enclosures:
    1. NEMA Type 1: Intended for indoor use, primarily to provide a degree of protection from accidental contact with energized parts or equipment.
    2. NEMA Type 4: Intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing.
    3. NEMA Type 4X: Made from corrosion resistant materials (fiberglass reinforced plastic, 316 stainless steel or equal) and are intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing, and corrosion.
    4. NEMA Type 12: Intended for indoor use, primarily to provide a degree of protection from dust, falling dirt and dripping non-corrosive liquids.
    5. NEMA Type 6: Rated for submergence.
    6. NEMA Type 6P: Rated for prolonged submergence.
    7. NEMA Type 7: Intended for installation in locations where explosive or combustible gas or vapors may be present (Class I Division 1 or Class I Division 2) meeting the requirements outlined in Section 16052.

C. Plant area Electrical Work requirements:
    1. Provide all Electrical Work in accordance with the following table, unless otherwise specifically indicated on the Drawings:

PLANT AREA	NEMA ENCLOSURE TYPE	EXPOSED CONDUIT TYPE	ENVIRONMENT W = WET D = DAMP C = CLEAN/DRY X = CORROSIVE H = HAZARDOUS	SUPPORT MATERIALS
ML Flumes	NEMA 4X SS	PCS	W, D, X	Stainless Stl
Secondary Clarifier	NEMA 4X SS	PCS	W, D, X	Stainless Stl
RAS Pump Station	NEMA 4X SS	PCS	W, D, X	Stainless Stl
Aeration Basins	NEMA 4X SS	PCS	W, D, X	Stainless Stl
Electrical Rooms	NEMA 12	GRC	C	Galv Stl
Biotower Pumping Station (Pump pit)	NEMA 7	PCS	H (Class I, Div 1), W, X	Stainless Stl
Biotower Pumping Station (From pump pit deck to 18" above pump pit deck)	NEMA 7	PCS	H (Class I, Div 2), W, X	Stainless Stl
Biotower Pumping Station (above 18" above pump pit deck)	NEMA 4X SS	PCS	W, D, X	Stainless Stl
Outdoors (unless otherwise listed)	NEMA 4X SS	PCS	W, D, X	Stainless Stl

2. Modify exposed conduit runs as specified in Section 16130.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:
   1. As specified in Sections 01312 and 01756.
   2. Testing requirements are specified in Section 01756, 16950 and other sections.
   3. General scheduling requirements are specified in Section 01324A.
   4. Work restrictions and other scheduling requirements are specified in Section 01140.
   5. Commissioning and Process Start-up requirements as specified in Section 01756.

B. Pre-submittal conference:
   1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire Project, equipment, control philosophy, schedules, and submittal requirements.
   2. The Contractor, electrical subcontractor, all suppliers, and individual equipment manufacturers furnishing major pieces of equipment must attend.

1.11 WARRANTY

A. Warrant the Electrical Work as specified in Document 00700:
   1. Provide additional warranty as specified in the individual Electrical Specifications.

1.12 SYSTEM START-UP

A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
   1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

B. Furnish all spare parts as required by other sections of the Specifications.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide similar items of same manufacturer throughout the electrical and instrumentation portion of the Project.

B. Allowable manufacturers are specified in individual Electrical Specifications.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products and that bear all approvals and labels as required by the Specifications.

B. Provide materials complying with the applicable industrial standard as specified in Document 00700.

C. Stainless steel:
   1. Where stainless steel is indicated or used for any portion of the Electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
   2. Provide exposed screws of the same alloys.
   3. Provide finished material free of any burrs or sharp edges.
   4. Use only stainless steel hardware, when chemically compatible, in all areas that are or could be in contact with corrosive chemicals.
   5. Use stainless steel hardware, when chemically compatible, in all chemical areas or areas requiring NEMA Type 4X construction.
   6. Do not use stainless steel in any area containing chlorine, gas or solution, chlorine products or ferric chloride.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products.

PART 3 EXECUTION

3.01 EXAMINATION

A. The electrical subcontractor is encouraged to visit the site to examine the premises completely before bidding.

B. It is the electrical subcontractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations.

C. Comply with pre-bid conference requirements as specified in Document 00200

D. Review the site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions indicated on the Drawings:
      a. Actual field conditions govern all final installed locations, distances, and levels.
   2. Review all Contract Documents and approved equipment shop drawings and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
   3. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.
   4. Provide a complete electrical system:
      a. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical system.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. Cutting and patching:
   1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
      a. Secure the permission of the Engineer before performing any operation likely to affect the strength of a structural member such as drilling, cutting or piercing:
         1) Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made:
            a) Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables, etc.
            b) Use tone-locate system or X-ray to ensure that area is clear of obstructions.
      b. Review the complete Drawing set to ensure that there are no conflicts or coordination problems before cutting, channeling, or core drilling any surface.
   2. Perform all patching to the same quality and appearance as the original work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:
      a. 3M CP 25WB+ Caulk.
      b. 3M Fire Barrier Putty.
   3. Use the installation details indicated on the Drawings as a guide for acceptable sealing methods.

D. Install all conduits and equipment in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear:
   1. Install all conduits and equipment in accordance with working space requirements in accordance with the NEC:
      a. This includes any panel, disconnect switch or other equipment that can be energized while open exposing live parts regardless of whether it is likely to require examination or has serviceable parts.
   2. Where the Drawings do not show dimensions for locating equipment, install equipment in the approximate locations indicated on the Drawings:
      a. Adjust equipment locations as necessary to avoid any obstruction or interferences.
   3. Where an obstruction interferes with equipment operation or safe access, relocate the equipment.
   4. Where the Drawings do not indicate the exact mounting and/or supporting method to be used, use materials and methods similar to the mounting details indicated on the Drawings.

E. Earthwork and concrete:
   1. Install all trenching, shoring, concrete, backfilling, grading and resurfacing associated with the Electrical Work:
      a. Requirements as specified in the Contract Documents.

F. Roof penetrations:
   1. Seal conduit penetrations in accordance with roofing manufacturer's instructions.

G. Terminations:
   1. Provide and terminate all conductors required to interconnect power, controls, instruments, panels, and all other equipment.

H. Miscellaneous installation requirements:
   1. In case of interference between electrical equipment indicated on the Drawings and the other equipment, notify the Engineer as specified in Document 00700.
   2. Location of manholes and pullboxes indicated on the Drawings are approximate. Coordinate exact location of manholes and pullboxes with Mechanical and Civil Work.
   3. Provide additional manholes or pullboxes to those shown where they are required to make a workable installation.
   4. Circuits of different service voltage:
      a. Voltage and service levels:
         1) Low voltage: 120 V to 480 V.
         2) Instrumentation: Less than 50 VDC.
      b. Install different service voltage circuits in separate raceways , junction boxes, manholes, hand holes, and pullboxes.
      c. In manholes, install all cables operating at less than 50 VDC in PVC coated flexible metallic conduit, with corrosion resistant fittings.

I. Labeling:
   1. Provide all nameplates and labels as specified in Sections 16075 and 16305.

J. Equipment tie-downs:
   1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing criteria, which apply to the Site.
   2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., must be permanently mounted and tied down to structures in accordance with the Project seismic criteria.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. For Owner and Engineer witnessed FAT:
   1. The Contractor is responsible for the Owner's and Engineer's costs associated with FAT as specified in Section 01756.

C. Owner training:
   1. As specified in Section 01756 and in this Section.

D. Source testing (FAT):
   1. Provide source testing and owner training on electrical equipment as defined in the table below:

Table: Source Testing and Owner Training Requirements:

Section Number	Section Title	Source Testing	Owner Training Requirements	
		(Witnessed or Non-witnessed)	Maintenance (hrs per session)	Operation (hrs per session)
16262	Variable Frequency Drives 0.50- 50 Horsepower	Witnessed	8	8
16422	Motor Starters	Non-Witnessed	8	8
16444	Low Voltage Motor Control Centers	Witnessed	N/A	N/A

3.08 FIELD QUALITY CONTROL

A. Inspection:
   1. Allow for inspection of electrical system installation as specified in Section 01450.
   2. Provide any assistance necessary to support inspection activities.
   3. Engineer inspections may include, but are not limited to, the following:
      a. Inspect equipment and materials for physical damage.
      b. Inspect installation for compliance with the Drawings and Specifications.

c. Inspect installation for obstructions and adequate clearances around equipment.
d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
e. Inspect equipment nameplate data to verify compliance with design requirements.
f. Inspect raceway installation for quality workmanship and adequate support.
g. Inspect cable terminations.
h. Schedule structural engineer to inspect all mounting of electrical devices and all penetration and connections to structures.

4. Inspection activities conducted during construction do not satisfy inspection or testing requirements specified in Section 16950.

B. Field acceptance testing (Functional Testing):
1. Notify the Engineer when the Electrical Work is ready for field acceptance testing.
2. Perform the field acceptance tests as specified in Section 16950.
3. Record results of the required tests along with the date of test:
a. Use conduit identification numbers to indicate portion of circuit tested.

C. Workmanship:
1. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
a. Neatly coil and label spare wiring lengths.
b. Shorten, re-terminate, and re-label excessive used as well as spare wire and cable lengths, as determined by the Engineer.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 01770.

B. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.

C. Clean and vacuum all enclosures to remove all metal filings, surplus insulation and any visible dirt, dust or other matter before energization of the equipment or system start-up:
1. Use of compressors or air blowers for cleaning is not acceptable.

D. Clean and re-lamp all new and existing luminaries that were used in the areas affected by the construction, and return all used lamps to the Owner.

E. As specified in other sections of the Contract Documents.

3.11 PROTECTION

A. Protect all Work from damage or degradation until Substantial Completion.

B. Maintain all surfaces to be painted in a clean and smooth condition.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16052

HAZARDOUS CLASSIFIED AREA CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Executing and completing Work in hazardous and/or classified areas as defined by the NEC Articles 500 through 516, NFPA 820, and as indicated on the Drawings and specified in the Specifications.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16130 - Conduits.
   5. Section 16134 - Boxes.
   6. Section 16140 - Wiring Devices.
   7. Section 16150 - Low Voltage Wire Connections.

1.02 REFERENCES

A. As specified in Section 16050.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions:
   1. For the purposes of these Specifications, the terms “Hazardous” and “Classified” will be considered synonymous.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Regulatory requirements:
   1. All wiring in hazardous and/or classified locations shall comply with all applicable articles of the NEC, in particular Articles 500 through 516.
   2. Except as modified in Articles 500 through 516, all other applicable rules contained in the NEC shall apply to electric equipment and wiring installed in hazardous and/or classified locations.

3. All devices used in Class I Division 1 or Division 2 areas must have visible manufacturer installed nameplates specifically stating the Class, Division, and Group for which the device is approved.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. A list of hazardous areas is specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Conduit and sealing fittings:
   1. As specified in Section 16130.

B. Conduit boxes and bodies:
   1. As specified in Section 16134.

C. Wiring devices:
   1. As specified in Section 16140.

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Conduit installation:
   1. As specified in Section 16130.
   2. Wrench tighten all conduit joints to minimize sparking when fault current flows through the conduit system.
   3. Make all conduit connections so that there are a minimum of 5 threads fully engaged in the connection.
   4. Flexible conduit:
      a. Class I Division 1 hazardous areas:
         1) Approved and marked suitable for Class I Division 1.
         2) Listed for compatibility with the group type atmosphere where used.
      b. Class I Division 2 areas:
         1) Liquidtight metal conduit with approved fittings.
      c. Maximum length as specified in Section 16130.

C. Sealing fittings:
   1. Provide an approved seal, no more than 12 inches from the enclosure, for all conduits entering an enclosure containing switches, circuit breakers, fuses, relays, resistors, or any other apparatus which may produce arcs, sparks, or high temperatures:
      a. Only explosion proof unions, couplings, elbows, capped elbows, and conduit bodies similar to “L”, “T”, and “X” may be installed between the sealing fitting and the enclosure.
   2. Provide entire assemblies approved for Class I locations for self-sealing or factory sealed assemblies where the equipment that may produce arcs, sparks, or high temperatures is located in a compartment separate from the compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other:
      a. Seals are required in all conduit connections to the compartment containing splices and must be within 12 inches of the enclosure.
   3. Install a conduit seal within 12 inches of the boundary in each conduit run entering or leaving a classified location. No union, coupling, box, or fitting is allowed in the conduit between the sealing fitting and the point at which the conduit leaves the classified location.

4. For underground conduits entering or leaving a classified location or between Class I Division 1 and Division 2 locations:
    a. Provide a conduit seal at both points where the conduit emerges from the ground:
        1) Place the conduit seal within 18 inches of finished grade.
        2) No union, coupling, box, or fitting is allowed in the conduit system between the seal fitting and the point at which the conduit enters the ground.
5. Separate all conductors within the conduit system and seal using an approved packing dam installed to both hold the sealing compound and to maintain the separation between the wires:
    a. Remove the outer jacket of multi-conductor non-shielded cables in the area of the sealing fitting and separate each conductor from the cable and seal individually.
6. Install seals with drains in all electrical control stations, low points of conduit or any place where moisture may condense and accumulate.
7. Install the sealing compound with a minimum thickness of 5/8 inch or the trade size of the conduit, whichever is greater.

D. Boxes and fittings:
1. Class I Division 1 areas:
    a. Utilize threaded connections for all metallic boxes, fittings, and joints to the conduit system.
2. Class I Division 2 areas:
    a. Provide approved grounding bushings on conduits entering and exiting metallic boxes to bond the conduits together.

E. Outlet boxes and bodies:
1. Provide conduits bodies and boxes suitable for the conduit system as specified in Section 16130.
2. Class I Division 2 areas:
    a. Boxes not containing arcing parts:
        1) Material and NEMA ratings as specified in Section 16050.
        2) Pressed metal boxes are not allowed.
    b. Provide heavy duty cast construction type conduit fittings and joints:
        1) Explosion proof rated fittings and joints are not necessary.
    c. Any enclosure containing arcing parts, etc. shall have all construction associated with the enclosure, conduit system, etc. conforming to Class I Division 1 construction.

F. Motor connections:
1. Conduit installation in Class I Division 1 and Class I Division 2 locations for motors that contain arcing parts, shall proceed as follows:
    a. First - Conduit.
    b. Second - Explosion proof flexible coupling.
    c. Third - Sealing fitting.
    d. Fourth - Explosion proof union.
    e. Fifth - Connection to the motor terminal box.
2. Wiring connections to motor leads shall be as specified in Section 16150.
3. Bond the non-current-carrying metal parts of equipment, raceways and other enclosures as required by the NEC to ensure electrical continuity.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Grounding materials and requirements.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16950 - Field Electrical Acceptance Tests.

1.02 REFERENCES

A. As specified in Section 16050.

B. ASTM International (ASTM):
   1. B3 - Standard Specification for Soft or Annealed Copper Wire.
   2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

D. Underwriters Laboratories, Inc. (UL):
   1. 467 - Ground and Bonding Equipment.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Ground equipment and raceway systems so that the completed installation conforms to all applicable code requirements.

B. Provide a complete electrical grounding system as indicated on the Drawings and as specified including but not limited to:
   1. Grounding electrodes.
   2. Bonding jumpers.
   3. Ground connections.

C. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.

D. The ground system resistance (electrode to ground) of the completed installation, as determined by tests specified in Section 16950, shall be:
   1. 5 ohms or less for industrial systems.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Catalog cut sheets.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. All grounding components and materials shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT/SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Compression connectors: One of the following or equal:
   1. FCI Burndy.
   2. Thomas & Betts.

B. Ground rods: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Conex.

C. Ground cable: One of the following or equal:
   1. Nehring.
   2. Harger.
   3. Southwire.

D. Precast ground well boxes: One of the following or equal:
   1. Brooks Products, 3-RT Valve Box.
   2. Christy Concrete Products, G12 Valve Box.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Ground rod:
   1. Minimum: 3/4-inch diameter, 10 feet long.
   2. Uniform 10 mil covering of electrolytic copper metallically bonded to a rigid steel core:
      a. The copper-to-steel bond shall be corrosion resistant.
   3. In accordance with UL 467.
   4. Sectional type joined by threaded copper alloy couplings.
   5. Fit the top of the rod with a threaded coupling and steel-driving stud.

B. Ground cable:
   1. Requirements:
      a. Soft drawn (annealed).
      b. Concentric lay, coarse stranded in accordance with ASTM B8.
      c. Bare copper in accordance with ASTM B3.
   2. Size is as indicated on the Drawings, but not less than required by the NEC.

C. Compression connectors:
   1. Manufactured of high copper alloy specifically for the particular grounding application.
   2. Suitable for direct burial in earth and concrete.
   3. Identifying compression die number inscription to be impressed on compression fitting.

D. Equipment grounding conductors:
   1. Conductors shall be the same type and insulation as the load circuit conductors:
      a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
   2. Minimum size in accordance with the NEC.

E. Grounding electrode conductors:
   1. Minimum size in accordance with the NEC.

F. Main bonding jumpers and bonding jumpers:
   1. Minimum size in accordance with the NEC.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Precast ground well boxes:
   1. Minimum 10 inch interior diameter.
   2. Traffic-rated cast iron cover.
   3. Permanent “GROUND” marking on cover.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material:
   1. Multi-conductor power and control cables shall include an integral green insulated grounding conductor.
   2. Provide a separate grounding conductor in each individual raceway for parallel feeders.

C. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding connectors:
   1. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.

D. Provide a grounding type bushing with lug for connection of grounding conductor for conduits that originate from each motor control center section, switchboard, or panelboard:
   1. Individually bond these raceways to the ground bus in the equipment.

E. Provide grounding type bushings with lugs for connection of grounding conductor at both ends of metallic conduit runs. Bond ground bushings to the grounding system.

F. Provide a green insulated wire-grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.

G. Interconnect the secondary switchgear, switchboard, or panelboard neutral bus to the ground bus in the secondary switchgear, switchboard, or panelboard compartment, only at service entrance point or after a transformer.

H. Duct bank ground system:
   1. Provide a bare copper grounding conductor the entire length of each duct bank, embedded in the concrete of the duct bank as indicated on the Drawings and specified in the Specifications.
   2. Bond duct bank ground conductors together where duct banks join, merge, intersect, or split.

I. Grounding at service (600 V or Less):
   1. Connect the neutral to ground only at one point within the enclosure of the first disconnecting means on the load side of the service transformer.

J. Ground connections:
   1. All connections to the ground grid system, the duct bank grounding system, equipment, ground rods, etc., shall be made using compression type grounding connectors as indicated on the Drawings, UL listed, and labeled for the application.
   2. Make ground connections in accordance with the manufacturer's instructions.
   3. Do not conceal or cover any ground connections until the Engineer or authorized representative has established and provided written confirmation that every grounding connection is as indicated on the Drawings and specified in the Specifications.

K. Grounding electrode system:
   1. Ground ring:
      a. Provide all trenching and materials necessary to install the ground ring as indicated on the Drawings.
      b. Ground ring conductor shall be in direct contact with the earth, or where embedded, concrete, of the size as indicated on the Drawings.
      c. Minimum burial depth 36 inches or as indicated on the Drawings.
      d. Re-compact disturbed soils to original density in 6-inch lifts.
   2. Ground rods:
      a. Locations as indicated on the Drawings.
      b. Length of rods forming an individual ground array shall be equal in length.
      c. Drive ground rods and install grounding conductors before construction of concrete slabs and duct banks.
      d. Pre-crimp all ground rods, as recommended by the manufacturer, before crimping connector to ground rod.
   3. Metal underground water pipe:
      a. Bond metal underground domestic water pipe to grounding electrode system.
   4. Metal frame of building or structure:
      a. Bond metal frame of building or structure to grounding electrode system.
   5. Extend grounding conductors through concrete to accessible points for grounding equipment and electrical enclosures.
   6. Where grounding conductors are not concrete-encased or direct buried, install in Schedule 40 PVC conduit for protection.

7. Install grounding system at each structure where switchgear, motor control centers, switchboards, panelboards, panels, or other electrical equipment are installed.

L. Shield grounding:
   1. Shielded instrumentation cable shall have its shield grounded at one end only unless shop drawings indicate otherwise:
      a. The grounding point shall be at the control panel or at the power source end of the signal carried by the cable.
   2. Terminate the shield drain wire on a dedicated terminal block.
   3. Use manufacturer's terminal block jumpers to interconnect ground terminals.
   4. Connection to the panel main ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.

M. Where indicated on the Drawings, install ground rods in precast ground wells.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

B. Measure grounding electrode system resistance to ground in accordance with IEEE 81.

3.09 ADJUSTING

A. Under the direction of the Engineer, add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurement meets the specified resistance requirements:
   1. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16070

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Mounting and supporting electrical equipment and components.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01410 - Regulatory Requirements.
   3. Section 01756 - Commissioning.
   4. Section 05190 - Mechanical Anchoring And Fastening To Concrete And Masonry.
   5. Section 09910 - Painting.
   6. Section 16050 - Common Work Results for Electrical.

1.02 REFERENCES

A. As specified in Section 16050.

B. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A240 – Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Conform to the requirements of the Building Code as specified in Section 01410.
   2. Demonstrate the following using generally accepted engineering methods:
      a. That the anchors to the structure are adequate to resist the loads generated in accordance with the Building Code and equipment requirements.
      b. That the required load capacity of the anchors can be fully developed in the structural materials to which they are attached.
   3. Design loading and anchoring requirements:
      a. As indicated in the Building Code unless otherwise specified.

b. Seismic loading requirements:
    1) Freestanding, suspended or wall-hung equipment shall be anchored in place by methods that will satisfy the requirements for the seismic design specified in Section 16050.
c. Wind loading requirements:
    1) All exterior equipment shall be anchored in place by methods that will satisfy the requirements for wind design specified in Section 16050.
d. Minimum safety factor against overturning: 1.5.
e. The foundation and structures to which hangers and supports are attached shall be capable of withstanding all anchor loads.

B. Performance requirements:
1. Hangers and supports individually and as a system shall resist all weights and code-required forces without deflections and deformations that would damage the supporting elements, the equipment supported, or the surrounding construction.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
1. Supports:
    a. Materials.
    b. Geometry.
    c. Manufacturer.
2. Hardware:
    a. Materials.
    b. Manufacturer.

C. Shop drawings:
1. Complete dimensioned and scalable shop drawings of all supporting structures, trapezes, wall supports, etc.
2. Complete anchoring details for equipment, lighting and raceway, supporting structures, trapezes, wall supports for all equipment in excess of 200 pounds, and all freestanding supports:
    a. Stamped by a professional engineer licensed in the state where the Project is being constructed.
    b. Said submittals, by virtue of the fact that they bear the stamp of a registered engineer, will be reviewed for general consistency with the requirements specified in the Contract Documents, but not for context, accuracy, or method of calculation.
3. Include data on attachment hardware and construction methods that will satisfy the design loading and anchoring criteria.

D. Installation instructions:
1. Furnish anchorage instructions and requirements based on the seismic and wind conditions of the Site:
    a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM STARTUP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Thomas & Betts.
   2. Power-Strut.
   3. Unistrut.
   4. Cooper B-Line.
   5. Robroy.
   6. Aickinstrut.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Use materials appropriate for the area as specified in Section 16050.

B. Hot dip galvanized steel:
   1. Supports:
      a. In accordance with ASTM A123 or A153.
      b. Minimum zinc coating thickness of 2.5 mils.

2. Hardware:
    a. Electro-galvanized.
    b. In accordance with ASTM A153.

C. Stainless steel:
1. Supports:
    a. In accordance with ASTM A240.
    b. ANSI Type 316 material.
2. Hardware:
    a. ANSI Type 316 material.

D. PVC coated galvanized steel:
1. Supports:
    a. Hot dip galvanized steel as specified in this Section.
    b. PVC coating thickness of 10 to 20 mils.
2. Hardware:
    a. ANSI Type 316 material.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Anchor bolts:
1. As specified in Section 05190.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Paint and finish all supporting structures as specified in Section 09910.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings.
   1. Provide the necessary sway bracing to keep trapeze type structures from swaying under seismic events or wind loading.

C. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:
   1. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.

D. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:
   1. Fabricate pedestals out of welded angle, tube sections, or preformed channel.
   2. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.
   3. Provide auxiliary floor supports for transformers hung from stud walls and weighing more than 200 pounds.
   4. Mount all equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel:
      a. Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.

E. Corrosion protection:
   1. Isolate dissimilar metals, except where required for electrical continuity:
      a. Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.

F. Raceway:
   1. Furnish all racks and trapeze structures needed to support the raceway from the structure:
      a. Group raceway and position on racks to minimize crossovers.
      b. Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.

G. Anchoring methods:
   1. Solid concrete: Anchor bolts, anchor rods or post-installed anchors as specified in Section 05190.
   2. Metal surfaces: Machine screws or bolts.
   3. Hollow masonry units: Post-installed anchors as specified in Section 05190.

H. Recoat or seal all drilled holes, cut or scratched surfaces or with products recommended by the manufacturer.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16075

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Identification of electrical equipment, devices and components.
   2. Material, manufacturing and installation requirements for identification devices.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16130 - Conduits.
   5. Section 16990 - Conduit Schedule.

1.02 REFERENCES

A. As specified in Section 16050.

B. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

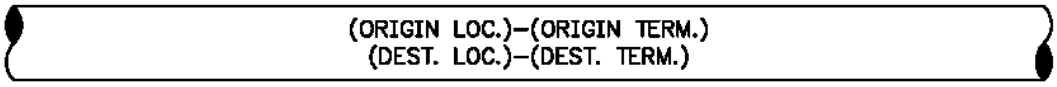
A. Nameplates:
   1. Provide a nameplate for each piece of electrical equipment and devices, control panel and control panel components.
   2. Provide all nameplates of identical style, color, and material throughout the facility.
   3. Device nameplates information:
      a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.

B. Wire numbers:
   1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
      a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
      b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
      c. Internal panel wires on a common terminal shall have the same wire number.

d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:
   1) Label armored multi-conductor cable using the conduit number as indicated on the Drawings, following the requirements for conduit markers in Section 16130.

2. Provide the following wiring numbering schemes throughout the project for field wires between Remote Telemetry Unit, (RTU), vendor control panels, (VCP), motor control centers, (MCC), field starters, field instruments, etc.

OR



Where:

ORIGIN LOC. = Designation for originating panel or device
ORIGIN TERM. = Terminal designation at originating panel or device
DEST. LOC. = Designation for destination panel or device
DEST. TERM. = Terminal designation at destination panel or device or PLC I/O address at destination panel:

a. Identify equipment and field instruments as the origin.
b. RTUs are always identified as the destination.
c. Location is the panel designation for VCP, LCP, or RTU. For connections to MCCs, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
d. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multi-conductor cables, all terminal numbers shall be shown, separated by commas.
e. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g. T1, T2, T3, etc.).
f. Terminal designations at RTUs where the field conductor connects to field terminal blocks for a PLC input or output shall be the PLC address (Note: the following PLC I/O numbering scheme is typical for Allen-Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project):
   1) Discrete Point: W:X:Y/Z
      Analog Point: W:X:Y.Z
      Where:
      W = I for input, O for output
      X = PLC number (1, 2, 3…)
      Y = Slot number (01, 02, 03…)

Z = Terminal number (00, 01, 02…) for a discrete point or a word number for an analog point (1, 2, 3…)

g. Terminal designations at RTUs where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (e.g. C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with "A" (e.g. C0010A).

3. **Case 1**: Vendor control panel (VCP) to remote telemetry unit (RTU):
Field wire number/label: A-B/C-D
A = Vendor control panel number without hyphen (VCP#)
B = Terminal number within VCP (manufacturer's or vendor's standard terminal number)
C = Remote telemetry unit number without hyphen (RTU#)
D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

Examples: VCP#-10/RTU#-I:1:01/01
VCP#-10/RTU#-O:1:10/07
VCP#-10/RTU#-C0100

4. **Case 2**: Field instrument to remote telemetry unit (RTU):
Field wire number/label: E-F/C-D
C = Remote telemetry unit number without hyphen (RTU#)
D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
E = Field mounted instrument tag and loop numbers without hyphen (EDV#)
F = Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma

Examples: TIT#-2,3/RTU#-I:1:01.1
TSH#-1/RTU#-I:2:01/00

5. **Case 3**: Motor control center (MCC) to remote telemetry unit (RTU):
Field wire number/label: G-B/C-D
B = Terminal number within Motor Control Center (manufacturer's or vendor's standard terminal number)
C = Remote telemetry unit without hyphen (RTU#)
D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
G = Actual starter designation in the motor control center without hyphen (MMS#)

Examples: MMS#-10/RTU#-I:1:01/01
MMS#-10/RTU#-O:1:10/07
MMS#-10/RTU#-C0100

6. **Case 4**: Motor control center (MCC) to vendor control panel (VCP):
Field wire number/label: G-B/A-B
A = Vendor control panel number without hyphen (VCP#)

B = Terminal number within motor control center or vendor control panel (manufacturer's or vendors standard terminal number)
G = Actual starter designation in the motor control center without hyphen (MMS#)

Example: MMS#-X2/VCP#-10

7. **Case 5**: Motor leads to a motor control center (MCC):
Field wire number/label: H-I/G-B
B = Terminal number within motor control center (manufacturer's standard terminal number)
G = Actual starter designation in the motor control center without hyphen (MMS#)
H = Equipment tag and loop number without hyphen (PMP#)
I = Motor manufacturer's standard motor lead identification (e.g. T1, T2, T3, etc.)

Example: PMP-#-T3/MMS#-T3

8. **Case 6**: Remote or separately mounted starter or variable frequency drive (VFD) to remote telemetry unit (RTU):
Field wire number/label: J-B/C-D
B = Terminal number within starter or variable frequency drive (manufacturer's standard terminal number)
C = Remote telemetry unit number without hyphen (VCP#)
D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
J = Starter or variable frequency drive tag and loop number without hyphen (MMS#)

Examples: MMS#-10/RTU#-I:1:01/01
MMS#-10/RTU#-O:2:10/07
MMS#-10/RTU#-C0010

9. Identify all spare conductors as required for other field wires with an "S" prefix:

Example: S MMS#-10/RTU#-C011

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
1. Nameplates:
a. Color.
b. Size:
1) Outside dimensions.
2) Lettering.
c. Material.
d. Mounting means.

2. Nameplate schedule:
    a. Show exact wording for each nameplate.
    b. Include nameplate and letter sizes.
3. Wire numbers:
    a. Manufacturer's catalog data for wire labels and label printer.

C. Record documents:
1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nameplates and signs:
1. One of the following or equal:
    a. Brady.
    b. Seton.

B. Conductor and cable markers:
1. Heat-shrinkable tubing:
    a. One of the following or equal:
        1) Raychem.
        2) Brady.
        3) Thomas & Betts.
        4) Kroy.

C. Conduit and raceway markers:
   1. One of the following or equal:
      a. Almetek: Mini Tags.
      b. Lapp Group: Maxi System.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Nameplates:
   1. Fabricated from white-center and red face or black-center, white face laminated plastic engraving stock:
      a. 3/32-inch thick material.
      b. Two-ply.
      c. With chamfered edges.
      d. Block style engraved characters of adequate size to be read easily from a distance of 6 feet:
         1) No characters smaller than 1/8-inch in height.

B. Signs:
   1. Automatic equipment and high voltage signs:
      a. Suitable for exterior use.
      b. In accordance with OSHA regulations.

C. Conductor and cable markers:
   1. Machine printed black characters on white tubing.
   2. Ten point type or larger.

D. Conduit and raceway markers:
   1. Non-metallic:
      a. UV resistant holder and letters.
      b. Black letters on yellow background.
      c. Minimum letter height: 1/2-inch.
      d. Adhesive labels are not acceptable.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Nameplates:
   1. Provide all nameplates for control panel operator devices (e.g. pushbuttons, selector switches, pilot lights, etc.):
      a. Same material and same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Nameplates:
   1. Attach nameplates to equipment with rivets, bolts or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
   2. On NEMA Type 4, NEMA Type 4X, or NEMA Type 7 enclosures, use epoxy-based cement to attach nameplates.
   3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire length:
      a. Misaligned or crooked nameplates shall be remounted, or provide new enclosures at the discretion of the Engineer.

C. Conductor and cable markers:
   1. Apply all conductor and cable markers before termination.
   2. Heat-shrinkable tubing:
      a. Tubing shall be shrunk using a heat gun that produces low temperature heated air.
      b. Tubing shall be tight on the wire after it has been heated.
      c. Characters shall face the open panel and shall read from left to right or top to bottom.
      d. Marker shall start within 1/32 inch of the end of the stripped insulation point.

D. Conduit markers:
   1. Furnish and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system:
      a. Conduit markings shall match the conduit schedule; as specified in Section 16990.
   2. Mark conduits at the following locations:
      a. Each end of conduits that are greater than 10 feet in length.
      b. Where the conduit penetrates a wall or structure.
      c. Where the conduit emerges from the ground, slab, etc.
      d. The middle of conduits that are 10 feet or less in length.

3. Mark conduits after the conduits have been fully painted.
4. Position conduit markers so that they are easily read from the floor.
5. Attach non-metallic conduit markers with nylon cable ties:
    a. Provide ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
6. Mark conduits before construction review by Engineer for punch list purposes.
7. Label intrinsically safe conduits in accordance with the requirements of the NEC.

E. Signs and labeling:
1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
    a. Fasten warning signs with round head stainless steel screws or bolts.
    b. Locate and mount in a manner to be clearly legible to operations personnel.
2. Furnish and install permanent and conspicuous warning signs on equipment (front and back), doorways to equipment rooms, pull boxes, manholes, etc. where the voltage exceeds 600 volts.
3. Furnish and install warning signs on equipment that has more than one source of power:
    a. Warning signs to identify every panel and circuit number of the disconnecting means of all external power sources.
4. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking:
    a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. Replace any nameplates, signs, conductor markers, cable markers or raceway labels that in the sole opinion of the Engineer do not meet the Engineer's aesthetic requirements.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16123

600-VOLT OR LESS WIRES AND CABLES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. 600 volt class or less wire and cable.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16060 - Grounding and Bonding.
   5. Section 16075 - Identification for Electrical Systems.

1.02 REFERENCES

A. As specified in Section 16050.

B. ASTM International (ASTM):
   1. B3 - Standard Specification for Soft or Annealed Copper Wire.
   2. B8 - Standard Specification for Concentric-Lay–Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. CSA International (CSA).

D. Insulated Cable Engineers Association (ICEA):
   1. NEMA WC 70/ICEA S-95-658-1999 - Standard for Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   2. NEMA WC 57/ICEA S-73-532 - Standard for Control, Thermocouple Extension, and Instrumentation Cables.

E. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
   2. 72 - National Fire Alarm and Signaling Code.
   3. 101 - Life Safety Code.

F. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
   1. 568-C.2 - Balanced Twisted-Pair Telecommunication Cabling and Components Standard.

G. Underwriter's Laboratories Inc., (UL):
   1. 44 - Thermoset-Insulated Wires and Cables.
   2. 1277 - Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   3. 1424 - Standard for Cables for Power-Limited Fire-Alarm Circuits.
   4. 1569 - Standard for Metal-Clad Cables.

5. 2196 - Standard for Tests for Fire Resistive Cables.
6. 2225 - Standard for Cables and Cable-Fittings For Use in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Definitions of terms and other electrical considerations as set forth in the:
   1. ASTM.
   2. ICEA.

1.04 SYSTEM DESCRIPTION

A. Furnish and install the complete wire and cable system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Manufacturer of wire and cable.
   2. Insulation:
      a. Type.
      b. Voltage class.
   3. American wire gauge (AWG) size.
   4. Conductor material.
   5. Pulling compounds.

C. Shop drawings:
   1. Show splice locations:
      a. For each proposed splice location provide written justification describing why the splice is necessary.

D. Test reports:
   1. Submit test reports for meg-ohm tests.

E. Calculations:
   1. Submit cable pulling calculations to the Engineer for review and comment for all cables that will be installed using mechanical pulling equipment. Show that the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:
      a. Provide a table showing the manufacturer's recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
      b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. All wires and cables shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER`S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. 600 volt class wire and cable:
      a. General Cable.
      b. Okonite Company.
      c. Southwire Company.
   2. 600 volt VFD cable:
      a. General Cable.
      b. Southwire Company.
   3. Instrumentation class wire and cable:
      a. Alpha Wire Company.
      b. Belden CDT.
      c. General Cable BICC Brand.
      d. Okonite Company.
      e. Rockbestos Surprenant Cable Corporation.
   4. Network cables:
      a. Belden CDT.
      b. General Cable.
      c. CommScope.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Conductors:
   1. Copper in accordance with ASTM B3.

2.04 MANUFACTURED UNITS

A. General:
   1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
   2. Permanently mark each wire and cable with the following at 24-inch intervals:
      a. AWG size.
      b. Voltage rating.
      c. Insulation type.
      d. UL symbol.
      e. Month and year of manufacture.
      f. Manufacturer's name.
   3. Identify and mark wire and cable as specified in Section 16075:
      a. Use integral color insulation for Number 2 AWG and smaller wire.
      b. Wrap colored tape around cable larger than Number 2 AWG.

B. 600 volt class wire and cable:
   1. Provide AWG or kcmil sizes as indicated on the Drawings or in the Conduit Schedules:
      a. When not indicated on the Drawings, size wire as follows:
         1) In accordance with the NEC:
            a) Use 75 degree Celsius ampacity ratings.
            b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
         2) Provide Number 12 AWG minimum for power conductors.
         3) Provide Number 14 AWG minimum for control conductors.
   2. Provide Class B stranding in accordance with ASTM B8:
      a. Provide Class C stranding where extra flexibility is required.
   3. Insulation:
      a. XHHW-2.
      b. 90 degrees Celsius rating.

C. 600 volt VFD cables:
      a. Conductor:
         1) Provide Class B stranding in accordance with ASTM B8.
      b. Insulation:
         1) Cross-linked Polyethylene.
         2) 90 degrees Celsius rating.
         3) UL 44 Type RHH/RHW-2.
      c. Ground:
         1) Provide Class B stranding in accordance with ASTM B8.
         2) 3 symmetrically placed bare copper conductors in direct contact with shield.
      d. Metallic shield:
         1) Overall 5 mil bare copper tape shield with 50 percent overlap.
      e. Outer jacket:
         1) UL 1277 Type Polyvinyl Chloride (PVC).
      f. Cable tray rated.

D. Instrumentation class cable:
   1. Type TC.
   2. Suitable for use in wet locations.

3. Voltage rating: 600 volts.
4. Temperature rating:
    a. 90 degrees Celsius rating in dry locations.
    b. 75 degrees Celsius rating in wet locations.
5. Conductors:
    a. Insulation:
        1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
    b. Number 16 AWG stranded and tinned.
    c. Color code:
        1) Pair: Black and white.
        2) Triad: Black, white and red.
        3) Multiple pairs or triads:
            a) Color-coded and numbered.
6. Drain wire:
    a. 18 AWG.
    b. Stranded, tinned.
7. Jacket:
    a. Flame retardant, moisture and sunlight resistant PVC.
    b. Ripcord laid longitudinally under jacket to facilitate removal.
8. Shielding:
    a. Individual pair/triad:
        1) Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100 percent coverage.
    b. Multiple pair or triad shielding:
        1) Group shield: Minimum 1.35-mil double-faced aluminum foil/polyester tape overlapped to provide 100 percent coverage.
        2) Completely isolate group shields from each other.
        3) Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
    c. All shielding to be in contact with the drain wire.

E. Network cables:
1. Category 6:
    a. General:
        1) Provide all Cat 6 cables meeting the standards set by TIA/EIA-568-C.2.
    b. Conductors:
        1) 24 AWG solid bare copper conductors.
    c. Insulation:
        1) Polyolefin.
        2) 4 non-bonded twisted pair cables formed into a cable core.
    d. Color code:
        1) Pair 1: White/blue stripe and blue.
        2) Pair 2: White/orange stripe and orange.
        3) Pair 3: White/green stripe and green.
        4) Pair 4: White/brown stripe and brown.
    e. Outer jacket:
        1) PVC with ripcord.
    f. Electrical characteristics:
        1) Frequency range: 0.772-100 MHz.
        2) Attenuation: 32.1 dB/100 m.

3) Near-end crosstalk (NEXT): 39.3 dB.
4) Power sum NEXT: 37.3 dB.
5) Attenuation to crosstalk ratio (ACR): 7.2 dB.
6) Power sum attenuation to crosstalk ratio (PSACR): 5.3 dB/100 m.
7) Equal level far-end crosstalk (ELFEXT): 22.8 dB.
8) Power sum ELFEXT: 19.8 dB/100 m.
9) Return loss: 17.3 dB.
10) Propagation delay: 537 ns/100 m.
11) Delay skew: 45 ns/100 m.
12) Propagation delay (skew), max: 2.5 ns/100 m.

2. RS-485 cable:
   a. Two-wire:
      1) Shielded twisted pair.
      2) Tinned, copper conductors minimum with 7 by 30 stranding.
      3) AWG #22.
      4) Insulation:
         a) FHDPE: Foam high-density polyethylene.
         b) 300-volt insulation level.
      5) Outer shield:
         a) 100 percent coverage.
         b) Tape/braid.
         c) Aluminum foil-polyester tape.
         d) Tinned copper braid.
      6) Outer shield drain wire:
         a) Tinned, copper conductor minimum with 7 by 30 stranding.
         b) AWG #22.
      7) Outer jacket PVC:
         a) Sunlight resistant.
      8) UL/CSA flame tested.
      9) Minimum bending radius 2.5 inches.
      10) Nominal OD 0.284 inch.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Wire ties:
   1. One of the following or equal:
      a. T&B "Ty-Rap" cable ties.
      b. Panduit cable ties.

B. Wire markers:
   1. As specified in Section 16075.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Assembly and testing of cable shall comply with the applicable requirements of ICEA S-95-658-1999.

B. Test Type XHHW-2 in accordance with the requirements of UL 44.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Color-coding:
   1. Color-coding shall be consistent throughout the facility.
   2. The following color code shall be followed for all 240/120 volt and 208/120 volt systems:
      a. Phase A - Black.
      b. Phase B - Red.
      c. Phase C - Blue.
      d. Single phase system - Black for one hot leg, red for the other.
      e. Neutral - White.
      f. High phase or wild leg - Orange.
      g. Equipment ground - Green.
   3. The following color code shall be followed for all 480/277 volt systems:
      a. Phase A - Brown.
      b. Phase B - Orange.
      c. Phase C - Yellow.
      d. Neutral - Gray.
      e. Equipment ground - Green.
   4. The following color code shall be followed for all 120 VAC control wiring:
      a. Power - Red.
      b. Neutral - White.
   5. The following color code shall be followed for all general purpose DC control circuits:
      a. Grounded conductors - White with blue stripe.
      b. Ungrounded conductors - Blue.
   6. Switch legs shall be violet. Three-way switch runners shall be pink.
   7. Wires in intrinsically safe circuits shall be light blue.
   8. Wire colors shall be implemented in the following methods:
      a. Wires manufactured of the desired color.
      b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
         1) Colored tape shall be wrapped to overlap 1/2 of the width of the tape.

C. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
    1. Install wires only in approved raceways.
    2. Do not install wire:
        a. In incomplete conduit runs.
        b. Until after the concrete work and plastering is completed.

D. Properly coat wires and cables with pulling compound before pulling into conduits:
    1. For all Number 4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
        a. Ideal Products.
        b. Polywater Products.
        c. 3M Products.
        d. Greenlee Products.
        e. Or equal as recommended by cable manufacturer.
        f. Do not use oil, grease, or similar substances.

E. Cable pulling:
    1. Prevent mechanical damage to conductors during installation.
    2. For cables Number 1 AWG and smaller, install cables by hand.
    3. For cables larger than Number 1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
    4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
    5. Ensure cable pulling crews have all calculations and cable pulling limitations while pulling cable.
    6. Make splices or add a junction box or pullbox where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of manufacturer’s recommendation for the specified cable size:
        a. Make splices in manholes or pull boxes only.
        b. Leave sufficient slack to make proper connections.

F. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer’s recommendations.

G. Install and terminate all wire in accordance with manufacturer's recommendations.

H. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
    1. Do not lace wires in gutter or panel channel.
    2. Install all wire ties with a flush cutting wire tie installation tool:
        a. Use a tool with an adjustable tension setting.
    3. Do not leave sharp edges on wire ties.

I. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:
    1. Use ring type lugs if box lugs are not available on the equipment.

J. Lighting circuits:
   1. Each circuit shall have a dedicated neutral.

K. Splices:
   1. Provide continuous circuits from origin to termination whenever possible:
      a. Obtain Engineer's approval prior to making any splices.
   2. Lighting and receptacle circuit conductors may be spliced without prior approval from the Engineer.
   3. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths:
      a. Splice box NEMA rating requirements as specified in Section 16050.
      b. Make splices in labeled junction boxes for power conductors.
      c. Make splices for control and instrument conductors in terminal boxes:
         1) Provide terminal boards with setscrew pressure connectors, with spade or ring lug connectors.
   4. Power and control conductors routed in common raceways may be spliced in common junction boxes.
   5. Clearly label junction and terminal boxes containing splices with the word "SPLICE LOCATED WITHIN".
   6. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.
   7. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:
      a. In NEMA Type 4 or NEMA Type 4X areas, provide heat-shrink sleeves that are listed for submersible applications.
   8. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made waterproof using:
      a. A heat shrink insulating system listed for submersible applications.
      b. Or an epoxy resin splicing kit.

L. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.

M. Instrumentation class cable:
   1. Install instrumentation class cables in separate raceway systems from power cables:
      a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
      b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
   2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.
   3. Shield grounding requirements as specified in Section 16060.

N. Signal cable:
   1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.

O. Submersible cable in wet wells:
   1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

P. Wiring allowances:
   1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.
   2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes and duct banks within 20 linear feet of locations indicated on the Drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

B. Grounding:
   1. As specified in Section 16060.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16125

FIBER OPTIC CABLE AND APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fiber optic cable.
   2. Fiber splices and terminations.
   3. Accessories.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 01782 - Operation and Maintenance Data.
   4. Section 16050 - Common Work Results for Electrical.
   5. Section 16075 - Identification for Electrical Systems.
   6. Section 16130 - Conduits.
   7. Section 16950 - Field Electrical Acceptance Tests.
   8. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   9. Section 17733 - Control System - Network Materials and Equipment.

C. Furnish a complete fiber optic network as indicated on the Drawings.

1.02 REFERENCES

A. As specified in Section 16050.

B. Bellcore Standards:
   1. GR-409, “Generic Requirements for Intrabuilding Fiber.”

C. Electronic Industry Association (EIA) 455B "Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components":
   1. FOTP-25 - Repeated Impact testing of Fiber Optic Cables and Cable Assemblies.
   2. FOTP-33 - Fiber Optic Cable Tensile Loading and Bending Test.
   3. FOTP-41 - Compressive Loading Resistance of Fiber Optic Cables.
   4. FOTP-81 - Compound Flow (Drip) Test for Filled Fiber Optic Cable.
   5. FOTP-104 - Fiber Optic Cable Cyclic Flexing Test.
   6. FOTP-181 - Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components.

D. Insulated Cable Engineer’s Association (ICEA):
   1. S-83-596, “Optic Fiber Premises Distribution Cables.”
   2. S-87-640, “Optic Fiber Outside Plant Communications Cable.”
   3. S-104-696, “Fiber Optic Premises Distribution Cables.”

E. TIA/EIA Standards:
   1. 598, “Color Coding of Fiber Optic Cables.”

F. Underwriters Laboratories, Inc. (UL):
   1. 1666 - Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
   2. 1685 - Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

1.03 DEFINITIONS

A. As specified in Sections 16050 and 17050.

B. Specific definition:
   1. N/Cm: Newtons per centimeter.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Complete manufacturer’s brochures that identify materials and options.
   2. Completed data sheets, including catalog number and source for determining catalog number.
   3. Manufacturer’s installation instructions.
   4. Include the following:
      a. Manufacturer’s data on testing equipment used on this project.
      b. Manufacturer’s specifications and data sheets for all fiber types.
      c. Manufacturer’s specifications and data sheets for all connectors, bulkheads, splicing kits, breakout devices, and appurtenances used connecting and terminating the fiber spans.
   5. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the NIST.
   6. Manufacturer’s test procedures and quality assurance procedures:
      a. After review, the Engineer may require that additional tests be performed before installation.

C. Shop drawings:
   1. Interconnection cabling diagrams for the complete system including every fiber in each cable.
   2. Drawings indicating the locations of all pull boxes including pull box identifiers and lengths.
   3. Submit optical power budget calculations for all fiber segments. Include the following:
      a. Minimum transmit power of active devices.
      b. Minimum receive sensitivity.
      c. Available power, in dBm.

d. Loss for each segment in dBm, including cable attenuation and connector losses. Use manufacturer's data for cable attenuation, at the wavelength to be used. Assume 0.5 dB per connector.
e. Demonstrate that remaining power budget at each receiver is equal to or greater than 3.0 dBm.

D. Installation instructions:
1. Submit a cable pulling and splicing work plan a minimum of 45 days before the planned initiation of cable pulling. The cable pulling and splicing work plan must be approved a minimum of 15 days before pulling cable. Include the following:
a. Pull tension calculations.
b. Detailed description of pull operation methods for all conduit runs.
c. Tools and equipment to be used for cable installation and testing.
d. Physical location of equipment setup and type.
e. Exact locations of splice points.
f. Safety and manual assist cable-pulling operations.
g. Detailed schedule for pulling and testing cables.
h. The name and qualifications of the supervisory personnel directly responsible for the installation of the conduit system.
i. Sample fiber optic cable test sheets.
j. All signed test sheet results.

E. Operation and maintenance manuals:
1. Compile completed test reports, instruction manuals, and manufacturer's information into the operating manuals and submitted in accordance with Section 01782.

F. Test reports:
1. Submit the results of all specified tests to the Engineer.
2. Submit 3 copies of all test reports showing the results of all tests specified herein or in Section 16950:
a. Test forms shall include the following information at a minimum:
1) Test type.
2) Test location.
3) Test date.
4) Wavelength.
5) Index of refraction.
6) Cable identification.
7) Fiber type.
8) Fiber number.
9) Fiber color.
10) Result of the value of the tested parameter.
3. Furnish hard copy and electronic copy for all OTDR traces.
4. Submit certification that the fiber optic cable has passed each testing stage:
a. Submit separate documentation for each testing stage result.

G. Record documents:
1. Furnish updated electrical drawings, network diagrams, and fiber cable block diagrams at the end of construction and submit as Record Drawings.

H. Calculations:
    1. Cable pulling calculations for all conduit runs:
        a. Indicate on the submittal any additional pull boxes that are required, including pull box identifiers and a written description of the location.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Furnish all cable and appurtenances manufactured within 1 year of installation.

C. Proof test all optical fibers by the fiber manufacturer at a minimum load of 50 kpsi.

D. Provide 100 percent attenuation testing for all optical fibers:
    1. Include with each cable reel the attenuation of each fiber.

E. Provide information on at least 5 successful fiber optic cable installations of comparable size and complexity in the past 3 years with name, address, and telephone number of facility owner, name of project with completion date, and type of conduit system and length of cable pulled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

B. Package the cable for shipment on wooden reels:
    1. Seal both ends of the cable to prevent the ingress of moisture.
    2. Place fiber cable assemblies on reels such that both cable ends are available for testing.
    3. Weatherproof cable reel markings shall include the following:
        a. Manufacturer.
        b. Date of manufacture.
        c. Shipping date.
        d. Cable identification.
        e. Cable configuration/fiber count.
        f. Cable length.
        g. Gross weight.
        h. Cable test date.
        i. Handling instructions.
        j. Direction to unreel.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING

A. Testing:
    1. Perform testing of each fiber in each cable as follows:
        a. At the factory before shipment.
        b. At the project site upon delivery.

c. After installation, before breakout and terminations.
d. After installation is complete.

2. Submit test reports following each set of tests as specified in this Section.

B. Notify the Engineer and Owner a minimum of 15 days before post-installation testing.

1.10 SCHEDULING

A. As specified in Section 16050.

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers are indicated with each component type as listed in the remainder of this specification.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General fiber cable requirements:
1. Suitable for the installed environment.
2. Color-coded fibers according to EIA/TIA-598.
3. Color-coded buffer tubes according to EIA/TIA-598.
4. Furnish buffer tubes of a single layer nylon construction or of a material with similar mechanical performance.
5. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
6. Utilize a glass reinforced plastic rod as the central anti-buckling member.
7. Apply binders with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes:
   a. Provide binders that are:
      1) Non-hygroscopic.
      2) Non-wicking (or rendered so by the flooding compound).
      3) Dielectric with low shrinkage.
8. Provide a minimum of 1 ripcord under the cable sheath.

9. Provide the high tensile strength Aramid yarns, Kevlar, and/or fiberglass helically stranded evenly around the cable core:
    a. No metallic elements whatsoever are allowed in non-armored cable.
10. The jacket or sheath shall be free of holes, splits, and blisters.
11. Mark the jacket or sheath with:
    a. Manufacturer's name.
    b. The words "Optical Cable".
    c. Year of manufacture.
    d. Sequential meter marks.
    e. Repeat markings every 1-meter.
    f. The actual length of the cable to be within 1 percent of the length marking.
    g. The marking must be in a contrasting color to the cable jacket.
    h. The height of the marking:
        1) Approximately 2.5 millimeters.
12. The shipping, storage, and operating temperature range of the cable shall be -40 degrees Celsius to +70 degrees Celsius.
13. General performance characteristics:
    a. The rated tensile load of the cables:
        1) 2,670 N (600 lbf) for armored cables, 1,334 N (300 lbf) for non-armored cables.
        2) Maximum fiber strain within a cable no greater than 60 percent of the fiber proof test level.
    b. Non-armored fiber optic cables: Compressive load withstand of 220 N/cm applied uniformly over the length of the cable.
    c. Armored fiber optic cables: Compressive load withstand of 440 N/cm applied uniformly over the length of the cable.
    d. The average increase in attenuation for the fibers: Less than or equal to 0.10 dB at 1,550 nm for a cable subjected to this load:
        1) With no measurable increase in attenuation after load removal.
    e. Test in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cable," except that the load must be applied at the rate of 3 millimeters to 20 millimeters per minute and maintained for 10 minutes.
    f. Capable of withstanding 25 cycles of mechanical flexing at a rate of 30 within 1 cycles/minute.
    g. The average increase in attenuation for the fibers: Less than or equal to 0.10 dB at 1,550 nm at the completion of the test.
    h. For armored cables, any visible cracks causing separation of the armor and propagating more than 5 millimeters constitutes failure.
    i. Outer cable jacket cracking or splitting observed under 10X times magnification, constitutes failure.

B. Indoor/outdoor cable:
    1. General:
        a. Application: Interior and exterior of buildings.
    2. Cable construction:
        a. General:
            1) Cable type: Indoor/Outdoor - Flame retardant, low smoke, zero halogen, UV resistant.
            2) Fiber count: 12 strand.
            3) Fiber type: Multimode.
            4) Buffer tube: Tight buffer.

5) Armoring: None.
6) Waterproofing: Water blocking layer.
7) Strength member: Central nonmetallic strength member with a coefficient of thermal expansion similar to the fibers.
8) Approvals and listings: UL 1666 and UL 1685.
9) Design and test criteria: In accordance with ICEA S-104-696.

b. Testing:
1) All fibers in the cable:
a) Proof test of 100 kpsi.
b) Each optical fiber: Bellcore GR-409 strip force testing.
c) No gaps are allowed between the coating material and the buffer material visible under a 50-power microscope.

c. Outer jacket material:
1) Linear low-density polyethylene.
2) Color: black.
3) Meet all requirements of the NEC for use in all indoor/outdoor areas (excluding plenums) without being enclosed in conduit.
4) Flame retardant OFNR riser rated conforming to UL 1666.
5) Printed with all necessary UL marks and manufacturer identification.
6) Sequential printing of footage in 2-foot increments.
7) With a ripcord incorporated under the cable jacket.

d. Manufacturers: One of the following or equal:
1) Corning Cable Systems Freedm® One (OFNR Tight-Buffered).
2) KRONE LSZH, Indoor/Outdoor (OFNR) distribution cables.

C. Single mode fibers:
1. All fibers in the cable must be usable fibers and meet required specifications.
2. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.
3. Single mode fiber characteristics:
a. Fiber type: Single mode:
b. Core diameter: 8.2 within 2.5 µm.
c. Clad diameter: 125 within 0.7µm.
d. Cladding non-circularity: Less than .7 percent.
e. Numerical aperture: 14 within 0.015.
f. Maximum attenuation: .4 dB/km at 1,310 nm, .3 dB/km at 1,550 nm.
g. Gigabit Ethernet distance: 5,000 m at 1,310 nm.
h. Coating diameter: 245 within 5 µm.
i. Cabled cutoff wavelength: Less than 1,260.
j. Mode-field diameter: 9.2 within 0.4 µm at 1,310 nm, 10.4 within 0.5 µm at 1,550 nm.
k. Zero dispersion wavelength: 1,313 nm.
l. Dispersion slope: .086 ps/(nm^2*km).
4. Manufacturers: One of the following or equal:
a. ADC/KRONE Group.
b. Berk-Tek.
c. Corning Cable Systems.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Patch cords:
   1. General:
      a. Connector types to match supplied equipment and the patch panel terminations.
      b. Maximum length of patch cords: 25 feet.
      c. Provide 2 spare patch cords (or 1 duplex patch cord) of each type used at each PLC or network cabinet.
      d. Factory assembled and optically tested.
   2. Manufacturers: One of the following or equal:
      a. Krone.
      b. Corning Cable Systems.

B. Fiber connectors:
   1. As specified in Section 17733.

C. Fiber optic identification/warning tags:
   1. Black letters on orange or yellow background.
   2. UV resistant polyethylene or other suitable material.
      a. Manufacturers: The following or equal:
         1) Almetek.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify the condition of the conduit system before installation of the fiber optic cable or inner duct.

B. Pass a test mandrel through all fiber optic conduits prior to pulling fiber or installing inner duct:
   1. Run the mandrel in both directions.

C. Examine all materials and equipment before installation and verify they are free from physical damage and defects.

3.02 PREPARATION

A. Before fiber splicing terminating or testing activities, verify sufficient workspace is available to perform the activity without interferences from other trades.

B. Pre-installation test:
   1. Conduct pre-installation tests on all fiber optic cable.

2. Upon arrival at the site:
    a. Inspect the cable and reel for damage.
    b. Test all fibers with an optical time domain reflectometer (OTDR) for fiber integrity.
    c. Verify that the fiber lengths are consistent with the cable manufacture.
    d. Verify that all traces yield no point discontinuities.
3. Complete test sequence and obtain approval from the Engineer of submitted test results before cable installation:
    a. Replace any cable failing to meet the requirements of the required tests and test before installation.
4. Submit copies of the test results to the Engineer within 5 days after the delivery to the site.

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install fiber optic patch cords in open network trays or in dedicated conduits no longer than 25 feet in length.

C. Install all fiber optic system components in accordance with the recommendations of the manufacturer.

D. Install fiber optic cable in continuous lengths without intermediate splices, except where approved by the Engineer.

E. Installation:
1. Utilize personnel certified by the manufacturer with specific knowledge of the cable manufacturer's recommended procedures:
    a. Schedule Engineer, 5 days before installation, to witness all cable installations.
2. Properly attach the fiber optic cable’s strength elements to a 600-pound breakaway swivel containing tension or shear pins using Kellums pulling grips that are a minimum of 18 inches long.
3. Certify that cable tensile limits do not exceed cable pull tension and bend limits using tension monitoring devices.
4. Leave an extra loop of fiber optic cable in each pull box.
5. Conform with the cable manufacturer's specifications, practices, and the following requirements:
    a. When power equipment is used to install fiber optic cables, use low speeds and do not exceed a rate of 30 meters per minute.
    b. Do not exceed the tensile and bending limitation for fiber optic cables under any circumstances.
    c. Use large diameter wheels, pulling sheaves, and cable guides to maintain the specified bending radius.
    d. Use commercial dynamometers or load cells to monitor pulling tension.
    e. A nonfreezing type of swivel inserted between the pulling line and cable pulling grip to prevent twisting under strain.
    f. All cable to be installed using a breakaway swivel.

6. Apply to all conduits a lubricant at each conduit ingress and egress location during the pull operation:
    a. Pour or pump lubricant into the end of the conduit at the feed location at a nominal application rate of 3 gallons per 1,000 feet of cable.
    b. If the conduit is open at intermediate locations, then apply the appropriate proportion of lubricant at each opening.
    c. Continuously lubricate the cable as it is being pulled by pouring or pumping the lubricant into the conduit at the feed location and at each intermediate location.
    d. Station workers at each intermediate location as required.
    e. Remove all excess lubricant that has collected.
    f. Remove and clean the surrounding area after cable installation.
7. Install using a hydraulic capstan or winch equipped with a recording running line dynamometer graph which measures and records pulling tensions:
    a. Use pulling equipment with “slip-load” capability to allow the winch to maintain a constant pulling force without taking up the winch line.
    b. Use pulling equipment equipped with a hydraulic bypass set so that a maximum tension of 600 pounds is not exceeded.
    c. Use only equipment designed to prevent a preset pulling tension from being exceeded.
    d. Fiber optic cable manufacturer to provide the pulling tension setpoint.
    e. If during the pulling operation excessive tension is detected, cease all operations and notify the Engineer.
8. Position the cable reel at the feed point in alignment with the raceway and in such a position that the cable can be passed from the top of the reel in a long, smooth bend into the raceway system:
    a. The use of a cable feeder is required, unless the cable is hand-pulled.
9. Supply all bull wheels, blocks, split wheels, cable feeders, and necessary equipment required to provide a clean and safe operation:
    a. The cable shall not be allowed to travel over any wheel or block that has a radius less than the minimum radius allowed by the cable manufacturer.
10. Minimize the use of snatch blocks and rollers to guide the cable into the conduit at the feed point:
    a. Slack feed by hand the cable into the feed point and raceway without the use of rollers.
11. Tend the cable reel at all times and turn by hand to provide the required cable slack:
    a. Under no circumstances shall the cable tension be allowed to turn the cable reel.
12. Use a rim roller, with a wheel radius greater than the minimum cable bending radius placed at the manhole or vault opening to prevent the cable from dragging on the manhole rim or steps.
13. Perform a continuous thorough visual inspection for flaws, breaks, and abrasions in the cable sheath as the cable leaves the reel, and maintain a slow pulling speed to permit this inspection.
14. Damage to the sheath or finish of the cable is cause for rejecting the cable:
    a. Replace any cable damaged in any way during installation.
15. If the cable becomes damaged during installation, stop operations and notify the Engineer immediately:
    a. Engineer to determine whether to replace the entire reel of cable or to install a termination panel to eliminate the damaged section.

16. Document all pulls by a graph which is annotated with the following information:
    a. Reel number.
    b. Pull point ID.
    c. Date and time.
    d. Explanations for abnormalities in readings or interruptions.
    e. Sign-off by Contractor and Engineer.
17. Under no conditions shall the fiber optic cable be left exposed or unattended.

F. After the cables are installed and spliced:
1. Rack the cables:
    a. Loosely secure in racked position with wire ties.
    b. Attach imprinted plastic coated cloth identification/warning tags to each cable in at least 2 locations in each handhole/manhole.

G. Splices:
1. Submit all splice locations to the Engineer for approval before installation of the fiber cables.
2. Provide field splices in a splice tray located in a waterproof splice enclosure:
    a. Manufacturer: The following or equal:
        1) Tyco/Raychem FOSC style splice enclosure.
3. Loop the individual fibers a minimum of 1 full turn within the splice tray to avoid macro/micro bending.
4. After completion of cable terminations, neatly dress all cables.
5. Protect all splices with a thermal shrink sleeve.
6. Provide fusion type fiber optic cable splicing meeting the following requirements:
    a. Joins multimode or single mode fibers.
    b. Establishes a permanent fusion splice.
    c. Waterproof.
    d. Re-enterable, rearrangable, and reusable.
    e. Splice loss less than 0.10 dB.
    f. Protected by a splice enclosure.
7. Requirement for outdoor fiber splice enclosures:
    a. Seal.
    b. Bond.
    c. Anchor.
    d. Protect fiber optic cable splices.
    e. Stand-alone unit that does not require an outer enclosure.
    f. Provide for a maximum of 6 cable entries in a butt-end configuration.
    g. Used in aerial, underground, and direct buried applications.
8. Requirement for indoor fiber splice enclosures:
    a. Anchor.
    b. Protect fiber optic cable splices.
    c. Stand-alone unit that does not require an outer enclosure.
    d. Suitable for the minimum number of splices at that location plus additional capacity for reconfigurations.
9. Re-splice any splice that has a loss greater than 0.10 dB.
10. Leave a minimum of 20 feet of fiber optic cable at each end of splice.

H. Terminations:
    1. Terminate all fiber inside a patch panel:
        a. Direct landing to a switch, router hub, or PLC will be allowed.
    2. Terminate outdoor cables using a breakout kit that seals the cable and provides physical protection for the fiber strands.
    3. Terminate indoor cables using breakout kits with field installed terminators.
    4. Labeling:
        a. Permanently label all cable terminations. Use labels produced by a wire printer using pressure sensitive polyester labels. Label patch panels as specified in Section 16075.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. Factory test:
    1. Before shipment and while on the shipping reel, test 100 percent of all fibers for attenuation:
        a. Copies of the results shall be:
            1) Maintained on file.
            2) Attached to the cable reel in a waterproof pouch.
            3) Submitted before the delivery of the cable to the job site to Engineer for approval.
    2. Conduct the flex test in accordance with FOTP-104 test condition I and III with a maximum sheave diameter of 20 times the cable OD.
    3. Verify that the cable withstands 25 impact cycles with:
        a. The average increase in attenuation for the fibers less than 0.20 dB at 1,550 nm.
        b. No evidence of cracking or splitting.
        c. Conduct the test in accordance with FOTP-25.
    4. Certify that the cable withstands a tensile load of 2,700 N (600 pounds):
        a. Without exhibiting an average increase in attenuation of greater than 0.10 dB.
        b. Test in accordance with FOTP-33 using a maximum mandrel and sheave diameter of 560 millimeters.
        c. Apply the load for 1 hour in Test Condition II.
    5. Certify that the cable withstands a simulated lightning strike:
        a. Peak value of the current pulse greater than 105kA.
        b. Use a test current with a damped oscillatory maximum time-to-peak value of 15 µs (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz.
        c. The time to half-value of the waveform envelope 40 to 70 µs.
        d. Conduct the test in accordance with the FOTP-181.
        e. In addition to the analysis criterion set forth in FOTP-181, the integrity of the buffer tubes (or analogous loose tube, i.e. core tube) and strength

members must be intact after removal of the cable specimens from the test box.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

B. General:
   1. All test results shall meet or exceed manufacturer specifications:
      a. Test each fiber of each cable for breaks, abnormalities, and overall attenuation characteristics.
      b. Replace any fiber that does not meet or exceed manufacturer specifications.
   2. Conduct post-installation tests of the fiber optic system in accordance with Section 16950.
   3. Pre-installation tests and post-installation tests to be witnessed and signed off by Engineer and Owner.
   4. Perform attenuation tests with an optical loss test set capable and calibrated to show anomalies of 0.1 dB as a minimum:
      a. Test multimode fibers at 850 nm and 1,300 nm.
      b. Test single mode fibers at 1,310 and 1,550 nm.
   5. Perform OTDR tests on fiber cables less than 100 meters with the aid of a launch cable:
      a. Adjust OTDR pulse width settings to a maximum setting of 1/1000th of the cable length or 10 nanoseconds.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. Clean all fiber optic connectors after termination and before testing. After cleaning, cover all un-terminated connectors with a protective boot.

B. At the completion of construction, touch up the finish on all fiber patch panels and enclosures.

3.11 PROTECTION

A. As specified in Section 16050.

B. Protect the fiber system from physical damage and the encroachment of dust, before, during, and after installation.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16130

CONDUITS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Metallic conduits.
   2. Nonmetallic conduits.
   3. Conduit bodies.
   4. Conduit fittings and accessories.
   5. Conduit installation.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16052 - Hazardous Classified Area Construction.
   5. Section 16070 - Hangers and Supports.
   6. Section 16075 - Identification for Electrical Systems.
   7. Section 16133 - Duct Banks.

1.02 REFERENCES

A. As specified in Section 16050.

B. American National Standards Institute (ANSI):
   1. C80.1 - Electrical Rigid Steel Conduit.
   2. C80.3 - Steel Electrical Metallic Tubing.
   3. C80.6 - Electrical Intermediate Metal Conduit.

C. National Electrical Manufacturer's Association (NEMA):
   1. RN-1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
   2. TC2 - Electrical Polyvinyl Chloride (PVC) Conduit.
   3. TC3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   4. TC7 - Smooth-Wall Coilable Electrical Polyethylene Conduit.
   5. TC13 - Electrical Nonmetallic Tubing.
   6. TC14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

D. Underwriters Laboratories (UL):
   1. 1 - Standard for Flexible Metal Conduit.
   2. 6 - Standard for Electrical Rigid Metal Conduit - Steel.
   3. 360 - Standard for Liquidtight Flexible Steel Conduit.
   4. 651 - Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
   5. 651B - Standard for Continuous Length HDPE Conduit.
   6. 797 - Standard for Electrical Metallic Tubing - Steel.

7. 1242 - Standard for Electrical Intermediate Metal Conduit - Steel.
8. 1653 - Standard for Electrical Nonmetallic Tubing.
9. 1660 - Standard for Liquidtight Flexible Nonmetallic Conduit.
10. 1684 - Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions and abbreviations:
1. Conduit bodies: A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of 2 or more conduit sections. Includes, but not limited to, Shapes C, E, LB, T, X, etc.
2. Conduit fitting: An accessory that primarily serves a mechanical purpose. Includes, but not limited to, bushings, locknuts, hubs, couplings, reducers, etc.
3. GRC: Galvanized rigid steel conduit.
4. PCS: Polyvinyl chloride (PVC) coated rigid steel conduit.
5. PVC: Polyvinyl chloride rigid nonmetallic conduit.
6. SLT: Sealtight-liquidtight flexible conduit.
7. EFLX: Explosionproof flexible conduit.
8. FLX: Flexible metallic conduit.
9. FRD: Fiberglass-reinforced duct.
10. NPT: National pipe thread.

1.04 SYSTEM DESCRIPTION

A. Provide conduits, conduit bodies, fittings, junction boxes, and all necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
1. Furnish complete manufacturer’s catalog sheets for every type and size of conduit, fitting, conduit body, and accessories to be used on the Project.
2. Furnish complete manufacturer’s recommended special tools to be used for installation if required.
3. Certified test results for PVC-coated metallic conduit showing the adhesive bond is stronger than the tensile strength of the PVC.

C. Certifications:
1. Furnish PVC-coated conduit manufacturer’s certification for each installer.

D. Record Documents:
1. Incorporate all changes in conduit routing on electrical plan drawings.
2. Dimension underground and concealed conduits from building lines.
3. Furnish hard copy drawings and electronic files in AutoCAD format Version: 2004.

E. Installation drawings: Installation drawings, including individual conduit numbers, routing, sizes, cable sizes, and circuit numbers for each conduit.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. All conduits, conduit bodies, and fittings shall be UL listed and labeled.

C. Every installer of PVC-coated metallic conduit shall be certified by the manufacturer for installation of the conduit.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

B. Do not expose Type PVC, FRD, NFC, and ENT to direct sunlight.

C. Do not store conduit in direct contact with the ground.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING

A. Before installing any conduit or locating any device box:
   1. Examine the complete set of Drawings and Specifications, and all applicable shop drawings.
   2. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Galvanized rigid steel conduit:
   1. One of the following or equal:
      a. Western Tube and Conduit.
      b. Allied Tube and Conduit.
      c. Wheatland Tube Co.

B. PVC-coated rigid steel conduit:
   1. One of the following or equal:
      a. Robroy Industries.
      b. Ocal, Inc.
      c. Calbond.

C. Flexible metallic conduit:
   1. One of the following or equal:
      a. AFC Cable Systems.
      b. Southwire.
      c. Electri-Flex Company.

D. Sealtight-liquidtight flexible conduit:
   1. One of the following or equal:
      a. Southwire.
      b. AFC Cable Systems.
      c. Electri-Flex Company.
      d. Anaconda.

E. Explosionproof flexible conduit:
   1. One of the following or equal:
      a. Appleton.
      b. Crouse-Hinds.
      c. Hubbell Killark.

F. Rigid nonmetallic PVC conduit:
   1. One of the following or equal:
      a. Carlon.
      b. Cantex.
      c. Triangle Conduit and Cable.

G. Conduit bodies:
   1. One of the following or equal:
      a. Crouse-Hinds.
      b. Appleton.
      c. O-Z/Gedney.
      d. Ocal, Inc.
      e. Robroy Industries.
      f. Calbond.
      g. Carlon.

H. Joint compound:
   1. Thomas and Betts.

I. Galvanized rigid steel conduit expansion fittings:
   1. One of the following or equal:
      a. Crouse-Hinds.
      b. Appleton.
      c. O-Z/Gedney.

J. Conduit sleeve:
   1. One of the following or equal:
      a. Crouse-Hinds.
      b. Appleton.
      c. O-Z/Gedney.

K. Conduit seals:
   1. One of the following or equal:
      a. Appleton.
      b. Crouse-Hinds.
      c. O-Z/Gedney.

L. Conduit hangers and supports:
   1. As specified in Section 16070.

M. Conduit through wall and floor seals:
   1. The following or equal:
      a. O-Z/Gedney:
         1) Type "WSK."
         2) Type “CSM.”

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. GRC:
   1. All threads: NPT standard conduit threads with a 3/4-inch taper per foot:
      a. Running conduit threads are not acceptable.
   2. Hot-dip galvanized inside and out:
      a. Ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface.
      b. Electro-galvanizing is not acceptable.
   3. Manufactured in accordance with:
      a. UL-6.
      b. ANSI C80.1.

B. PCS:
   1. The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, conforming to the requirements for Type GRC.
   2. Coated conduit NEMA Standard RN-1:
      a. The galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
   3. Factory-bonded PVC jacket:
      a. The exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
      b. Nominal thickness of the exterior PVC coating shall be 0.040 inch except where part configuration or application of the piece dictates otherwise.
      c. PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
      d. The PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
         1) Confirm bond with certified test results.
   4. A urethane coating shall be uniformly and consistently applied to the interior of all conduits and fittings:
      a. Nominal thickness of 0.002 inch.
      b. Conduits having areas with thin or no coating are not acceptable.
      c. All threads shall be coated with urethane.
   5. The PVC exterior and urethane interior coatings applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).
   6. PCS conduit bodies and fittings:
      a. Malleable iron.
      b. The conduit body, before PVC coating, shall be new, unused material and shall conform to appropriate UL standards.
      c. The PVC coating on the outside of conduit bodies shall be 0.040-inch thick and have a series of longitudinal ribs to protect the coating from tool damage during installation.
      d. 0.002-inch interior urethane coating.
      e. Utilize the PVC coating as an integral part of the gasket design.
      f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.
      g. A PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening:
         1) The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
         2) The sleeve shall provide a vapor- and moisture-tight seal at every connection.

C. FLX:
   1. Materials:
      a. Single strip steel hot-dip galvanized on all 4 sides before conduit fabrication.
   2. Interlocking design formed from continuous metal strip for integrity and flexibility.
   3. Manufactured in accordance with:
      a. UL-1.

D. SLT:
   1. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
      a. General purpose:
         1) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
      b. Oil-resistant:
         1) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
   2. Sunlight-resistant, weatherproof, and watertight.
   3. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
   4. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
   5. Overall PVC jacket.
   6. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.

E. EFLX:
   1. Suitable for the hazardous Class and Group where installed:
      a. As specified in Section 16050.
   2. Metallic braid shall provide continuous electrical path.
   3. Stainless steel construction.
   4. Provide fittings and unions as required for the installation.

F. PVC:
   1. Extruded from virgin PVC compound:
      a. Schedule 40 unless otherwise specified.
      b. Schedule 80 extra-heavy wall where specified.
   2. Rated for 90 degrees Celsius conductors or cable.
   3. Rated for use in direct sunlight.

G. Conduit bodies:
   1. Material consistent with conduit type:
      a. Malleable iron bodies and covers when used with Type GRC.
      b. PVC bodies and covers when used with Type PVC.
      c. PVC-coated malleable iron bodies and covers when used with Type PCS.
   2. Conduit bodies to conform to Form 8, Mark 9, or Mogul design:
      a. Mogul design conforming to NEC requirements for bending space for large conductors for conduit trade sizes of 1 inch and larger with conductors #4 AWG and larger, or where required for wire-bending space.
   3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.

2.07 ACCESSORIES

A. Connectors and fittings:
   1. Manufactured with compatible materials to the corresponding conduit.

B. Insulated throat metallic bushings:
   1. Construction:
      a. Malleable iron or zinc-plated steel when used with steel conduit.
      b. Positive metallic conduit end stop.

c. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
d. Use fully insulated bushings on nonmetallic conduit system made of high-impact 150 degrees Celsius rated non-combustible thermosetting phenolic.

C. Insulated grounding bushings:
1. Construction:
a. Malleable iron or steel, zinc-plated, with a positive metallic end stop.
b. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
c. Tin-plated copper grounding saddle for use with copper or aluminum conductors.

D. Electrical unions (Erickson Couplings):
1. Construction:
a. Malleable iron for use with steel conduit.
b. Concrete tight, 3-piece construction.
c. Rated for Class I Division 1 Group D in hazardous areas.

E. FLX fittings:
1. Provide insulated die-cast connectors with ridges that thread into the inside of the conduit to achieve a force fit.
2. Binding screw connectors are not acceptable.

F. SLT fittings:
1. Construction:
a. Malleable iron.
b. Furnished with locknut and sealing ring.
c. Liquidtight, rain-tight, oil-tight.
d. Insulated throat.
e. Furnish as straight, 45-degree elbows, and 90-degree elbows.
f. Designed to prevent sleeving:
1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device, if inserted into raceway and directly in contact with conductors, shall have rolled-over edges for sizes under 5 inches.
h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture-resistant/oil-resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.
2. Corrosion-resistant and outdoor SLT fittings:
a. Construction:
1) PVC-coated liquidtight fittings with a bonded 0.040-inch thick PVC coating on the metal connector to form a seal around the SLT conduit.
2) Insulated throat and an integral sealing ring.

G. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
   1. Construction:
      a. Insulated throat.
      b. PVC-coated when used in corrosive areas.
      c. Bonding locknut.
      d. Recessed neoprene O-ring to ensure watertight and dust-tight connector.
      e. One half (1/2)-inch through 1-1/4-inch steel zinc electroplated.
      f. One and one half (1-1/2)-inch through 6-inch malleable iron zinc plated.
   2. Usage:
      a. All conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.

H. Sealing fittings:
   1. Construction:
      a. 40-percent wire fill capacity.
      b. PVC-coated when used in corrosive areas.
      c. Malleable ductile iron with steel conduit.
      d. Crouse-Hinds Type EYD where drains are required.
      e. Crouse-Hinds Type EYS where drains are not required.
      f. UL listed for use in Class I, Division 1, Groups A, B, C, D; Class I, Division 2, Groups A, B, C, D; and Class II, Divisions 1 and 2, Groups E, F, and G.
   2. Sealing compound:
      a. Fiber filler and cement as recommended by the sealing fitting manufacturer.
      b. Approved for the conditions and use.:
         1) Not affected by surrounding atmosphere or liquids.
      c. Melting point shall be 200 degrees Fahrenheit minimum.

I. PVC fittings:
   1. Shall include the following:
      a. Couplings.
      b. Terminal adapters.
      c. Female adapters.
      d. Caps.
      e. Reducer bushings.
      f. Duct couplings.
      g. End bells.
      h. Expansion couplings.
      i. Duct couplings: 5 degree.
      j. C-Type pull fittings.
      k. E-Type pull fittings.
      l. LB-Type pull fittings.
      m. LL-Type pull fittings.
      n. LR-Type pull fittings.
      o. T-Type pull fittings.
      p. X-Type pull fittings.
      q. Service entrance caps.
   2. Materials:
      a. All devices shall be made of PVC, using the same materials as used for Type PVC conduit.
      b. All metal hardware shall be stainless steel.

J. Through wall and floor seals:
   1. Materials:
      a. Body: Casting of malleable or ductile iron with a hot-dip galvanized finish.
      b. Grommet: Neoprene.
      c. Pressure rings: PVC-coated steel.
      d. Disc material: PVC-coated steel.

K. Expansion/deflection couplings:
   1. Use to compensate for movement in any directions between 2 conduit ends where they connect.
   2. Shall allow movement of 3/4 inch from the normal in all directions.
   3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
   4. Constructed to maintain electrical continuity of the conduit system.
   5. Materials:
      a. End couplings: Bronze or galvanized ductile iron.
      b. Sleeve: Neoprene.
      c. Bands: Stainless steel.
      d. Bonding jumper: Tinned copper braid.

L. Expansion couplings:
   1. Shall allow for expansion and contraction of conduit:
      a. Permitting 8-inch movement, 4 inches in either direction.
   2. Constructed to maintain electrical continuity of the conduit system.
   3. Materials:
      a. Head: Malleable or ductile iron.
      b. Sleeve: Steel.
      c. Insulating bushing: Phenolic.
      d. Finish: Hot-dip galvanized.

M. Conduit markers:
   1. As specified in Section 16075.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. As specified in Section 16050.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. General:
1. Conduit routing:
   a. The electrical drawings are diagrammatic in nature:
      1) Install conduit runs as specified with schematic representation indicated on the Drawings and as specified.
      2) Modify conduit runs to suit field conditions, as accepted by the Engineer:
         a) Make changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions.
         b) Make changes in conduit routing due to the relocation of equipment.
      3) The electrical drawings do not indicate all required junction boxes and pull boxes:
         a) Provide junction boxes and pull boxes to facilitate wire pulling as required:
            (1) To meet cable manufacturer's pulling tension requirements.
            (2) To limit total conduit bends between pull locations.
         b) Install junction boxes and pull boxes at locations acceptable to the Engineer.
   b. The Contractor is responsible for any deviations in general location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer:
      1) The Engineer is the sole source in determining whether the change is constituted as a deviation.
      2) Perform any changes resulting in additional conduits, or extra work from such deviations.
      3) Incorporate any deviations on the Record Documents.
2. Use only tools recommended by the conduit manufacturer for assembling the conduit system.
3. Provide adequate clearances from high-temperature surfaces for all conduit runs. Provide minimum clearances as follows:
   a. Clearance of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.
   b. Clearance of 12 inches from surfaces greater than 149 degrees Fahrenheit.
   c. Keep conduits at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings, and 12 inches from fuel lines and gas lines.
   d. Where it is necessary to route conduits close to high-temperature surfaces, provide a high-reflectance thermal barrier between the conduit and the surface.
4. Support conduit runs on water-bearing walls a minimum of 7/8-inch away from wall on an accepted preformed channel:
   a. Do not run conduits within water-bearing walls unless otherwise indicated on the Drawings.
5. Do not install 1-inch or larger conduits in or through structural members unless approved by the Engineer.

6. Run conduits exposed to view parallel with or at right angles to structural members, walls, or lines of the building:
    a. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends.
    b. Make changes in direction with long radius bends or with conduit bodies.
7. Install conduits with total conduit bends between pull locations less than or equal to 270 degrees.
8. Route all exposed conduits to preserve headroom, access space and work space, and to prevent tripping hazards and clearance problems:
    a. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and do not block or interfere with ingress or egress, including equipment-removal hatches.
    b. Route conduits to avoid drains or other gravity lines. Where conflicts occur, relocate the conduit as required.
9. Conduits may be run in concrete members or slabs with permission of the Engineer or as indicated on the Drawings:
    a. Refer to the typical details for conduit spacing and size requirements.
10. When installing conduits through existing slabs or walls, make provisions for locating any possible conflicting items where the conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into the existing conduits, piping, cables, post-tensioning cables, etc.
11. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
12. Install conduits through wall and floor seals where indicated on the Drawings.
13. For existing and new 2-inch and larger conduit runs, snake conduits with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of the conduit:
    a. Remove and replace conduits through which mandrel will not pass.
14. Provide all sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically indicated on the Drawings.
15. Install complete conduit systems before conductors are installed.
16. Provide metallic conduits terminating in transformer, switchgear, motor control center, or other equipment conduit windows with grounding bushings and ground with a minimum No. 6 AWG ground wire.
17. Underground conduits:
    a. Install underground conduits, including conduit runs below slabs-on-grade in concrete-reinforced duct bank construction:
        1) As specified in Section 16133.
    b. Make underground conduit size transitions at handholes and manholes.
    c. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and handholes.
    d. Seal around conduit penetrations of below grade walls with a mechanical seal.

C. Lighting and receptacle conduits:
    1. Provide conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings:
    2. Install conduits in accordance with the requirements of this Section unless otherwise indicated.

3. Minimum conduit size:
   a. 3/4-inch for exposed conduits.
   b. 1-inch for underground or in-slab conduits.
4. Provide conduit materials for the installed location as specified in Section 16050.

D. Hazardous areas:
1. As specified in Section 16050 for hazardous areas and specific Class and Division.
2. As specified in Section 16052 for hazardous area conduit installation requirements.

E. Conduit usage:
1. Exposed conduits:
   a. Rigid conduit:
      1) Install the rigid conduit type for each location as specified in Section 16050.
      2) Minimum size: 3/4-inch.
   b. Flexible conduit:
      1) Use flexible conduit for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment, or where required for equipment servicing:
         a) Use Type SLT with rigid metallic conduit.
         b) Use Type EFLX in Class I Division 1 locations.
         c) Use Type FLX in finished areas.
      2) Minimum size: 3/4-inch:
         a) 1/2 when required for connection to instruments.
      3) Maximum length:
         a) Fixed equipment:

Conduit Trade Size	Flexible Conduit Length (inch)
3/4	18
1	18
1-1/4	18
1-1/2	18
2	36
2-1/2	36
3	36
3-1/2	38
4	40

         b) Removable instruments or hinged equipment:
            (1) As required to allow complete removal or full movement without disconnecting or stressing the conduit.

2. Concrete-encased and embedded conduits:
    a. Type PVC Schedule 40 and PVC-coated rigid metallic conduit as specified below:
        1) Use Type PCS in underground and embedded installation as follows:
            a) Stub-up and risers to grade floor or equipment from nonmetallic conduits.
            b) Entering and exiting underground or embedded conduit runs a minimum 12 inches above and below grade of finished floor.
            c) For any and all bends where the total deflection is greater than 45 degrees.
    b. Minimum size:
        1) 2-inch in duct banks unless otherwise indicated on the Drawings.
        2) 1-inch for in-slab conduits unless otherwise indicated on the Drawings.
3. Direct-buried and sand-bedded duct bank conduits:
    a. Type PCS.
    b. Minimum size: 1-inch.
4. Concrete capped, pea gravel-bedded duct bank conduits:
    a. Type PVC40.
    b. Minimum size: 1-inch.
5. PVC-coated rigid metallic conduit:
    a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.
6. GRC:
    a. Conduit shall be cut square and reamed before threading.
7. PVC:
    a. Conduit terminations shall be via threaded adapters into threaded hubs on the junction boxes or conduit bodies.
    b. Conduit terminations into boxes without threaded hubs shall utilize a threaded adapter and a flat neoprene washer on the outside of the box:
        1) Use a locknut on the inside of the box to tighten the adapter to the box.
    c. Route conduit to afford it the maximum physical protection:
        1) If necessary, cover conduit to afford additional protection when it cannot be shielded by the structure or machinery frames:
            a) Use Schedule 80 where exposed runs may be subject to physical damage.

F. Conduit joints and bends:
    1. General:
        a. Where conduit is underground, under slabs on grade, exposed to the weather, or in NEMA Type 4 or NEMA Type 4X locations, make joints liquidtight.
        b. Keep bends and offsets in conduit runs to an absolute minimum.
        c. All bends shall be symmetrical.
        d. The following conduit systems shall use large-radius sweep elbows:
            1) Underground conduits.
            2) Conduits containing medium-voltage cables.
            3) Conduits containing shielded cables.
            4) Conduits containing fiber optic cables.
        e. Provide large-radius factory-made bends for 1-1/4-inch trade size or larger.

f. Make field bends with a radius of not less than the requirements found in the NEC:
    1) The minimum bending radius of the cable must be less than the radius of the conduit bend.
    2) Make all field bends with power bending equipment or manual benders specifically intended for the purpose:
        a) Make bends so that the conduit is not damaged and the internal diameter is not effectively reduced.
        b) For the serving utilities, make bends to meet their requirements.
g. Replace all deformed, flattened, or kinked conduit.

2. Threaded conduit:
    a. Cut threads on rigid metallic conduit with a standard conduit-cutting die that provides a 3/4-inch per foot taper and to a length such that all bare metal exposed by the threading operation is completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that all joints become secure and wrench-tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
    b. Thoroughly ream conduit after threads have been cut to remove burrs.
    c. Use bushings or conduit fittings at conduit terminations.
    d. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing “Galvabar,” or CRC “Zinc It.”
    e. Coat conduit threads with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation:
        1) Apply to the male threads and tighten joints securely.
        2) Clean excess sealant from exposed threads after assembly.
    f. Securely tighten all threaded connections.
    g. Any exposed threaded surfaces must be cleaned and coated with a galvanizing solution so that all exposed surfaces have a galvanized protective coating.

3. PVC:
    a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray-type cement is not allowed.
    b. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to ensure full inside diameter at all bends:
        1) Utilize a heater specifically for PVC conduit as recommended by the conduit manufacturer.

G. Conduit sealing and drainage:
1. Conduit drainage and sealing other than required for hazardous and classified areas:
    a. Provide sealing and drainage in vertical drops of long (in excess of 20 feet), exterior, above-grade conduit runs at the points at which the conduit enters buildings, switchgear, control panels, lighting panelboards, and other similar enclosures.
    b. Provide seal fittings with drains in vertical drops directly above grade for exterior and above-grade conduit runs that are extended below grade.
    c. Provide conduit seals with drains in areas of high humidity and rapidly changing temperatures:
        1) Where portions of an interior raceway pass through walls, ceilings, or floors that separate adjacent areas having widely different temperatures.

d. Provide conduit seals similar to O-Z/Gedney (Type CSM) on all conduits between corrosive and non-corrosive areas.
e. Seal one end only of all underground conduits at highest point with O-Z/Gedney sealing (non-hazardous) filling, or equal.

2. Install seals with drains at any location along conduit runs where moisture may condense or accumulate. This requirement includes, but is not limited to, the following locations: control panels, junction boxes, pullboxes, or low points of the conduit.

H. Conduit supports:
1. General:
a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
1) As specified in Section 16070.
2) Provide support materials consistent with the type of conduit being installed as specified in Section 16050.
b. Support conduit at the intervals required by the NEC.
c. Perforated strap and plumbers tape are not acceptable for conduit supports.
2. Conduit on concrete or masonry:
a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
b. Use preset inserts in concrete when possible.
c. Use pipe spacers (clamp backs) in wet locations.
d. On plaster or stucco, use 1-hole malleable iron straps with toggle bolts.
3. Conduit on metal decking:
a. Use 1-hole malleable iron straps with 1-inch long cadmium-plated Type A panhead sheet-metal screws. Fully or partially hammer-driven screws are not acceptable.
4. Suspended conduit:
a. Use malleable-iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
b. For grouped conduits, construct racks with threaded rods and tiered angle iron or preformed channel cross members. Clamp each conduit individually to a cross member. Where rods are more than 2-feet long, provide rigid sway bracing.
5. Supports at structural steel members:
a. Use beam clamps.
b. Drilling or welding may be used only as specified or with approval of the Engineer.
6. PVC-coated rigid metal systems:
a. Provide right-angle beam clamps and “U” bolts specially formed and sized to snugly fit the outside diameter of the coated conduit. Provide "U" bolts with PVC-encapsulated nuts that cover the exposed portions of the threads.
b. Securely fasten exposed conduits with Type 316 stainless steel clamps or straps.

I. Expansion or expansion/deflection fittings:
1. General:
a. Align expansion coupling with the conduit run to prevent binding.

b. Follow manufacturer's instructions to set the piston opening.
c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction.
d. Furnish fittings of the same material as the conduit system.

2. For metallic conduit, provide expansion or expansion/deflection couplings, as appropriate, where:
   a. Install expansion fittings a minimum of every 200 feet in straight conduit runs.
3. For PVC, provide expansion or expansion/deflection couplings, as appropriate, where length change due to temperature variation exceeds 2 inches:
   a. Rigidly fix the outer barrel of the expansion coupling so it cannot move.
   b. Mount the conduit connected to the piston loosely enough to allow the conduit to move as the temperature changes.

J. Empty conduits:
1. Provide a polyethylene rope rated at 250 pounds tensile strength in each empty conduit more than 10 feet in length.
2. Seal ends of all conduits with approved, manufactured conduit seals, caps, or plugs immediately after installation:
   a. Keep ends sealed until immediately before pulling conductors.

K. Miscellaneous:
1. Seal roof penetrations for raceways and other items that penetrate the roof in accordance with roofing manufacturer's instructions and as indicated on the Drawings.
2. Provide electrical unions at all points of union between ends of rigid conduit systems that cannot otherwise be coupled:
   a. Running threads and threadless couplings are not allowed.
3. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.
4. Provide conduit housekeeping curb around all embedded or below-grade conduits exiting or entering the slab, per the Typical Details.

3.04 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16133

DUCT BANKS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Electrical underground duct banks.
   2. Duct bank installation requirements.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 02318 - Trenching.
   4. Section 02952 - Pavement Restoration and Rehabilitation.
   5. Section 03200 - Concrete Reinforcing.
   6. Section 03300 - Cast-In-Place Concrete.
   7. Section 16130 - Conduits.
   8. Section 16050 - Common Work Results for Electrical.

1.02 REFERENCES

A. As specified in Section 16050.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Provide trenching, forming, rebar, spacers, conduit, concrete, backfill, and compaction necessary for the complete installation of the duct banks.

B. Provide reinforced concrete duct banks for all conduits installed below grade, on the site, below structures, or in contact with the earth, unless otherwise indicated on the Drawings.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. PVC conduit spacers.
   2. Detectable underground marking tape.
   3. Pull line.

C. Provide applicable submittal documents as specified in:
   1. Section 02318.

2. Section 03200.
3. Section 03300.

D. Shop drawings:
1. Submit site plan drawings of duct banks including underground profiles indicating all underground utilities.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

B. Field conditions and related requirements:
1. Underground water table may be near or above the location of new duct banks.
2. Include cost for necessary dewatering, and cleaning equipment to perform work in underground duct banks, pull boxes and manholes, before installation.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conduit spacers:
1. One of the following or equal:
a. Carlon Snap-Loc.
b. Cantex.
c. Osburn Associates, Inc.

B. Detectable underground marking tape:
   1. One of the following or equal:
      a. Blackburn Manufacturing Company.
      b. Pro-Line Safety Products.
      c. Panduit.

C. Pull line:
   1. One of the following or equal:
      a. Arnco.
      b. Greenlee.
      c. Osburn Associates, Inc.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Provide conduit as specified in Section 16130:
   1. Use duct suitable for use with 90-degree Celsius rated conductors.

B. Provide reinforcing steel as specified in Section 03200:
   1. Provide minimum Number 4 reinforcing steel.

2.04 MANUFACTURED UNITS

A. Conduit spacers:
   1. Provide conduit spacers recommended by the conduit manufacturer or specified above.
   2. Saddle type.
   3. Non-metallic, non-corrosive, non-conductive.
   4. Interlocking type:
      a. Vertical interlocking.
      b. Horizontal interlocking.
   5. Suitable for concrete encasement.
   6. Molded-in rebar holder.
   7. Accommodates 2-inch through 6-inch conduit sizes.
   8. Relieves the conduit from both horizontal and vertical stresses.

B. Pull line:
   1. Minimum 1/4-inch wide, flat design.
   2. Polyester.
   3. Minimum pulling strength 1,200 pounds.
   4. Sequential footage markings.

C. Detectable marking tape:
   1. Provide a detectable tape, locatable by a cable or metal detector from above the undisturbed grade.
   2. Aluminum core laminated between polyethylene film.
   3. Six-inch wide red tape imprinted with black lettering "CAUTION - BURIED ELECTRIC UTILITIES."

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES

A. Concrete mix requirements as specified in Section 03300.

B. Provide a red-oxide conduit encasement coloring agent as specified in Section 03300.

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Duct banks:
   1. Install duct banks encased in concrete at least 24 inches below finish grade, unless otherwise indicated on the Drawings.
   2. Damage minimization:
      a. Conduit should not be left exposed in an open trench longer than is necessary.
      b. Protect all underground duct banks against damage during pouring of concrete or backfilling.
   3. All plastic conduit fittings to be joined should be exposed to the same temperature conditions for a reasonable length of time before assembly.
   4. Provide No. 4/0 American Wire Gauge bare copper ground wire the entire length of duct bank and bond to the grounding system as indicated on the Drawings.
   5. Install underground ducts to be self-draining:
      a. Slope duct banks away from buildings to manholes and pull boxes.
      b. Slope duct banks uniformly from manholes and pull boxes to manholes and pull boxes or both ways from high points between manholes and pull boxes.
      c. Slope a minimum of 1/4 inch per 10 feet.
   6. Where new duct banks join to existing manholes or pull boxes make the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions, as indicated on the Drawings.

7. Install pull line in spare conduits:
    a. Provide adequate pull line at both ends of conduits to facilitate conductor pulling.
    b. Cap above ground spare conduit risers at each end with screw-on conduit caps.

C. Trenching:
1. Perform trenching as specified in Section 02318.
2. Trench must be uniformly graded with the bottom, rock free and covered with select material.
3. Whenever possible, use the walls of the trench as forms for concrete encasement:
    a. Forms are required where the soil is not self-supporting.
4. Avoid damaging existing ducts, conduits, cables, and other utilities.

D. Duct spacing:
1. Separate conduits with manufactured plastic spacers using a minimum space between the outside surfaces of adjacent conduits of 2 inches, unless otherwise indicated on the Drawings:
    a. Separate medium voltage ducts a minimum of 7.5 inches on center.
2. Install spacers to maintain uniform spacing of duct assembly a minimum of 4 inches above the bottom of the trench during concrete pour. Install spacers on 8-foot maximum intervals:
    a. Due to some distortion of conduit from heat, and other means, it may be necessary to install extra spacers within the duct bank:
        1) Install the intermediate set of spacers within normal required spacing to maintain the proper horizontal clearance:
            a) Clearance is required to allow the proper amount of concrete to infiltrate vertically among the duct to ensure proper protection.
3. Spacers shall not be located at the center of a bend:
    a. Locate spacer in the tangent, free of the coupling on fabricated bends.
    b. Locate spacers midway between the tangent and the center bend on trench formed sweeps.

E. Terminating:
1. Use bell ends in duct at entrances into cable vaults.
2. Make conduit entrances into cable vaults tangential to walls of cable vault.
3. Form trapezoidal transitions between duct bank and cable vaults as needed in order to ensure adequate cable bending radius for the duct bank-to-vault transition.
4. New manhole or handhole applications, provide a single opening or “window” per duct bank, sized to accommodate the duct bank envelope.

F. Concrete:
1. Install concrete as specified in Section 03300.
2. Provide nonferrous tie wires to prevent displacement of the conduits during pouring of concrete:
    a. Tie wire shall not act as a substitute for spacers.
3. Install minimum 3-inch cover around conduit and rebar.

4. Consolidation of encasement concrete around duct banks shall be by hand pudding, with no mechanical vibration.
5. Conduit is subject to temperature rise. As concrete cures, allow the free end to expand by pouring the concrete from the center of the run or from one tie in point.

G. Marking tape:
1. Install a detectable marking tape 12 inches above the duct bank the entire length of the duct bank.

H. For conduit installations beneath building slabs:
1. Install steel reinforced concrete duct banks under all building slabs as indicated on the Drawings:
a. Concrete for encasement under building slabs need not be colored red.
b. For duct banks crossing under building footers or foundations, install the top of the duct bank a minimum of 6 inches below the footer.
c. Where duct banks enter through building walls, foundation walls, stem walls, etc. make connections as indicated on the Drawings.
d. Where duct banks terminate with conduit risers entering building walls, install an expansion/deflection fitting or a flat-wise elbow (elbow parallel to building wall) in order to accommodate differential movement between the conduits and structure.

I. Restore all surfaces to their original condition as specified in Section 02952, unless otherwise specified.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. Clean conduits of dirt and debris by use of an appropriately sized steel mandrel no less than 1/2 inch smaller than the inside diameter of the conduit.

3.11 PROTECTION

A. As specified in Section 16050.

B. Provide shoring and pumping to protect the excavation and safety of workers.

C. Protect excavations with barricades as required by applicable safety regulations.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16134

BOXES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Device boxes.
   2. Raceway system boxes.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.

1.02 REFERENCES

A. As specified in Section 16050.

B. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Castings.
   2. D149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
   3. D495 - Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation.
   4. D570 - Standard Test Method for Water Absorption of Plastics.
   5. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
   6. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   7. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

C. Joint Industry Conference (JIC).

D. Underwriters Laboratories, Inc. (UL):
   1. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions:
   1. Arcing parts: Circuit breakers, motor controllers, switches, fuses, or any device intended to interrupt current during its operation.
   2. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

1.04 SYSTEM DESCRIPTION

A. Provide outlet boxes for devices such as switches, receptacles, telephone and computer jacks, security systems, junction, and pullboxes for use in the raceway systems, etc.

B. Provide boxes as indicated on the Drawings or as needed to complete the raceway installation.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Manufacturer.
   2. Materials.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
      d. Weight.
      e. NEMA rating.
   4. Conduit entry locations.
   5. Catalog cut sheets.
   6. Installation instructions.

C. Shop drawings:
   1. Include identification and sizes of pull boxes.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Regulatory requirements:
   1. Outlet boxes shall comply with all applicable standards of:
      a. JIC.
      b. NEC.
      c. NEMA.
      d. UL.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING

A. As specified in Section 16050.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Pressed steel boxes:
      a. Steel City.
      b. Appleton.
      c. Crouse - Hinds.
      d. Thomas & Betts.
   2. Plastic coated boxes:
      a. Rob Roy.
      b. OCAL.
   3. Cast device boxes:
      a. Appleton.
      b. Crouse - Hinds.
      c. OZ/Gedney.
   4. Formed steel enclosures:
      a. Hoffman.
      b. Thomas and Betts.
      c. Stahlin.
      d. Rittal.
   5. Stainless steel enclosures:
      a. Hoffman.
      b. Stahlin.
      c. Rittal.
   6. Pressed steel boxes and concrete boxes:
      a. Appleton.
      b. Steel City.
      c. Cooper/Crouse Hinds.
      d. OZ Gedney.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Pressed steel boxes:
   1. One-piece galvanized pressed steel.
   2. Knockout type boxes.
   3. Minimum size 4-inch square by 2-1/8-inch deep.

B. Concrete boxes:
   1. For outlets and pull boxes in concrete construction.
   2. Pressed steel or cast construction, concrete tight.
   3. Knockout sizes range from 1/2 inch to 1 inch.
   4. Depth as needed.
   5. Types:
      a. Four-inch octagon.
      b. Four-inch octagon ceiling boxes with hanging bars.
      c. Gangable masonry boxes:
         1) 3-1/2-inch deep, 3-3/4-inch high, length as required:
            a) 2-1/2-inch deep boxes may be used where wall thickness precludes the use of the deeper boxes.
         2) With partitions as needed.

C. Cast device boxes:
   1. Construction:
      a. With internal green ground screw.
      b. Furnished with a suitable gasketed cover.
      c. With integral cast mounting lugs when surface mounted.
      d. Conduit sizes range from 3/4 inch to 1 inch.
      e. Tapered threaded hubs with integral bushing.
   2. Malleable iron boxes:
      a. Conforming to ASTM A47 Grade 32510.

D. Plastic coated cast device boxes:
   1. Construction:
      a. With internal green ground screw.
      b. Furnished with a suitable gasketed cover.
      c. With integral cast mounting lugs when surface mounted.
      d. Conduit sizes range from 3/4 inch to 1 inch.
      e. Double coated with a nominal 0.002-inch (2 mil) urethane on both the interior and exterior before application of PVC coating.
      f. With a minimum 0.040-inch (40 mil) PVC coating bonded to exterior.
      g. With pressure sealing sleeve to protect the connection with conduit.

E. Class I Division 1 areas:
   1. Provide boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
      a. The approval ratings must be permanently marked on each item.

F. Class I, Division 2 areas:
   1. For boxes not containing arcing parts:
      a. As specified in Section 16050.
      b. Pressed metal boxes are not allowed.

2. For boxes containing arching parts provide:
    a. Boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
        1) The approval ratings must be permanently marked on each item.
3. Case iron box and cover.
4. Precision machined flame path between box and cover with neoprene o-ring.
5. Bolt-on stainless steel slotted mounting feet for horizontal or vertical mounting.
6. For applications requiring hinged cover, provide flexible hinge mounting either left or right side.
7. External flange.
8. Provisions for mounting pan.
9. Ground lug.

G. Formed steel enclosures:
1. Steel:
    a. NEMA Type 12.
    b. Fabricated from 14-gauge steel, minimum.
    c. All seams continuously welded ground smooth.
    d. Door:
        1) Rolled lip around 3 sides.
        2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
    e. Neoprene door gasket to provide a watertight, dusttight, oiltight seal:
        1) Attached with an adhesive.
        2) Retained by a retaining strip.
    f. Fabricate all external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel:
        1) With a hasp and staple for padlocking.
    g. Provide large enclosures with door and body stiffeners for extra rigidity.
    h. No holes or knockouts.
    i. Finish:
        1) ANSI-61 gray electrostatically applied polyester powder inside and out over cleaned and primed surfaces.
        2) White electrostatically applied polyester powder mounting plate.
    j. Heavy gauge steel external mounting brackets when surface mounted.
2. Stainless steel:
    a. NEMA Type 4X:
        1) Boxes in locations subject to flooding or temporary submersion:
            a) NEMA Type 6.
    b. Fabricated from 14-gauge Type 316 stainless steel.
    c. All seams continuously welded.
    d. Door:
        1) Rolled lip around 3 sides.
        2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
    e. Neoprene door gasket to provide a watertight seal:
        1) Attached with an adhesive.
        2) Retained by a retaining strip.
    f. Fabricate all external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
        1) With a hasp and staple for padlocking.
    g. Provide large enclosures with door and body stiffeners for extra rigidity.

h. No holes or knockouts.
i. Finish:
1) Brushed.
j. Stainless steel external mounting brackets when surface mounted.

H. Cast iron junction boxes:
1. NEMA Type 4.
2. Recessed cover boxes.
3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
4. Designed for flush mounting in walls or floors:
a. Can be surface mounted using mounting lugs.
5. Construction:
a. Cast iron box.
b. Covers:
1) Checkered plate covers suitable for foot traffic.
2) When used in areas subject to vehicular traffic H-20 loading.
c. Hot dip galvanized.
d. Neoprene gasket.
e. Stainless steel screw covers.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Fasteners:
1. Electroplated or stainless steel in boxes with wiring devices.
2. Screws, nuts, bolts, and other threaded fasteners:
a. Stainless steel.

B. Provide breather and drain fittings where appropriate.

C. Internal panels:
1. Provide internal panels where required for mounting of terminal strips or other equipment.
2. With plated steel shoulder studs.
3. Steel with white polyester powder finish.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. General:
   1. Provide materials and construction suitable for environmental conditions at the location of the box as specified in Section 16050.
   2. Provide outlet box materials to match the conduit system:
      a. GRC - Cast ferrous boxes.
      b. PCS - PVC coated cast ferrous boxes.
   3. Solid type gang boxes:
      a. For more than 2 devices.
      b. For barriered outlets.
   4. Support all wall mounted NEMA Type 4 or NEMA Type 4X boxes to maintain a minimum of 7/8-inch free air space between the back of the enclosure and the wall:
      a. Use machined spacers to maintain air space; built-up washers are not acceptable.
      b. Use stainless steel or nylon materials for spacers.
   5. Use cast malleable iron boxes when box must support other devices.
   6. Boxes serving luminaires or devices:
      a. Use as pull boxes wherever possible.
   7. Fit all cast boxes and pressed steel boxes for flush mounting in concrete with cast, malleable box covers and gaskets.
   8. In terminal boxes, furnish terminals as indicated on the Drawings, with a minimum of 50 percent spare terminals:
      a. Furnish wireways for discrete and analog/DC wiring.
      b. Separate analog wiring from 120 V discrete or power wiring.
   9. Size boxes in accordance with NEC requirements and to provide sufficient room for the future components and cables indicated on the Drawings.
   10. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.

C. Outlet boxes:
   1. Locate outlet boxes as indicated on the Drawings:
      a. Adjust locations so as not to conflict with structural requirements or other trades.
   2. Use deep threaded-hub malleable iron or aluminum boxes:
      a. In hazardous areas.
      b. Where exposed to the weather.
      c. In unheated areas.
      d. Where subject to mechanical damage:
         1) Defined as exposed boxes less than 10 feet above the floor.
      e. To act as a pull box for conductors in a conduit system.
      f. Accommodate wiring devices.

3. Use deep threaded-hub plastic coated malleable iron boxes in corrosive and NEMA Type 4X area and when the conduit system is PVC coated steel.
4. Outlet boxes may be used as junction boxes wherever possible.

D. Pull boxes and junction boxes:
1. Size pull boxes in accordance with NEC requirements and to provide sufficient room for any future conduits and cables as indicated on the Drawings.
2. Install pull boxes such that access to them is not restricted.

E. For boxes not indicated:
1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system and environmental conditions as indicated in Section 16050.
2. Outlet, switch, and junction boxes for flush-mounting in general purpose locations:
   a. One-piece, galvanized, pressed steel.
3. Ceiling boxes for flush mounting in concrete:
   a. Deep, galvanized, pressed steel.
4. Outlet, switch, and junction boxes where surface mounted in exposed locations:
   a. Cast ferrous boxes with mounting lugs, zinc or cadmium plating finish.
5. Outlet, control station, and junction boxes for installation in corrosive locations:
   a. Fiberglass reinforced polyester, stainless steel, or plastic coated steel to match the conduit system.
   b. Furnished with mounting lugs.
6. Fire rated construction: Use materials and methods to comply with the listing requirements for the classified construction.

F. Hazardous locations:
1. All metallic boxes, fittings, and joints shall utilize threaded connections to the conduit system.
2. All threaded connections shall be wrench tightened so that at least 5 threads are fully engaged.
3. Conduits entering and exiting metallic boxes in Class I Division 2 areas shall utilize approved grounding bushings to bond the conduits together.
4. Provide the following types of conduit bodies and boxes:
   a. Malleable iron bodies and boxes with GRC or IMC conduit systems.
   b. PVC coated conduit bodies and boxes with PCS conduit systems.
   c. Aluminum conduit bodies and boxes with ARC conduit systems.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Switches.
   2. Receptacles.
   3. Plates.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.

1.02 REFERENCES

A. As specified in Section 16050.

B. Federal Specifications (FS):
   1. W-C 596 - Connector, Electrical, Power, General Specification for.
   2. W-S 896/2 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

C. National Electrical Manufacturers Association (NEMA):
   1. WD1 - General Color Requirements for Wiring Devices.
   2. ICS 5 - Industrial Control and Systems, Control Circuit and Pilot Devices.
   3. OS1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
   4. WD6 - Wiring Devices Dimensional Specifications.

D. Underwriters Laboratories Inc. (UL):
   1. 20 - General Use Snap Switches.
   2. 498 - Standard for Attachment Plugs and Receptacles.
   3. 514D - Cover Plates for Flush-Mounted Wiring Devices.
   4. 943 - Ground-Fault Circuit-Interrupters.
   5. 1472 - Solid State Dimming Controls.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions:
   1. GFCI: Ground fault circuit interrupter.

1.04 SYSTEM DESCRIPTION

A. Switches, receptacles, and plates as indicated on the Drawings wired and operable to form a complete system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Catalog cut sheets.

C. Shop drawings:
   1. Engraving schedule:
      a. Furnish complete engraving schedule for engraved nameplates.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Wiring devices shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switches:
   1. One of the following or equal:
      a. Hubbell.
      b. Leviton.
      c. Cooper Wiring Devices.

2. Switches for hazardous areas: One of the following or equal:
    a. Appleton.
    b. Crouse-Hinds.

B. Receptacles:
1. General purpose receptacles: One of the following or equal:
    a. Hubbell.
    b. Leviton.
    c. Cooper Wiring Devices.
2. Receptacles for hazardous areas: One of the following or equal:
    a. Crouse-Hinds.
    b. Appleton.

C. Plates:
1. General location: The following or equal:
    a. Pass and Seymour.
    b. Cooper Wiring Devices.
2. Wet or corrosive areas: One of the following or equal:
    a. Hubbell.
    b. Cooper Wiring Devices.
    c. Thomas and Betts.
    d. Pass and Seymour.
3. In-use covers: One of the following or equal:
    a. TayMac.
    b. Cooper Wiring Devices.
    c. Pass and Seymour.
    d. Thomas and Betts.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Switches:
1. General:
    a. 120-277 VAC.
    b. 20 ampere.
    c. Listed in accordance with UL 20.
    d. Designed and constructed in accordance with FS W-S-896/2.
    e. Back and side wired unless otherwise indicated.
    f. Integral grounding terminal.
    g. Totally enclosed:
        1) Color-coded body with color corresponding to ampere rating.
    h. Provide switches with the operator style and contact arrangement as indicated on the Drawings and as required for proper operation.
    i. Color:
        1) Ivory in finished areas.
        2) Brown in all other areas.
2. General purpose switches:
    a. Toggle type.

3. Switches for use with photocell:
    a. Maintained contact.
    b. Two circuit.
    c. Three position:
        1) Center off.
4. Switches for hazardous areas:
    a. Suitable for use in Class I Division 1 and Class I Division 2 locations.
    b. Factory sealed.
    c. Through-feed or dead-end as required.

B. Receptacles:
1. General purpose receptacles:
    a. Single or duplex as indicated on the Drawings.
    b. 125 VAC.
    c. 20 ampere or as indicated on the Drawings.
    d. NEMA Type 5-20R configuration for 20 ampere receptacles.
    e. Other NEMA configurations as indicated on the Drawings.
    f. Listed in accordance with UL 498.
    g. Designed and constructed in accordance with FS W-C-596.
    h. Back and side wired.
    i. One-piece, rivet-less mounting strap.
    j. Color:
        1) Ivory in finished areas.
        2) Brown in all other areas.
        3) Orange when powered by a UPS.
2. Ground fault interrupter receptacles (GFCI):
    a. 125 VAC.
    b. 20 ampere.
    c. Trip level 4-6 milliampere.
    d. Individual and feed through protection.
    e. UL 943 and UL 498 listed.
    f. NEMA Type 5-20R configuration.
    g. For damp or wet locations:
        1) Weather resistant, in accordance with UL 498.
3. Receptacles for hazardous areas:
    a. 125 VAC.
    b. 20 ampere.
    c. Factory sealed.
    d. Single receptacle.
    e. 2-wire, 3-pole.
    f. Grounded through extra pole and shell.
    g. Dead-front construction.
    h. Interlocked to prevent plug from being withdrawn until circuit has been broken.

C. Plates:
1. General location:
    a. Type 302 or 304 stainless steel.
    b. Brushed satin finish.
    c. Minimum thickness: 0.032 inches.
    d. Rectangular or square shape.

e. Engraving:
    1) Engrave each switch plate with the following:
        a) Area served.
        b) Panelboard and Circuit.
    2) Engrave each receptacle plate with the following:
        a) Panelboard and Circuit.
    3) Treat engraving to improve visibility.
    4) Characters shall be block letter pantograph engraved with a minimum character height of 1/8-inch.
f. Coordinate the number of gangs, number, and type of openings with the specific location.

2. Outdoor and wet areas requiring NEMA Type 4 or NEMA Type 4X enclosures:
    a. General:
        1) UL listed for wet locations.
        2) Gasketed.
        3) Die cast metal:
            a) Match material to box material.
    b. Switches:
        1) Lever operated:
            a) Provide toggle switch.
    c. Receptacles:
        1) Weather proof in-use cover:
            a) Die cast metal construction with electrostatic powder coating for corrosion resistance.
            b) Gasketed.
            c) Lockable.
            d) UL listed and in accordance with NEC.
3. Corrosive areas:
    a. Neoprene.
    b. Gasketed.
    c. Weatherproof.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Mounting heights:
   1. Process and production areas:
      a. Switches and receptacles 48 inches from finished floor to top of plate.
   2. Offices and finished areas:
      a. Switches: 48 inches from finished floor to top of plate.
      b. Receptacles: 18 inches from finished floor to center of plate.

C. Switches:
   1. Over 300 Volts:
      a. Where switches used in systems of more than 300 volts between conductors, are to be ganged in outlet boxes, provide switches having no exposed live parts or use barriers between the individual switches.

D. Receptacles:
   1. Provide GFCI receptacles as indicated on the Drawings:
      a. Provide weather resistant GFCI receptacles in all wet or damp areas:
         1) As specified in Section 16050.
   2. Mount non-weatherproof receptacles vertically:
      a. Ground slot down.
   3. Mount weatherproof receptacles horizontally:
      a. Neutral slot up.
   4. 3-phase receptacles shall be consistent with respect to phase connection at the receptacle terminals. Correct errors in phasing at the source and not the receptacle.

E. Ensure all plates make a firm seal with wall for recessed mounted devices:
   1. Outside edges of plates parallel with building lines.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16150

LOW VOLTAGE WIRE CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Wire connecting devices.
   2. Terminations.
   3. Splices.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16123 - 600-Volt or Less Wires and Cables.

1.02 REFERENCES

A. As specified in Section 16050.

B. ASTM International (ASTM):
   1. D3005 – Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

C. CSA International (CSA):
   1. C22.2 - No.197-M1983 (R2208) - PVC Insulating Tape.

D. Underwriters Laboratories, Inc. (UL):
   1. 510 - Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Provide a complete system of wiring connectors, terminators, fittings, etc. for a complete wiring system suitable for the cables and conductors used.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Catalog cut sheets.
   2. Installation instructions.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. All materials shall be UL listed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers for each type of technology are specified with the equipment in this Section.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Control connections:
   1. Use insulated ring type wire terminators for connections to all screw terminals:
      a. With chamfered/funneled terminal barrel entry.
      b. Deep internal serrations.
      c. Long barrel design to reduce electrical resistance and increased insulator-barrel surface area to ensure that the insulator remains in contact with the barrel.

d. Electroplated-tin copper conductor.
e. Manufacturer: The following or equal:
1) Thomas and Betts, Stakon.
2. For process equipment connections work from manufacturer's drawings.

B. Joints, splices, taps, and connections:
1. 600-volt conductors:
a. Use solderless connectors.
b. Use only plated copper alloy connectors or lugs:
1) Aluminum connectors or lugs are not acceptable for copper conductors.
c. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
d. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps:
1) Manufacturer: The following or equal:
a) Buchanan 2006S or 2011S, with 2007 or 2014 insulating caps.
e. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
1) Manufacturer: One of the following or equal:
a) Burndy.
b) Thomas and Betts.
f. Heat shrink tubing:
1) Suitable for indoors, outdoors, overhead, direct burial or submerged applications.
2) Minimum shrink ratio: 4 to 1.
3) Continuous operating temperature: -55 degrees Celsius to 110 degrees Celsius.
4) Internally applied adhesive sealant.
5) Cross-linked polyolefin:
a) Manufacturers, one of the following or equal:
(1) 3M ITCSN.
(2) Thomas & Betts Shrink-Kon.
2. Instrumentation class cable splices:
a. Suitable for indoor, outdoors, weather exposed, direct buried, or submersed applications.
b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kilovolt.
d. Two-part mold body with tongue and groove seams and built in spacer webbing.
e. Manufacturer: The following or equal:
1) 3M - Scotchcast 72-N.

C. Insulating tape:
1. General purpose insulating tape:
a. Minimum 7 mil vinyl tape.
b. Suitable for application in an ambient of -18 degrees Celsius (0 degrees Fahrenheit).
c. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
d. Flame retardant, hot- and cold- weather resistant, UV resistant.

e. For use as a primary insulation for wire cable splices up to 600 VAC.
f. Meeting and complying with:
   1) ASTM D3005 Type I.
   2) UL 510.
   3) CSA C22.2.
g. Manufacturer: The following or equal:
   1) 3M - Scotch Number Super 33+.

2. General-purpose color-coding tape:
   a. Minimum 7 mil vinyl tape.
   b. Suitable for application on PVC and polyethylene jacketed cables.
   c. For use indoors and outdoors in weather protected enclosures.
   d. Available with the following colors:
      1) Red.
      2) Yellow.
      3) Blue.
      4) Brown.
      5) Gray.
      6) White.
      7) Green.
      8) Orange.
      9) Violet.
   e. For use as phase identification, marking, insulating, and harnessing.
   f. Meeting and complying with:
      1) UL 510.
      2) CSA C22.2.
   g. Manufacturer: the following or equal:
      1) 3M - Scotch Number 35.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Load connections:
   1. Connect loads to the circuits as indicated. Color-code all branch circuits as specified in Section 16123.

C. Zero to 600-volt systems:
   1. Make all connections with the proper tool and die as specified by the device manufacturer.
   2. Use only tooling and dies manufactured by the device manufacturer.
   3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
   4. Number all power and control wires before termination.

D. Motor connections (600 volts and below):
   1. Terminate wires with compression type ring lugs at motors.
   2. Connection at both the motor leads and the machine wires shall have ring type compression lugs.
   3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
      a. In damp and wet locations, use a complete kit containing mastic that shall seal out moisture and contamination.
      b. Shrink cap with low heat as recommended by manufacturer.
   4. Wire markers shall be readable after boot installation.
   5. Manufacturer: The following or equal:
      a. Raychem MCK.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16222

LOW VOLTAGE MOTORS UP TO 500 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motors up to 500 horsepower.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16950 - Field Electrical Acceptance Tests.

1.02 REFERENCES

A. As specified in Section 16050.

B. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. American Petroleum Institute (API):
   1. 670 - Vibration, Axial Position, and Bearing Temperature Monitoring Systems.

D. ASTM International (ASTM):
   1. B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

E. Institute of Electrical and Electronic Engineers (IEEE):
   1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   2. 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
   3. 114 - Standard Test Procedure for Single-Phase Induction Motors.
   4. 303 - Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations.
   5. 841 - Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).
   6. 1349 - Guide for Application of Electric Motors in Class I, Division 2 Hazardous (Classified) Locations.

F. National Electrical Manufacturers' Association (NEMA):
   1. MG-1 - Motors and Generators.
   2. MG-2 - Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators.

G. Underwriters Laboratories Inc. (UL):
   1. 674 - Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Furnish and install electric motors and accessories as specified in this Section and the Sections specifying driven equipment to provide a complete and operable installation.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Submit completed motor data sheets for each motor supplied:
   1. Conform to data sheet in the appendix of this Section.
   2. Manufacturer's or other data sheets are not acceptable.

C. Product data:
   1. Descriptive bulletins.
   2. Machine tag and loop number as indicated on the Drawings and in the specification section number of the driven machine.
   3. Complete electrical data.
   4. Torque, current, and power factor vs. speed curves:
      a. At 100 percent rated voltage for all full voltage started and VFD driven motors.
      b. For motors on reduced voltage start at 70, 80, 90 and 100 percent rated voltage.
   5. Accessories data:
      a. Power factor correction capacitors:
         1) Size in KVAR, for all motors not connected to variable frequency drives.
      b. Motor winding heaters:
         1) Voltage.
         2) Watts.
      c. Winding temperature detectors:
         1) Type.
         2) Rating.
      d. Moisture detectors.
   6. Mechanical data:
      a. Bearing design and bearing life calculations.
      b. Resonant frequencies for all VFD-driven motors 50 horsepower or greater.

D. Shop drawings:
   1. Motor weight.
   2. Frame size.
   3. Conduit box(es), size(s), and location(s).

4. Outline drawings with dimensions.
5. Installation details for the project seismic criteria.

E. Test reports:
1. Factory test reports with test reference standard identified.

F. Certification:
1. When motors are driven by variable speed drive systems, submit certification that selected motor:
a. Is capable of satisfactory performance under the intended load.
b. Meets the requirements of the latest edition of NEMA MG-1 Part 31.

G. Calculations:
1. Where site conditions specified in Section 16050 exceed manufacturer's ratings, provide derating calculations for each motor.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTION (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
1. US Motors.
2. General Electric.

3. Reliance.
4. Toshiba.
5. Baldor.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. 3-phase induction motors - general:
   1. Voltage:
      a. All motors 1/2 hp and larger shall be rated 460 V, 3 phase unless otherwise indicated on the Drawings.
      b. Dual voltage motors rated 230/460 V, 3 phase are acceptable provided all leads are brought to the conduit box.
   2. Motors driving identical machines shall be identical.
   3. All motors greater than 1 hp and up to 500 hp shall meet the “NEMA Premium Efficiency” percent listed in NEMA MG-1.
   4. Horsepower as indicated on the Drawings:
      a. Horsepower ratings indicated on the Drawings are based on vendor’s estimates. Provide motors sized for the load of the actual equipment furnished without operating in the service factor.
   5. Service factor:
      a. 1.15 service factor on sine wave power.
      b. 1.0 when driven by VFD.
   6. Torque:
      a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
      b. When started using reduced voltage starters:
         1) Provide motors that develop sufficient torque for acceleration to full speed.
      c. NEMA Design B except where driven load characteristics require other than normal starting torque:
         1) In no case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
   7. Enclosures:
      a. As specified in the individual equipment Specifications or in this Section.
      b. Totally enclosed fan cooled:
         1) Cast iron conduit box.
         2) Tapped drain holes with Type 316 stainless steel plugs for frames 286 and smaller, and automatic breather and drain devices for frames 324 and larger.
      c. Explosion-proof:
         1) Tapped drain holes with corrosion resistant plugs for frames 286 and smaller and automatic breather and drain devices for frames 324 and larger.
      d. Lifting devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.

8. Manufactured with cast iron frames in accordance with NEMA MG-1 or manufacturer's standard material for the specified rating.
9. Nameplates:
    a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
        1) NEMA standard motor data:
            a) Indicate compliance with NEMA MG-1 Part 31 for inverter duty motors.
        2) AFBMA bearing numbers and lubrication instructions.
10. Hardware:
    a. Type 316 stainless steel.
11. Conduit boxes:
    a. Cast iron or stamped steel.
    b. Split from top to bottom.
    c. Provide gaskets at the following interfaces:
        1) Frames and conduit boxes.
        2) Conduit boxes and box covers.
    d. Rotatable through 360 degrees in 90-degree increments:
        1) Where available based on the size of the conduit box.
    e. Exceeding the dimensions defined in NEMA MG-1.
    f. Provide grounding lugs inside conduit boxes for motor frame grounding.
12. Motor bearings:
    a. Antifriction.
    b. Regreasable and initially filled with grease for horizontal motors, vertical motors per manufacturer's standard design.
    c. Bearings and lubrication suitable for ambient temperature and temperature rise.
    d. Suitable for intended application and have ABMA L-10 rating life of 60,000 hours or more.
    e. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
    f. Where specified in the equipment Specifications, provide split-sleeve type hydrodynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.
13. Insulation systems:
    a. Motors installed in ambient temperatures 40 degrees Celsius or less:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 40 degrees Celsius at the altitude where the motor will be installed.
    b. Motors installed in ambient temperatures between 40 degrees Celsius and 50 degrees Celsius:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 50 degrees Celsius at the altitude where the motor will be installed.
14. Motor leads:
    a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
15. Noise:
    a. Maximum operating noise level in accordance with NEMA MG-1.

B. Submersible motors:
   1. Enclosures:
      a. Totally enclosed non-ventilated (TENV) watertight casing.
      b. Inner and outer shaft seals separated by an oil chamber.
   2. Cooling:
      a. Suitable for continuous operation in totally, partially or nonsubmerged condition without overheating.
      b. Convection cooling by the surrounding environment or pump cooling by circulating a portion of the pumped media through a cooling water jacket as recommended by the manufacturer based on horsepower and application.
   3. Electrical cables:
      a. Wire unit without splices. Coordinate with Contractor to ensure cables of adequate length.
      b. Epoxy encapsulated cable entry into terminal box.
   4. Insulation:
      a. Sealed moisture resistant windings.
      b. Class H.
   5. Motor protection:
      a. Provide temperature detection in motor windings.
      b. Provide moisture detection in motor housing.
      c. Other detection and protection functions specified in the in the driven equipment Section.

C. Motors driven by variable frequency drives:
   1. Compatible with the variable frequency drives specified.
   2. Inverter duty rated and labeled.
   3. Meet the requirements of NEMA MG-1 Part 31.
   4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
   5. Capable of running continuously at 1/10th of full speed, with no harmful effects or overheating.
   6. Shaft grounding ring:
      a. Provide a shaft grounding ring for each VFD driven motor.
      b. Aluminum frame and internal components.
      c. Conductive microfiber brushes.
      d. Maintenance free design.
      e. Aegis Bearing Protection ring as manufactured by Electro Static Technology or equal.
   7. On motors over 100 HP, provide insulated bearings on bearings on both ends of the motor or on the end opposite of the shaft ground ring as recommended by the motor manufacturer.

D. Motors installed in corrosive environments:
   1. Stator double dipped in varnish and baked.
   2. Stator and rotor coated with corrosion resistant epoxy.
   3. Frame, brackets, fan guard and conduit box coated with minimum of 2 coats of epoxy paint.
   4. Withstand salt spray tests in accordance with ASTM B117.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Motor winding heaters:
   1. Provide all 3 phase motors with belted or cartridge space heaters mounted within the motor enclosure.
   2. Space heater rating shall be 120 volts, single-phase, unless otherwise indicated on the Drawings.
   3. Power leads for heaters wired into conduit box.
   4. Installed within motor enclosure adjacent to core iron.

B. Winding temperature detectors:
   1. Temperature switches with normally closed contacts as indicated on the Drawings.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install motors in accordance with manufacturer's instructions.

C. Install shaft grounding ring on VFD driven motors in accordance with the manufacturer’s instructions.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING AND PROCESS START-UP

A. As specified in Section 01756.

B. Factory testing:
   1. Motors less than 250 horsepower:
      a. Perform manufacturer's standard production tests including but not limited to:
         1) No load current.
         2) High potential test.
         3) Winding resistance.
      b. Furnish copies of standard test reports on prototype or identical units.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

B. Before start-up, perform insulation resistance test on each motor furnished or installed on this project:
   1. Windings energized to 1,000 volts DC for 1 minute.
   2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
   3. Inform the Engineer of any unusual or unacceptable test results.
   4. This test is in addition to the acceptance tests in Section 16950.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

END OF SECTION

MOTOR DATA SHEET

MOTOR/ EQUIPMENT TAG _____ MOTOR NUMBER _____

SPECIFICATION NUMBER OF DRIVEN MACHINE _____

MOTOR NAMEPLATE DATA

MANUFACTURER _____ MODEL/SERIES _____ MODEL NO. _____

FRAME _____ ENCLOSURE _____ NEMA DESIGN _____

HP _____ SERVICE FACTOR _____ RPM _____

INSULATION CLASS _____ VOLTS _____ FULL LOAD AMPS _____

AMBIENT TEMP _____ PHASE _____ NO LOAD AMPS _____

DESIGN TEMP _____ HERTZ _____ LOCK ROTOR AMPS _____

INRUSH CODE LETTER _____

	100% LOAD	75% LOAD	50% LOAD
GUARANTEED MINIMUM EFFICIENCIES:			
GUARANTEED MINIMUM POWER FACTOR:			

MAXIMUM SIZE OF POWER FACTOR CORRECTION CAPACITOR: _____ KVAR

ACCESSORIES

MOTOR WINDING HEATER _____ VOLTS _____ WATTS

WINDING THERMAL PROTECTION

WINDING TEMP SWITCHES (YES/NO) _____

RTD:

TYPE _____ QUANTITY PER PHASE _____ # OF WIRES _____

NOMINAL RESISTANCE _____ NOMINAL TEMP _____ COEFFICIENT _____

RECOMMENDED ALARM _____ DEGREES CELSIUS RECOMMENDED TRIP _____ DEGREES CELSIUS

SPECIAL APPLICATIONS

INVERTER DUTY* (YES/NO) _____ PART WINDING (YES/NO) _____ WYE - DELTA (YES/NO) _____

2 SPEED, 1 WINDING (YES/NO) _____ 2 SPEED, 2 WINDING (YES/NO) _____

AREA CLASSIFICATION:

CLASS _____ DIVISION _____ GROUP _____ TEMP CODE _____

* Conforms to NEMA MG-1 Part 31.

SECTION 16262

VARIABLE FREQUENCY DRIVES 0.50 – 50 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Variable frequency drives (VFD) 0.5 to 50 horsepower for control of NEMA Design B squirrel cage induction motors.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16222 - Low Voltage Motors Up To 500 Horsepower.

1.02 REFERENCES

A. As specified in Section 16050.

B. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems - Requirements.

C. National Electrical Manufacturers Association (NEMA):
   1. MGI, Part 31 – Motors with higher peak voltage capability.

D. Underwriters' Laboratories (UL):
   1. 508A - Standard for Safety for Industrial Control Panels.
   2. 508C - Standard for Power Conversion Equipment.
   3. 845 - Standard for Motor Control Centers.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions:
   1. Point of common coupling: the point of common coupling for all harmonic calculation and field measurements for both voltage and current distortions is defined as the closest directly connected bus supplying power to the VFD.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Each VFD system consists of all components required to meet the performance, protection, safety, testing, and certification criteria of this Section.

2. The VFD system:
    a. Is a fully integrated package.
    b. Includes all material necessary to interconnect all VFD system elements, even if shipped separately.
3. Coordinate bearing protection methods with the supplier of the driven equipment.

B. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer:
1. Each VFD shall be completely factory pre-wired, assembled, and then tested as a complete system by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
2. The VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics based upon the installed conditions:
    a. Provide equipment necessary to mitigate potential damage to motor insulation.
    b. Motors as specified in Section 16222.

C. Performance:
1. Operating envelope:
    a. Speed and torque requirements:
        1) Provide a variable torque or constant torque VFD as required by the driven load.
        2) The VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 200 percent (25 to 120 hertz) speed range.
    b. Current requirements:
        1) Full rated current output on a continuous basis.
        2) Variable torque VFD:
            a) Minimum 110 percent current overload for 1 minute.
2. Minimum VFD system efficiency:
    a. Ninety-six percent when operating at the rated kW output.
    b. VFD system efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \text{ x } 100$$

Power (Load) is the total power measured at the output terminals of the drive system, including VFD, output filters or transformers. Power (Supply) is the total power measured at the input terminals of the VFD including input filters, line reactors, isolation transformers, harmonic distortion attenuation equipment and auxiliary equipment (e.g., controls, fans) for complete system operation.

3. Total power factor:
    a. Minimum of 0.96 lagging across the entire speed range.
    b. At no speed shall the VFD have a leading power factor.
4. Frequency accuracy:
    a. Minimum of within 0.01 percent.
5. Speed regulation:
    a. Minimum of within 0.5 percent across the entire speed range.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050:
   1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.

B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
      d. Weight.
   4. Nameplate schedule.
   5. Bill of material.
   6. Ratings:
      a. Voltage.
      b. Phase.
      c. Input current.
      d. Output current.
      e. Interrupting rating.
      f. Momentary current rating.
   7. List of recommended spare parts.
   8. Catalog cut sheets for major components.
   9. Design data:
      a. Efficiency and power factor values.
      b. Certification that the drive is sized for the full nameplate motor horsepower and current of the driven load at the installed altitude and ambient temperature.
      c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
      d. Certification that all electronic circuits and printed circuit boards are conformally coated.
   10. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050:
      a. Manufacturer’s statement of seismic qualification with substantiating test data.
      b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop drawings:
   1. Complete plan and elevation drawings showing:
      a. All dimensions.
      b. Panel, sub-panel and component layout indexed to the bill of material.
      c. Conduit connections.
   2. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.

3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
    a. Include terminal number and wire numbers.
4. Complete single-line and 3-line diagrams including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
    a. Clearly indicate device electrical ratings on the drawings.

D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. For equipment installed in structures designated as seismic design category C, D, E, or F:
    a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050.
    b. Submit anchoring drawings with supporting calculations.
    c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

E. Operation and maintenance manuals:
1. Spare parts list with supplier names and part numbers.
2. Startup and commissioning instructions and data.
3. Operating manuals:
    a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
4. Operating instructions:
    a. Written descriptions detailing the operational functions of all controls on the front panel.
5. Maintenance manual:
    a. Furnish maintenance manuals with instructions covering all details pertaining to care and maintenance of all equipment as well as identifying all parts.
    b. Manuals shall include, but are not limited to the following:
        1) Adjustment and test instructions covering the steps involved in the initial test, adjustment and start-up procedures.
        2) Detailed control instructions which outline the purpose and operation of every control device used in normal operation.
        3) All schematic wiring and external diagrams:
            a) Furnish drawings in a reduced 11-inch by 17-inch format that are fully legible at that size.

F. Test forms and reports:
1. Submit complete factory acceptance test procedures and all forms used during the test.

G. Manufacturer’s Certificate of Installation and Functionality Compliance.

H. Manufacturer's field reports:
   1. Report listing the setting of all VFD adjustable parameters and their values after start-up.

I. Record Documents:
   1. Certified Record Documents of equipment with information listed above.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Qualifications:
   1. Any third party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
   2. VFDs shall be UL 508C listed and labeled:
      a. UL 508C for individual units.
      b. UL 508A for VFD systems in control panels.
      c. UL 845 for VFD systems in motor control centers.
   3. Variable frequency drives shall be manufactured by the VFD manufacturer at its own facility which shall have a quality assurance program that is certified in conformance with ISO 9001.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

B. Ship the VFDs and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on site off-loading equipment:
   1. VFDs shall be delivered to the site preassembled and wired.

C. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING

A. Conduct factory acceptance test and submit certified test results for Engineer's review.

B. Ship equipment to project site after successful completion of factory acceptance test.

C. Assemble equipment in the field.

D. Conduct field acceptance test and submit results for Engineer's review.

E. Submit Manufacturer's of Installation and Functionality Compliance.

F. Conduct Owner's training sessions.

G. Commissioning and process start-up as specified in Section 01756.

1.10 SCHEDULING

A. As specified in Section 16050.

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

B. The VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer and Owner.

1.13 OWNERS INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Spare parts:
   1. The following spare parts shall be furnished:
      a. One complete VFD of each size furnished.
      b. Any special dedicated tools for emergency service and troubleshooting.
      c. All hardware and software required for configuration, maintenance, troubleshooting and inquiry of all drive parameters.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Eaton/Cutler-Hammer.
   2. Allen-Bradley.
   3. Toshiba.
   4. Siemens-Robicon.
   5. Schneider Electric/Square D.
   6. General Electric.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. Sinusoidal pulse width modulated (PWM) type drive:
      a. Six-pulse insulated gate bipolar transistor (IGBT) power section.
      b. Microprocessor based controls.
      c. Line and load reactors.

B. Ratings:
   1. Voltage:
      a. Input voltage as indicated on the Drawings.

C. Operational features:
   1. Protective features:
      a. Provide the following minimum protective features:
         1) Motor overload protection.
         2) Instantaneous overcurrent.
         3) Instantaneous overvoltage.
         4) Undervoltage.
         5) Power unit overtemperature.
         6) Phase loss.
         7) VFD output short circuit.
   2. Control mode:
      a. Operation in either a constant volts/hertz or sensorless vector mode:
         1) The control mode selectable using the programming keypad.
   3. Frequency control:
      a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
      b. Programmable minimum frequency.
      c. Programmable maximum frequency.
   4. Acceleration/deceleration:
      a. Separately adjustable acceleration and deceleration rates:
         1) Each rate adjustable from 0.01 to 1,800 seconds.
   5. Spinning load:
      a. The VFD shall be capable of determining the speed and direction of a spinning load, “catch” the load and accelerate or decelerate it without damage to the load.
   6. Programmable loss of signal:
      a. Upon loss of speed reference the VFD shall be programmable to either:
         1) Stop.
         2) Maintain current speed.
         3) Default to pre-selected speed.
   7. Power interrupt ride-through:
      a. The VFD shall be capable of continuous operation in the event of a power loss of 5 cycles or less.
   8. Inputs/Outputs:
      a. Manufacturer’s standard number the following:
         1) Analog inputs:
            a) Configurable as either 0 to 10 volts or 4 to 20 milliamperes.
         2) Analog outputs:
            a) Programmable 4 to 20 milliamperes isolated.
         3) Discrete inputs:
            a) Programmable.

4) Discrete outputs:
a) Programmable.
b) Form C relay contacts.
5) Potentiometer 3-wire input.
b. Provide additional inputs/outputs as required to meet the control functions indicated on the Drawings.
9. Diagnostics:
a. Store a minimum of 4 fault conditions in non-volatile memory on a first in-first out basis.
b. Operational parameters stored at the time of a the fault:
1) Operating frequency.
2) Drive status.
3) Power mode.
c. Fault memory accessible via RS-232, RS-422 or RS-485.
10. Automatic restart:
a. User selectable automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
1) Programmable for up to 9 restart attempts.
2) Adjustable time delay between restart attempts.

2.06 COMPONENTS

A. Enclosure:
1. Wall or floor-mounted: NEMA 1.
2. Motor control center.
3. Provide cooling devices required to maintain the VFD within the manufacturer's specified temperature limits for the Project conditions:
a. Provide cooling device failure alarm.

B. Power disconnect:
1. Flange mounted motor circuit protector, MCP.
2. Lockable in the OFF position.

C. Reactors:
1. Line reactors: 3 percent input and 3 percent output.

D. Keypad:
1. Provide each VFD with a keypad for programming and control.
2. Keypad requirements:
a. Password security to protect drive parameters.
b. Mounted on the door of the motor control center.
c. Back-lit LCD:
1) Minimum of 2 lines with a minimum of 16 characters per line.
d. Programming and display features language: English.
e. Capable of displaying the following parameters:
1) Speed (percent).
2) Output current (amperes).
3) Output frequency (hertz).
4) Input voltage.
5) Output voltage.
6) Total 3-phase kilowatt.

7) Kilowatt-hour meter.
8) Elapsed run time meter.
9) Revolutions per minute.
10) Direct current bus voltage.

3. In addition to all keys required for programming, provide the following controls on the keypad:
   a. Auto/manual selector.
   b. Start pushbutton.
   c. Stop pushbutton.
   d. Jog pushbutton.
   e. Speed increment.
   f. Speed decrement.
   g. Forward/reverse selector.
   h. Run LED indicator.
   i. Program LED indicator.
   j. Fault LED indicator.
4. Provide the VFD with the hardwired controls as indicated on the Drawings.

E. Control power transformer:
   1. Furnish a control power transformer mounted and wired inside the VFD enclosure.
   2. With primary and secondary fusing.
   3. Sized to power all VFD controls and options as well as any external devices indicated on the Drawings including the motor winding heater.

2.07 ACCESSORIES

A. Metal oxide varistors:
   1. Provide protection for the VFD against:
      a. Line transients: 5,000 volt peak minimum.
      b. Line to ground transients: 7,000 peak minimum.

B. Output filters:
   1. dV/dT filters.

C. Conformal coating:
   1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as a protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories needed to complete the installation of the VFD (free-standing or within motor control center).
   2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
   3. Perform work in accordance with manufacturer's instructions and shop drawings.
   4. Furnish components and equipment as required to complete the installation.
   5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
   6. Install free-standing enclosures on 3-1/2 inch raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
      b. Weld and/or bolt the VFD frame to the leveling channels.
   7. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.
   8. Bundle circuits together and terminate in each unit:
      a. Tie with nylon wire ties.
      b. Label all wires at each end with wire numbers shown on the approved control drawings.
      c. All connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. Source testing (Factory Acceptance Tests):
   1. Owner and Engineer will witness the Factory Acceptance Test as specified in Section 16050.
   2. General:
      a. Incoming inspection of components and raw materials based on strategic supplier base and experience.
      b. All VFDs furnished under this Section shall be tested and inspected as specified below. Testing of VFDs based on sampling plans is not allowed.
      c. The testing procedures specified are the minimum acceptable requirements. The manufacturer may perform additional tests at its discretion.
   3. Failure of any component during testing requires repair of the faulted component and complete retest.
   4. Tests:
      a. Perform manufacturer's standard factory acceptance tests.

C. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756.

D. Owner training:
   1. As specified in Sections 01756 and 16050.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

B. Provide the services of a VFD manufacturer representative for startup assistance and training:
   1. Inspection and field adjustment:
      a. Supervise the following and submit written certification that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.
   2. Startup field testing:
      a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
      b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make all drive parameters and protective device settings:
   1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
   2. Provide documentation of VFD settings included but not limited to:
      a. Minimum speed.

b. Maximum speed.
c. Skip speeds.
d. Current limit.
e. Acceleration time.
f. Deceleration time.

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16272

DRY-TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Enclosed dry-type transformers:
      a. Rated 1 to 1,000 kilovolt-amperes, single and 3-phase.
      b. Primary voltage 600 volts and below.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 – Common Work Results for Electrical.

1.02 REFERENCES

A. As specified in Section 16050.

B. American National Standards Institute (ANSI):
   1. C57.96 – Distribution and Power Transformers, Guide for Loading Dry-Type.
   2. 389 - IEEE Recommended Practice for Testing Electronics Transformers and Inductors.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. C57.12.01 - Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings.

D. National Electrical Manufacturers Association (NEMA):
   1. TP-1 - 2002 - Guide for Determining Energy Efficiency for Distribution Transformers.
   2. TP-2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers.

E. Underwriters Laboratory (UL):
   1. 1561 - Standard for Dry-Type General Purpose and Power Transformers.

F. U.S. Department of Energy (DOE):
   1. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTIONS

A. Provide 3-phase or 1-phase, 60 hertz dry-type with voltage ratings, kilovolt-ampere capacities, and connections as indicated on the Drawings:
   1. Transformers shall provide full capacity at the Project elevation and environmental conditions as specified in Section 16050 after all derating factors have been applied.
   2. Suitable for continuous operation at full rating with normal life expectancy in accordance with ANSI C57.96.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Catalog cut sheets.
   2. Nameplate data.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   4. Inrush current.
   5. Insulation system and temperature constraints.
   6. Number and rating of taps.
   7. Sound levels.
   8. Connection diagrams:
      a. Primary.
      b. Secondary.
   9. BIL rating.
   10. Required clearances.
   11. Percent impedance.
   12. Efficiency.
   13. Certification of full capacity capability at the Project elevation and ambient conditions.
   14. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050:
      a. Manufacturer’s statement of seismic qualification with substantiating test data.
      b. Manufacturer’s special seismic certification with substantiating test data.

C. Installation instructions:
   1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
   2. For equipment installed in structures designated as seismic design category C, D, E, or F:
      a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050.
      b. Submit anchoring drawings with supporting calculations.
      c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. General Electric.
   2. Jefferson.
   3. Schneider Electric/Square D.
   4. Eaton/Cutler-Hammer.
   5. ABB.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Cores:
   1. Non-aging, grain-oriented silicon steel.
   2. Magnetic flux densities below the saturation point.

B. Windings:
   1. High-grade magnet wire.
   2. Impregnated assembly with non-hydroscopic, thermo-setting varnish:
      a. Cured to reduce hot-spots and seal out moisture.

3. Material electrical grade:
   a. Copper.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. 10 kilovolts BIL for 600-volt class windings.
   2. Sound levels, in accordance with ANSI 389 test conditions, not to exceed:

Kilovolt-Amperes Range	Audible Sound Level (db)
1-9	40
10-50	45
51-150	50
151-300	55
301-500	60
501-700	62
701-1000	64

   3. Taps:
      a. 15 kilovolt-amperes and less:
         1) Two 5 percent full capacity primary taps below rated voltage.
      b. 25 kilovolt-amperes and larger:
         1) Four 2.5 percent full capacity primary taps below rated voltage.
         2) Two 2.5 percent full capacity primary taps above rated voltage.
      c. Operated by a tap changer handle or tap jumpers accessible through a panel.
   4. Terminals:
      a. UL listed for either copper or aluminum conductors.
      b. Rated for 75 degrees Celsius.
   5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with ANSI C57.96.

B. Transformers less than 15 kilovolt-amperes:
   1. Insulation class: 185 degrees Celsius.
   2. Temperature rise: 115 degrees Celsius.

C. Energy efficient transformers 15 kilovolt-amperes and larger:
   1. Insulation class: 220 degrees Celsius.
   2. Temperature rise: 80 degrees Celsius, except as noted below:
      a. 150-degree Celsius rise for dry-type transformers located in motor control centers.
   3. Efficiency:
      a. In accordance with DOE 10 CFR Part 431.

D. Enclosures:
   1. Heavy gauge steel:
      a. Outdoor: Moisture and water resistant with rodent screens over all openings and in a weather-protected enclosure, NEMA Type 3R.
      b. Indoor: NEMA Type 2.

2. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.
3. Built-in vibration dampeners to isolate the core and coils from the enclosure:
   a. Neoprene vibration pads and sleeves.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Nameplates:
   1. Non-corrosive metal or UL listed non-metallic:
      a. Stamped, engraved or printed with the following information:
         1) Phases.
         2) Frequency.
         3) Kilovolt-ampere rating.
         4) Voltage ratings.
         5) Temperature rise.
         6) Impedance.
         7) Insulation class.
         8) BIL rating.
         9) Connection diagram.
         10) Weight.
         11) Manufacturer.
         12) The identification “transformer”.
         13) Classes of cooling.
         14) Tap voltage(s).
         15) Vector diagram.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposited manufacturer’s standard gray enamel rust-inhibiting paint.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
    1. Floor, wall, platform, motor control center, packaged power supply, or roof mounted, as indicated on the Drawings.
    2. Install where not in direct contact with building structure.
    3. Install on single layer vibration pad under the entire mounting surface:
        a. Manufacturers: The following or equal:
            1) Korfund.
    4. Make any necessary connections to the enclosure with liquidtight flexible conduit having neoprene gaskets and insulated ground bushings.
    5. Ground the enclosure:
        a. To an equipment ground conductor in the conduit.
        b. To the facility grounding electrode system.
    6. Floor mounted transformers:
        a. Install transformers on 3-1/2-inch housekeeping pads.
        b. Install transformers with adequate space from walls or other enclosures for proper ventilation in accordance with the manufacturer's recommendations.

3.04 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. Factory tests:
    1. Applied voltage test to each winding and from each winding to the core:
        a. 600-volt class winding 4.5 kilovolt.
    2. Induced voltage test at 2 times normal voltage and 400 hertz for 1,080 cycles.
    3. Voltage ratio and polarity.
    4. Sound level, performed in a test room with ambient sound level not exceeding 24 db.
    5. Perform all tests in accordance with UL 1561.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16290

ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Power meters.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16305 - Electrical System Studies

1.02 REFERENCES

A. As specified in Section 16050.

B. American National Standard Institute (ANSI):
   1. C12.20 - Electricity Meters - 0.2 and 0.5 Accuracy Classes.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. C57.13.6 - Standard for High Accuracy Instrument Transformers.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions:
   1. FS - Full Scale.
   2. RDG - Of Reading.
   3. SSM - Solid State Multifunction Power Meter.
   4. THD - Total Harmonic Distortion.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Power meter data including but not limited to:
      a. Power requirements.
      b. Communications protocols.
      c. Input/outputs.
      d. Dimensions.
      e. Measurement functions.

f. Front panel controls.
g. Display characteristics.

C. Operation and maintenance manuals:
1. Descriptive and technical bulletins and sales aids edited to reflect only the equipment to be provided and covering each of the components in the system.
2. A maintenance section including all instruction leaflets and technical data necessary to setup, change setup and maintain the power meters.
3. Original licensed copies of all software and software manuals.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Shall be of the same manufacturer as the equipment housing the power meter.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

1. Power meter type 2 (SSM2) device which shall include at a minimum:
    a. Individual phase currents, plus or minus 0.3 percent FS.
    b. Phase-to-phase and phase-to-neutral voltages, plus or minus 3 percent FS.
    c. Watts, VARs, VA, plus or minus 6 percent FS.
    d. Watt-hours 0.6 percent FS; VAR-hours 0.6 percent FS; VA-hours 0.6 percent FS.
    e. PF apparent 1 percent FS; PF displacement 1 percent FS.
    f. Frequency 0.17 percent FS.
    g. THD:
        1) Voltage - 31st harmonic.
        2) Current - 31st harmonic.
    h. Demand:
        1) Ampere, plus or minus 0.3 percent FS.
        2) Watt, VAR, VA, plus or minus 0.6 percent FS.
    i. Minimum and maximum values:
        1) Volts (L-L), volts (L-N), current (L), watts, VARs, VA.
        2) PF (apparent and displacement).
        3) Frequency.
        4) THD-amps, THD-volts.
        5) Demand:
            a) Ampere, watt, VAR, VA.
    j. Trend analysis:
        1) Two selectable parameters.
    k. Other features:
        1) 3 form C relays, rated 10 amps.
    l. Kilowatt hour pulse initiator.
    m. Synch-input kilowatt utility.
    n. Graphic LCD with LED backlight:
        1) Seven lines, 147 characters.

2.07 ACCESSORIES

A. Current transformers:
    1. Ring type current transformers:
        a. Suitable for service within low or medium voltage equipment as indicated on the Drawings.
        b. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the equipment of the application.
    2. Current ratio: As indicated on the Drawings, for use as a guideline:
        a. It is the manufacturer’s responsibility to size the current transformers to ensure that they will not saturate under the maximum available fault current at the installed location based upon the fault current study as specified in Section 16305.
    3. Rated in accordance with IEEE C57.13.6 with accuracy of the current transformers suitable for relay accuracy class and rated for 200 percent burden for the required connected devices.
    4. Identify polarity with standard marking or symbols.

5. Capable of carrying rated primary current continuously without damage.
6. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

B. Potential transformers:
1. Indoor dry type, single-phase, 60 hertz, with a minimum thermal capacity of not less than 400 volt-amperes at 55 Celsius rise above 40 Celsius ambient.
2. Accuracy classification determined in accordance with IEEE C57.13.6, suitable for relay accuracy class, and 200 percent burden, for the required connected devices, with the secondary voltage 120 volts.
3. Insulation levels as required for the equipment system voltage but not less then:
   a. 600 VAC, 10 kV BIL for 480 VAC systems.
4. Identify polarity with standard markings or symbols.
5. Connect transformer secondary to potential buses as required.
6. Protect low voltage potential transformers on the primary side and secondary side with current-limiting fuses.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install power meters in the electrical equipment as indicated on the Drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16305

ELECTRICAL SYSTEM STUDIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Short-circuit fault analysis study.
   2. Protective device coordination study.
   3. Arc-flash hazard study.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.

1.02 REFERENCES

A. As specified in Section 16050.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 141 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants (Red Book).
   2. 242 - IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
   3. 315 - IEEE Standards Electrical and Electronics Graphic and Letter Symbols and Reference Designations.
   4. 399 - IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book).
   5. 902 - IEEE Guide for Maintenance, Operation and Safety on Industrial and Commercial Power Systems (Yellow Book).
   6. 1015 - IEEE Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems - Corrigendum 1 (Blue Book).
   7. 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations.

C. National Fire Protection Association (NFPA):
   1. 70E - Standard for Electrical Safety in the Workplace.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. General study requirements:
   1. Scope:
      a. The short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall include all new and modified equipment in the

power distribution system (SWGR-7, MCC-7A/7B, MCC-8A/8B, MCC-9A/9B, SWGR-2, MCC-2F, MCC-2G) including, but not limited to:
    1) Switchgear.
    2) Transformers:
        a) Including all dry-type transformers.
    3) Motor control centers.
    4) Freestanding variable frequency drives and starters.
    5) Disconnect switches.
    6) Motors.
    7) Panelboards:
        a) Including all 240- and 208-volt systems.
    8) Vendor control panels.
    9) HVAC equipment.
b. Study scenarios:
    1) The studies shall include all possible electrical system configurations, for example:
        a) Operation on normal (utility) source.
        b) Main-breakers closed, tie-breaker open.
        c) Either main-breaker open, tie-breaker closed.

2. Obtain, for all equipment, the required data for preparation of the study including, but not limited to:
    a. Transformer kilovolt-ampere (kVA) and impedances.
    b. Generator impedances.
    c. Generator decrement curves.
    d. Bus withstand ratings.
    e. Cable and bus data.
    f. Protective device taps, time dials, instantaneous pickups, and time-delay settings.
3. Obtain the Electric Utility information on the minimum and maximum available fault current, minimum and maximum utility impedances, utility protective device settings including manufacturer and model number, interrupting ratings, X/R ratios, and model information one level above the point of connection:
    a. Utility tolerances and voltage variations.
4. The individual performing the studies shall visit the site and collect all necessary field data in order to perform and complete comprehensive electrical system studies.
5. Obtain equipment layouts and configurations from the manufacturer’s final submittal requirements and project layout drawings as required.
6. Bus and conductor data:
    a. Use impedances of the actual installed or specified conductors, unless otherwise indicated.
    b. Use cable and bus impedances calculated at 25 degrees Celsius, unless otherwise indicated.
    c. Use 600-volt cable reactance based on typical dimensions of actual installed or specified conductors, unless otherwise indicated.
    d. Use bus withstand values for all equipment having buses.
    e. Use medium-voltage cable reactances based on typical dimensions of shielded cables with 133-percent insulation levels, unless otherwise indicated.
7. Motors:
    a. Each motor shall be individually modeled:
        1) Grouping of motors for fault contribution current is not acceptable.

b. Motors with variable frequency drives may be assumed to have no contribution to fault current.

8. Use the equipment, bus, and device designations as indicated on the Drawings for all studies.

B. Short-circuit fault analysis study additional requirements:
   1. The short-circuit fault analysis shall be performed and submitted in 2 phases:
      a. Initial short-circuit fault analysis:
         1) Based on the Contract Documents and Electric Utility information.
         2) The initial short-circuit fault analysis study shall indicate the estimated available short-circuit current at the line side terminals of each piece of equipment covered by the scope of the study.
         3) Provide a list of assumptions used in the initial study.
      b. Final short-circuit fault analysis:
         1) The final short-circuit fault analysis shall modify the initial analysis as follows:
            a) Utilize the actual equipment provided on the project.
            b) Utilize conductor lengths based on installation.
   2. Calculate 3-phase bolted fault, line-to-line fault, line-to-ground fault, double line-to-ground fault, short-circuit 1/2 cycle momentary symmetrical and asymmetrical RMS, 1-1/2 to 4 cycle interrupting symmetrical RMS, and 30-cycle steady-state short-circuit current values at each piece of equipment in the distribution system.
   3. Evaluate bus bracing, short-circuit ratings, fuse interrupting capacity and circuit-breaker-adjusted interrupting capacities against the fault currents, and calculate X/R values:
      a. Identify and document all devices and equipment as either inadequate or acceptable.
   4. Calculate line-to-ground and double line-to-ground momentary short-circuit values at all buses having ground-fault devices.
   5. Provide calculation methods, assumptions, one-line diagrams, and source impedance data, including utility X/R ratios, typical values, recommendations, and areas of concern.

C. Protective device coordination study additional requirements:
   1. Furnish protective device settings for all functions indicated on the Drawings including, but not limited to:
      a. Current.
      b. Voltage:
         1) Provide settings for all voltage relays based upon actual utility and generator tolerances and specifications.
      c. Frequency:
         1) Provide settings for all frequency relays based upon actual utility and generator tolerances and specifications.
      d. Negative sequence.
      e. Reverse power.
      f. Machine protection functions:
         1) Provide settings for all motor and generator protective relays based on the manufacturer’s recommended protection requirements.

2. Provide log-log form time-current curves (TCCs) graphically indicating the coordination proposed for the system:
    a. Include with each TCC a complete title and one-line diagram with legend identifying the specific portion of the system covered by the particular TCC:
        1) Typical TCCs for identical portions of the system, such as motor circuits, are acceptable as allowed by the Engineer.
    b. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics:
        1) These details can be included on the TCC.
    c. Include a detailed description of each protective device tap, time dial, pickup, instantaneous, and time delay settings:
        1) These details can be included on the TCC.
3. TCCs shall include all equipment in the power distribution system where required to demonstrate coordination. Include utility relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, transformer characteristics, motor and generator characteristics, and characteristics of other system load protective devices:
    a. Include all devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, main breaker in branch panelboards, and fused disconnect switches.
    b. Provide ground fault TCCs with all adjustable settings for ground fault protective devices.
    c. Include manufacturing tolerances and damage bands in plotted fuse and circuit breaker characteristics.
    d. On the TCCs, show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and transformer damage curves.
    e. Cable damage curves.
    f. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed based on the short-circuit fault analysis study.
    g. Coordinate time interval medium-voltage relay characteristics with upstream and downstream devices to avoid nuisance tripping.
4. Site generation: When site generation (including cogeneration, standby, and emergency generators) is part of the electrical system, include phase and ground coordination of the generator protective devices:
    a. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices.
5. Suggest modifications or additions to equipment rating or settings in a tabulated form.

D. Arc-flash hazard study additional requirements:
1. Include the calculated arc-flash boundary and incident energy (calories/square centimeter) at each piece of equipment in the distribution system:
    a. Perform study with 15 percent arcing fault variation as defined by IEEE 1584.
    b. Perform arc-flash calculations at minimum and maximum utility fault contributions.

c. Perform arc-flash calculations for both the line side and load side of the switchgear, switchboard, motor control center, and panelboard main breakers.
d. Perform arc-flash calculations for all short-circuit scenarios with all motors on for 3 to 5 cycles and with all motors off.
e. Protective device clearing time shall be limited to 2 seconds, maximum.

2. Provide executive summary of the study results:
   a. Provide summary based upon worst case results.
3. Provide a detailed written discussion and explanation of the tabulated outputs:
   a. Include all scenarios.
4. Provide alternative device settings to allow the Owner to select the desired functionality of the system:
   a. Minimize the arc-flash energy by selective trip and time settings for equipment maintenance purposes.
   b. Identify the arc-flash energy based upon the criteria of maintaining coordination and selectivity of the protective devices.

E. Electrical system study meetings:
1. The individual conducting the short-circuit fault analysis, protective device coordination, and the arc-flash hazard studies shall meet with the Owner and Engineer 3 times.
2. The purpose of the 3 meetings is as follows:
   a. Initial meeting:
      1) Meet with the Owner and Engineer to discuss the scope of the studies.
      2) Discuss the Owner's operational requirements for both normal operation and maintenance.
   b. Preliminary results meeting:
      1) This meeting will be held after the studies have been completed, reviewed, and accepted by the Engineer.
      2) The purpose of this meeting is to inform the Owner of the results of the study and impacts on normal operation and maintenance including:
         a) Protective device coordination problems and recommended solutions.
         b) Explanation of the arc-flash hazard study results and its potential impact on operations.
         c) Recommendations for reduction of arc-flash category levels including reduction of protective device settings or changes in operational practices.
   c. Final meeting:
      1) Discuss changes to the studies based on the previous meeting.
      2) Discuss with the Owner how changes to the electrical system may change the arc-flash hazard category.
      3) Deliver the final electrical system studies report.
3. The meetings will be at the Owner's facility:
   a. Provide a minimum of 3-weeks notice to the Owner and Engineer in advance of the projected meeting date.
   b. Submit a draft of the meeting agenda when each meeting is requested.

4. Meeting materials:
    a. Prepare and provide the following materials:
        1) Meeting agenda. Include, at a minimum, the scope of the meeting, estimated time length for the meeting, and meeting goals.
        2) 6 copies of the project one-line diagrams for the initial meeting.
        3) 6 copies of the submitted studies.

F. By virtue of the fact that this is a professional study, the Owner reserves the right to modify the requirements of the study to comply with its operational requirements. The protective device coordination study and the arc-flash hazard study shall be modified based on the results of the meetings with the Owner.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Initial studies and reports:
1. Include the following in the initial short-circuit current report:
    a. List of all devices included in the studies.
    b. A description of all operating scenarios.
    c. Form and format of arc-flash labels.

C. Final studies and reports:
1. Format and quantity:
    a. Provide 6 bound copies of all final reports.
    b. Provide 3 complete sets of electronic files on CD or DVD media, including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports. Also provide an electronic version of the bound reports in PDF format.
    c. Provide the number of copies specified in Section 01330.
2. Include the sections below in the final report:
    a. Copies of correspondence and data obtained from the electric utility company.
    b. Letter certifying the inspection and verification of existing equipment.
    c. One-line diagrams:
        1) The following information shall be included at a minimum:
            a) Motor horsepower.
            b) Transformer data:
                (1) kVA.
                (2) Configuration.
            c) Cable data:
                (1) Insulation.
                (2) Size.
                (3) Length.
        2) One-line diagrams shall be fully legible at 11-inch by 17-inch size.
    d. Include in the short-circuit fault analysis study:
        1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
        2) Normal system connections and those that result in maximum fault conditions.
        3) Tabulation of circuit breaker, fuse, and other protective device ratings compared to maximum calculated short-circuit duties.

4) Fault current calculations for the cases run including a definition of terms and guide for interpretation of computer software printouts.

e. Protective device coordination study shall include:
   1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
   2) List all requirements used in the selection and setting criteria for any protective devices.
   3) Manufacturer's time-current curves for circuit breakers, fuses, motor circuit protectors, and other protective devices for all new equipment.
   4) TCCs graphically indicating the coordination proposed for the system on log-log graphs. At least 3 of the copies shall be in color.
   5) Tabulation of relay, fuse, circuit breaker, and other protective devices in graphical form with a one-line diagram to display area coordination.
   6) Where coordination could not be achieved, an explanation shall be included in the report to support the statement along with recommendations to improve coordination. Recommended equipment modifications or settings shall be in a tabulated form.

f. Include in the arc-flash hazard study:
   1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
   2) Normal system connections and those that result in maximum arc-flash conditions.
   3) Arc-flash raw data, calculations, and assumptions.
   4) Arc-flash label data:
      a) Identifying the content of each label.
      b) Identifying the location of each label.

D. Certification:
   1. Submit written certification, sealed and signed by the professional engineer conducting the study, equipment supplier, and electrical subcontractor stating that the data used in the study is correct.

E. Submit the credentials of the individual(s) performing the study and the individual in responsible charge of the study.

F. The Engineer will review all studies and reports. After review, the Engineer will make recommendations and/or require changes to be made to the short-circuit fault analysis, protective device coordination, or arc-flash hazard studies. These changes shall be provided as part of the scope of work.

G. Submit course outline for Owner's training.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Qualifications of the entity responsible for electrical system studies:
   1. The studies shall be performed, stamped, and signed by a professional engineer registered in the state where the project is located.
   2. A minimum of 5 years of experience in power system analysis is required for the individual in responsible charge of the studies.

3. The short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall be performed with the aid of a digital computer program:
   a. Point-to-point calculations are not acceptable.

C. The study shall be performed by an independent firm.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT/SITE CONDITIONS (NOT USED)

1.09 SEQUENCING

A. Site visit to gather data on the existing facility systems for all studies:
   1. Make multiple trips as required to obtain all data for the short-circuit fault analysis, protection device coordination, and arc flash hazard studies.

B. Submit the initial short-circuit fault analysis study before submittal of any electrical equipment.

C. Initial electrical system study meeting.

D. Submit the preliminary short-circuit fault analysis, protective device coordination, and arc-flash hazard studies.

E. Second electrical system study meeting for preliminary results.

F. Final arc-flash meeting and final short-circuit fault analysis, protective device coordination, and arc-flash hazard studies.

G. Label equipment with approved arc-flash labels.

H. Owner's training.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Electrical system study software: One of the following or equal:
   1. ETAP by Operation Technology Inc.
   2. Powertools by SKM Systems Analysis.
   3. Paladin DesignBase by Power Analytics Corporation.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Arc-flash hazard labels:
   1. Dimensions:
      a. Minimum 5 inches by 3.5 inches.
   2. Materials:
      a. Polyester with polyvinyl polymer over-laminate.
      b. Self-adhesive.
      c. Resistant to:
         1) UV.
         2) Chemicals and common cleaning solvents.
         3) Scuffing.
         4) Wide temperature changes.
   3. Contents:
      a. Short-circuit bus identification.
      b. Calculated incident energy (calories/square centimeter) range:
         1) Based on worst-case study results.
      c. Arc-flash protection boundary.
      d. Shock hazard boundary:
         1) The Contractor may provide separate labels for indication of the shock hazard boundary.
      e. Description of the combined level of personnel protective equipment.
   4. Color scheme:
      a. For locations above 40 calories/square centimeter:
         1) White label with red “DANGER” strip across the top.
         2) Black lettering.
      b. For locations below 40 calories/square centimeter:
         1) White label with orange “WARNING” strip across the top.
         2) Black lettering.

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. After review and acceptance of the arc-flash hazard study by the Engineer, install all arc-flash hazard labels:
   1. Install labels at all locations required by NFPA, ANSI, or IEEE standards.
   2. At a minimum, install labels in the following locations:
      a. The front of each main or incoming service compartment.
      b. The front of each low-voltage switchgear section.
      c. The front of each medium-voltage circuit breaker door.
      d. The front of each accessible auxiliary or conductor compartment.
      e. Each accessible rear or side vertical section.
      f. Each motor control center vertical section.
      g. Each panelboard covered by the study.
      h. Each control panel, individual starter or VFD, or other equipment covered by the scope of the study.
   3. Install labels prior to equipment energization.

C. After review and acceptance of the arc-flash hazard study and protective device coordination study by the Engineer, adjust protective device settings per final study prior to equipment energization:
   1. Devices that require power for configuration may be set during energization, but before any subfed loads are energized.
   2. Ensure that settings for upstream equipment are set prior to energizing downstream devices.

3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

B. The individual performing the arc-flash hazard study shall direct the installation of the arc-flash hazard labels:
   1. Remove and replace any improperly applied labels.
   2. Repair the equipment finish damaged by removal of any label.
   3. Install labels level or plumb across the entire dimension of the label.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16411

DISCONNECT SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fusible and non-fusible disconnect switches.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16075 - Identification for Electrical Systems.
   5. Section 16305 - Electrical System Studies.
   6. Section 16494 - Low Voltage Fuses.

1.02 REFERENCES

A. As specified in Section 16050.

B. Underwriters Laboratories Inc. (UL):
   1. 20 - General-Use Snap Switches.
   2. 98 - Enclosed and Dead-Front Switches.
   3. 508 - Standard for Industrial Control Equipment.

C. National Electric Manufacturer's Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment.
   2. KS 1-2001- Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions:
   1. Safety switches and disconnect switches are to be considered synonymous.

1.04 SYSTEM DESCRIPTION

A. Provide heavy-duty type disconnect switches as indicated on the Drawings and specified in the Contract Documents.

B. Provide disconnect switches with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Manufacturer.
   2. Manufacturer's specifications and description.
   3. Ratings:
      a. Voltage.
      b. Current.
      c. Horsepower.
      d. Short circuit rating.
   4. Fused or non-fused.
   5. NEMA enclosure type.
   6. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   7. Weight.
   8. Cross-referenced to the disconnect schedule indicated on the Drawings.

C. Shop drawings:
   1. Manufacturer's installation instructions:
      a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance, Regulatory Requirements below.
      b. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
   2. Identify motor or equipment served by each switch; indicate nameplate inscription.

D. Installation instructions:
   1. Provide anchorage instructions and requirement based on the seismic requirements at the Project Site as specified in Section 16050 and calculations:
      a. Stamped by a professional engineer registered in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Regulatory requirements:
   1. NEMA KS1- Enclosed and Miscellaneous Distribution Switches (600 V Maximum).
   2. UL 98 - Enclosed and Dead-Front Switches.

C. Disconnect switches shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING

A. Conduct the initial fault current study as specified in Section 16305 and submit results for Engineer's review.

B. After successful review of the initial fault current study, submit complete equipment submittal.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Schneider Electric/Square D Company.
   2. Eaton/Cutler-Hammer.
   3. General Electric.
   4. Siemens.
   5. Appleton.
   6. Crouse-Hinds.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Switch mechanism:
   1. Quick-make, quick-break heavy-duty operating mechanisms:
      a. Provisions for padlocking the switch in the Off position.
      b. A minimum of 90-degree handle travel position between Off and On positions:
         1) Provide handle position indicators to identify the handle position.
      c. Full cover interlock to prevent opening of the switch door in the On position and to prevent closing the switch mechanism with the door open:
         1) With an externally operated override.

B. Switch interior:
   1. Switch blades visible when the switch is Off and the cover is open.
   2. Lugs:
      a. Front accessible.
      b. Removable.
      c. UL listed for 60/75-degree Celsius copper conductors.
   3. Current carrying parts completely plated to resist corrosion.
   4. Removable arc suppressors to facilitate easy access to line side lugs.
   5. Furnish equipment ground kits for every switch.

C. Fused switches:
   1. Furnish with fuses as indicated on the Drawings:
      a. Provide fuses as specified in Section 16494.
   2. UL approved for field conversion from standard Class H fuse spacing to Class J fuse spacing:
      a. Ratings 100 amperes through 600 amperes at 240 volts.
      b. Ratings 30 amperes through 600 amperes at 600 volts.
      c. Provide spring reinforced and plated fuse clips.

D. Ratings:
   1. UL horsepower rated for AC or DC with the rating not less than the load served.
   2. Current:
      a. 30 to 1,200 amperes.
   3. Voltage:
      a. 250 volts AC, DC.
      b. 600 volts (30 A to 200 A, 600 volts DC).
   4. Poles:
      a. 2, 3, 4, and 6 poles.
   5. UL listed short circuit ratings:
      a. 10,000 RMS symmetrical amperes when used with or protected by Class H or K fuses (30-600 amperes).
      b. 200,000 RMS symmetrical amperes when used with or protected by Class R or J fuses (30-600 amperes employing appropriate fuse rejection).
      c. 200,000 RMS symmetrical amperes when used with or protected by Class L fuses (800-1,200 amperes).
   6. Where not indicated on the Drawings, provide switches with the NEMA ratings specified in Section 16050 for the installed location.

E. Size, fusing and number poles as indicated on the Drawings or as required:
   1. Provide solid neutral where indicated on the Drawings.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Disconnect switches to have provisions for a field installable “B” type electrical interlock for position indication as indicated on the Drawings.

B. Disconnect switches to have provisions for a field installed insulated groundable neutral kit as indicated on the Drawings.

C. NEMA Type 7 and 9 enclosures furnished with drain and breather kit when used in outdoor applications.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Use Myers hubs or bolt-on hubs for all conduit penetrations on NEMA Type 12, Type 4, and Type 4X enclosures.
   2. Provide all mounting brackets, stands, supports and hardware as required:
      a. Match finish and materials for all brackets, stands, and hardware with the switch installed.
      b. Provide adequate supporting pillar(s) for disconnect switches in accordance with the approved seismic calculations, and locate aboveground or above decks, where there is no structural wall or surface for box.
   3. When possible, mount switches rigidly to exposed building structure or equipment structural members:
      a. For NEMA Type 4 and Type 4X locations, maintain a minimum of 7/8 inch air space between the enclosure and supporting surface.
      b. When mounting on preformed channel, position channel vertically so that water may freely run behind the enclosure.
   4. Provide a nameplate for each disconnect switch:
      a. Provide per requirements specified in Section 16075.
      b. Identify voltage, circuit, fuse size, and equipment served on the nameplate.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16412

LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage molded case circuit breakers.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16305 - Electrical System Studies.

1.02 REFERENCES

A. As specified in Section 16050.

B. National Electrical Manufacturers Association (NEMA):
   1. AB 3. - Molded Case Circuit Breakers and Their Application.

C. Underwriter's Laboratories (UL):
   1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   2. 943 - Ground Fault Circuit Interrupters.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. In accordance with UL 489.

1.04 SYSTEM DESCRIPTION

A. Molded case thermal magnetic or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Catalog cut sheets.
   2. Manufacturer's time-current curves for all molded case circuit breakers furnished.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Low voltage molded case circuit breakers shall be UL listed and labeled.

1.07 DELIVERY, STORAGE AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Eaton/Cutler-Hammer.
   2. General Electric Company.
   3. Schneider Electric/Square D Company.
   4. ABB.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:
   1. Conforming to UL 489.
   2. Operating mechanism:
      a. Quick-make, quick-break, non-welding silver alloy contacts.
      b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.

c. Mechanically trip free from the handle.
d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
e. Lockable in the "OFF" position.

3. Arc extinction:
   a. In arc chutes.
4. Voltage and current ratings:
   a. Minimum ratings as indicated on the Drawings.
   b. Minimum frame size 100A.
5. Interrupting ratings:
   a. Minimum ratings as indicated on the Drawings.
   b. Modify as required to meet requirements of the short circuit fault analysis - as specified in Section 16305.
   c. Not less than the rating of the assembly (panelboard, switchboard, motor control center, etc.)

B. Motor circuit protectors:
1. Instantaneous only circuit breaker as part of a listed combination motor controller.
2. Each pole continuously adjustable in a linear scale with ‘LO’ and ‘HI’ settings factory calibrated.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Terminals:
1. Line and load terminals suitable for the conductor type, size, and number of conductors in accordance with UL 489.

B. Case:
1. Molded polyester glass reinforced.
2. Ratings clearly marked.

C. Trip units:
1. Provide thermal magnetic or solid-state trip units as indicated on the Drawings.
2. Thermal magnetic:
   a. Instantaneous short circuit protection.
   b. Inverse time delay overload.
   c. Ambient or enclosure compensated by means of a bimetallic element.
3. Solid state:
   a. With the following settings as indicated on the Drawings:
      1) Adjustable long time current setting.
      2) Adjustable long time delay.
      3) Adjustable short time pickup.
      4) Adjustable short time delay.
      5) Adjustable instantaneous pickup.
      6) Adjustable ground fault pickup as indicated on the Drawings.
      7) Adjustable ground fault delay as indicated on the Drawings.

D. Molded case circuit breakers for use in panelboards:
   1. Bolt-on type:
      a. Plug-in type breakers are not acceptable.
   2. Ground fault trip devices as indicated on the Drawings.

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
   1. UL 489.
   2. Manufacturer's standard testing procedures.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install breakers to correspond to the accepted shop drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING

A. Adjust trip settings in accordance with Protective Device Coordination Study as accepted by the Engineer and in accordance with manufacturer's recommendations.

B. Adjust motor circuit protectors in accordance with NEC and the manufacturer's recommendation based on the nameplate values of the installed motor.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16414

LOW VOLTAGE POWER CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage draw-out type power circuit breakers.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16305 - Electrical System Studies.

1.02 REFERENCES

A. As specified in Section 16050.

B. National Electrical Manufacturer's Association (NEMA):
   1. Standard SG 3 - Low Voltage Power Circuit Breakers.

C. American National Standards Institute (ANSI):
   1. Standard C37.13 - Low Voltage AC Power Circuit Breakers Used in Enclosures.
   2. Standard C37.16 - Low Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
   3. Standard C37.17 - Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
   4. Standard C37.50 - Low Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures.

D. Underwriter's Laboratories (UL):
   1. Standard No. UL 1066 - Standard for Low Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Power circuit breakers as indicated on the Drawings and connect to form a completed system:
   1. Used to open and close a circuit, and to open a circuit automatically on a predetermined overload or overcurrent, without damage to itself when properly applied within its ratings.

B. Power circuit breakers to match existing breakers in SWGR-7.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Catalog cut sheets.
   2. Manufacturer's time-current curves for all trip devices furnished.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

1.07 DELIVERY, STORAGE AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following:
   1. Eaton/Cutler-Hammer.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Operating mechanism:
   1. Manual or electric as indicated on the Drawings:
      a. Manual operation:
         1) The circuit breaker closing spring is energized by no more than 6 operations of the constant-force charging handle.
         2) Pushing the “CLOSE (ON)” button will close the breaker’s contacts and pushing the “OPEN (OFF)” button will open the breaker’s contacts.
         3) The opening springs are automatically charged when the breaker is closed.
      b. Quick-make, quick-break, non-welding silver alloy contacts.
      c. Common trip, open and close for multi-pole breakers such that all poles open and close simultaneously.
      d. Lock to prevent closing or racking.
   2. Anti-pump feature: Prevents any attempts to reclose the breaker on a short circuit fault if the close signal is maintained.
   3. Equipped with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell.

B. Arc extinction:
   1. In arc chutes.

C. Voltage and current ratings:
   1. Minimum ratings as indicated on the Drawings.
   2. Minimum short time current ratings equal to the interrupting rating.

D. Interrupting ratings:
   1. Minimum ratings as indicated on the Drawings:
      a. Modify as required to meet requirements of Contractor’s Short Circuit Fault Analysis as specified in Section 16305.
   2. Matching the rating of the equipment.

E. Circuit breaker mounting as indicated on the Drawings:
   1. Draw out type capable of being racked to the disconnect position with the door closed.
   2. Interlocks:
      a. To prevent connecting or disconnecting the circuit breaker unless the breaker is in the open position.
      b. To prevent breaker from being closed during any racking operation.
   3. Test position:
      c. Permits operating the breaker while it is disconnected from the power circuit.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Case:
   1. Molded polyester glass reinforced.
   2. Double level of insulation between primary current-carrying parts and operating personnel.

3. Ratings clearly marked.
4. Open contact indication.
5. Closed contact indication.
6. Charging spring charged indication.
7. Charging spring discharged indication.
8. Open pushbutton.
9. Close pushbutton.
10. Retractable charging handle.
11. Terminal blocks.

B. Trip units:
   1. Microprocessor based with positive action flux-shifting trip device and a solid-state type with the following functions:
      a. Adjustable ampere setting:
         1) Controls the value of current that the breaker will carry indefinitely.
         2) Adjustable from 0.5 to 1.0 in 0.05 increments.
      b. Adjustable long time delay:
         1) Varies the time it will take the breakers to trip under sustained overload.
      c. Adjustable short time pickup:
         1) Controls the level of high current the breaker will carry for short periods.
      d. Adjustable short time delay:
         1) Controls the length of time the breaker will carry a high current without tripping.
      e. Adjustable instantaneous pickup:
         1) Controls level at which immediate tripping of breaker occurs.
         2) This trip function may be disabled on the main breakers, based on Contractor's short circuit and fault analysis study.
      f. Adjustable ground fault pickup:
         1) Controls the level at which the breaker will trip under a ground fault condition.
      g. Adjustable ground fault delay:
         1) Controls the time that a ground fault can exist without tripping the breaker.
      h. Long time pickup indicator:
         1) Provides a visual indication that the breaker is experiencing an overload condition.
      i. Zone selective interlocking:
         1) Zone selective interlocking on ground fault, short time, and instantaneous protection. Zone selective interlocking shall have independent setting for both the restrained condition (signal from downstream breaker indicates it senses fault) and unrestrained condition (no signal from downstream breaker).
   2. Maintenance mode settings:
      a. Allows for input of alternative trip settings for arc flash hazard reduction during maintenance procedures.
      b. Enabled by the following:
         1) Hardwired input.
         2) Trip unit controls.
         3) Trip unit network.

c. Status:
1) Contact for remote indication.
2) Indication on trip unit.
3) Status communicated over trip unit network.

3. Fault indicators:
a. Powered from a lithium battery.
b. LED indicators for:
1) Overcurrent fault trip on long-time feature.
2) Overcurrent fault trip on short-time feature.
3) Short circuit fault trip on the Instantaneous feature.
c. Communications:
1) Provide for networked communications of the metered electrical values to the plant control system.
2) Protocol:
a) Manufacturer's standard protocol between trip units.
b) Convert manufacturer's standard protocol to Ethernet for communications to the plant control system.

2.07 ACCESSORIES

A. Provide circuit breakers with the following accessories as indicated on the Drawings:
1. Spring charging motor (field convertible by adding a plug-in motor operator):
a. The circuit breaker closing spring is energized by an electric motor-driven charging mechanism.
b. Control voltage for electrically operated circuit breakers: as indicated on the Drawings.
2. Remote close solenoid.
3. Auxiliary switch to signal the breaker's opened or closed status:
a. 4 NO/NC (SPDT).

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
1. UL 1066.
2. ANSI C37.50.
3. Manufacturer's standard testing procedures.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install breakers to correspond to the accepted shop drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING

A. Adjust trip settings in accordance with the Protective Device Coordination Study as accepted by the Engineer and in accordance with the manufacturer's trip unit instructions.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16422

MOTOR STARTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Motor starters and contactors.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16070 - Hangers and Supports.
   5. Section 16075 - Identification for Electrical Systems.
   6. Section 16123 - 600-Volt or Less Wires and Cables.
   7. Section 16412 - Low Voltage Molded Case Circuit Breakers.
   8. Section 16444 - Low Voltage Motor Control Centers.
   9. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

1.02 REFERENCES

A. As specified in Section 16050.

B. International Electrotechnical Commission (IEC):
   1. 60 947-4 - Low-Voltage Switchgear and Control Gear.
   2. 801-1 - Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment - Part 1: General Information.

C. National Electrical Manufacturer's Association (NEMA):
   1. ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V.

D. Underwriters Laboratories (UL):
   1. 508 - Standard for Industrial Control Equipment.
   2. 508A - Standard for Industrial Control Panels.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions and abbreviations:
   1. FVNR: Full voltage non-reversing.
   2. Overload relay class: A classification of an overload relay time current characteristic by means of a number which designates the maximum time in seconds at which it will operate when carrying a current equal to 600 percent of its current rating.

1.04 SYSTEM DESCRIPTION

A. General requirements:
   1. Starters for motor control centers, individual enclosed starters, or control panels.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050:
   1. Submit motor starter data with equipment submittal.

B. Product data:
   1. Manufacturer.
   2. Catalog cut sheets.
   3. Technical information.
   4. Complete nameplate schedule.
   5. Complete bill of material.
   6. List of recommended spare parts.
   7. Confirmation that the overload relay class for each starter meets the requirements of the equipment and motor supplier.
   8. Electrical ratings:
      a. Phase.
      b. Wire.
      c. Voltage.
      d. Ampacity.
      e. Horsepower.
   9. Furnish circuit breaker submittals as specified in Section 16412.

C. Shop drawings:
   1. Elementary and schematic diagrams:
      a. Provide 1 diagram for every starter and contactor.
      b. Indicate wire numbers for all control wires on the diagrams:
         1) Wire numbering as specified in Section 16075.
      c. Indicate interfaces with other equipment on the drawings.

D. Operation and maintenance manuals:
   1. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment furnished or installed under this Section. Including but not limited to:
      a. Electrical ratings:
         1) Phase.
         2) Wire.
         3) Voltage.
         4) Ampacity.
      b. Complete bill of material.
      c. Manufacturer's operating and maintenance instructions starter and/or contactor component parts, including:
         1) Protective devices (fuses, breakers, overload relays, heater elements, etc.).
         2) Pilot devices.
      d. Complete renewal parts list.

e. As-built drawings:
    1) Furnish as-built drawings for each starter and contactor indicating final:
        a) Wire numbers.
        b) Interfaces with other equipment.
    2) 11-inch by 17-inch format.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Regulatory requirements:
1. All starters and components shall be UL listed and labeled:
    a. UL 508 - Industrial Control Equipment.
    b. UL 508A - Industrial Control Panels.
2. NEMA ICS 2 - Industrial Control and System Controllers; Contactors and Overload Relays Rated: 600 Volts.
3. Combination starters shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Spare parts:
1. Provide the following spare parts, suitably packaged and labeled with the corresponding equipment number:
    a. One spare fuse of each size and type per starter.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. NEMA starters and contactors:
      a. Allen-Bradley.
      b. Schneider Electric/Square D.
      c. General Electric.
      d. Eaton/Cutler-Hammer.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:
   1. Provide combination type starters with motor circuit protector or thermal-magnetic circuit breaker and control power transformer with ratings as indicated on the Drawings.
   2. NEMA size, design, and rated:
      a. NEMA Size 1 minimum.
   3. Coordinate motor circuit protector, thermal magnetic circuit breaker, or fusible disconnect, and overload trip ratings with nameplate horsepower and current ratings of the installed motor:
      a. If motors provided are different in horsepower rating than those specified or indicated on the Drawings, provide starters coordinated to the actual motors furnished.
   4. Provide starters NEMA Size 2 and larger with arc quenchers on load breaking contacts.
   5. Mount extended overload reset buttons to be accessible for operation without opening starter enclosure door.

B. Full voltage starters (FVNR, FVR, TS1W, TS2W):
   1. Across-the-line full voltage magnetic starters.
   2. Rated for 600 volts.
   3. Electrical characteristics as indicated on the Drawings.
   4. Provide positive, quick-make, quick-break mechanisms, pad lockable enclosure doors.
   5. Furnish starter with bi-metallic overload relays.
   6. Double-break silver alloy contacts.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Molded case circuit breakers:
   1. Circuit breaker type and ratings as indicated on the Drawings.
   2. Provide as specified in Section 16412.

B. Contactors:
   1. NEMA size as indicated on the Drawings.
   2. Electrically held:
      a. For lighting loads designed to withstand the initial inrush currents of ballast and lamp loads.
   3. Factory adjusted and chatter free.
   4. Auxiliary contacts:
      a. Contact ratings as per NEMA A 600 rating:
         1) Auxiliary contacts rated 10 amps at 600 volts.
      b. Provide all contacts indicated on the Drawings, and any additional contacts required for proper operation.
      c. Provide at least 1 normally open and 1 normally closed spare auxiliary contact.
   5. Constructed in accordance with the following standards:
      a. UL 508.
      b. IEC 947-4:
         1) Type 1 coordination when protected by a circuit breaker.
         2) Type 2 coordination when protected by a suitable UL listed fuse.
      c. IEC 801-1 parts 2 through 6.

C. Overloads:
   1. Bi-metallic overload relay:
      a. Class 20 protection.
      b. Ambient compensated.
      c. Interchangeable heater pack:
         1) One heater per phase.
         2) Coordinate with installed motor full load amps and service factor.
      d. Visible trip indicator.
      e. Push-to-trip test.
      f. Isolated normally open alarm contact.
      g. Normally closed trip contacts.
      h. Manual reset.

D. Control power transformer:
   1. Furnish integral control power transformer capacity to power:
      a. All motor controls; Motor and starter accessories indicated on the Drawings or specified.
   2. Primary and secondary fusing as indicated on the Drawings:
      a. Fusing sized by the manufacturer for the rating of the transformer furnished.
   3. Control power transformer secondary voltage:
      a. As indicated on the Drawings.

2.07 ACCESSORIES

A. Lugs and terminals:
   1. For all external connections of No. 6 AWG and larger.
   2. UL listed for either copper or aluminum conductors.

B. Surge protective devices:
   1. Furnish surge protection devices across the coil of each starter, contactor, and relay.

C. Pilot devices:
   1. Provide pilot lights, switches, elapsed time meters, and other devices as specified or as indicated on the Drawings.
   2. As specified in Section 17710.

D. DeviceNet input/output module:
   1. Where indicated on the Drawings, provide starters with DeviceNet input/output module.
   2. Minimum input/output requirements:
      a. 2 outputs.
      b. 4 inputs.

E. Nameplates and wire markers:
   1. As specified in Section 16075.

F. Conformal coating:
   1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. Starters in motor control centers:
   1. Install as specified in Section 16444.

D. Starters in control panels:
   1. Install as specified in Section 17710.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. Factory testing:
   1. Owner and Engineer will witness the factory acceptance test as specified in Section 16050.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Set all overloads and motor circuit protectors based on the nameplate values of the installed motor.

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16444

LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motor control centers.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16075 - Identification for Electrical Systems.
   5. Section 16123 - 600-Volt or Less Wires and Cables.
   6. Section 16150 - Low Voltage Wire Connections.
   7. Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower.
   8. Section 16272 - Dry-Type Transformers.
   9. Section 16285 - Surge Protective Devices.
   10. Section 16305 - Electrical System Studies.
   11. Section 16412 - Low Voltage Molded Case Circuit Breakers.
   12. Section 16422 - Motor Starters.
   13. Section 16445 - Panelboards.
   14. Section 16494 - Low Voltage Fuses.
   15. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.

1.02 REFERENCES

A. As specified in Section 16050.

B. National Electrical Manufacturer's Association (NEMA):
   1. ICS 18-2001 - Motor Control Centers.

C. Underwriters Laboratories (UL):
   1. 845 - Motor Control Centers.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Factory assembled, factory wired and factory tested motor control centers:
   1. Motor control centers and major components to be products of a single manufacturer.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Manufacturer of motor control center.
   2. Manufacturer of motor control center parts.
   3. Nameplate schedule.
   4. Bill of material.
   5. Enclosure:
      a. NEMA rating.
      b. Finish color.
   6. Ratings:
      a. Voltage.
      b. Phase.
      c. Current:
         1) Horizontal bus ampacity.
         2) Vertical bus ampacity.
         3) Ground bus ampacity.
      d. Short circuit withstand rating.
      e. Protective device interrupting rating.
   7. List of recommended spare parts.
   8. Catalog cut sheets:
      a. Submit complete manufacturer's catalog information:
         1) Clearly indicate the features of the equipment including any options necessary to meet the required functionality.
   9. Furnish component submittals as specified in the appropriate Section.
   10. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050:
      a. Manufacturer's statement of seismic qualification with substantiating test data.
      b. Manufacturer's special seismic certification with substantiating test data.

C. Shop drawings:
   1. Layout drawings:
      a. Provide fully dimensioned and to scale layout drawings which include:
         1) Dimensions:
            a) Overall length.
            b) Overall width.
            c) Overall height.
            d) Overall weight and weight of individual shipping splits.
   2. Interfaces to other equipment.
   3. Shipping splits.
   4. Allowable top and bottom conduit windows.
   5. Complete component and unit layout drawings.

6. Indicate lug sizes, type, and manufacturer based on the cable size specified in the Contract Documents and as indicated on the Drawings.
7. Elementary schematics:
    a. Provide one custom schematic diagram for each compartment:
        1) Include all remote devices.
        2) Show wire numbers on the schematics:
            a) Provide wire numbering as specified in Section 16075.
8. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
9. One-line diagrams:
    a. Provide complete one-line diagrams for each motor control center, including but not limited to: protective devices, starters, drives, metering, and other equipment.
    b. Indicate electrical ratings of the equipment shown on the one-line diagrams.

D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. For equipment installed in structures designated as seismic design category C, D, E, or F:
    a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050.
    b. Submit anchoring drawings with supporting calculations.
    c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

E. Operation and maintenance manuals:
1. Provide complete operating and maintenance instructions presenting full details for care and maintenance of all types of equipment furnished and/or installed under this Section. Include the following:
    a. Electrical ratings:
        1) Phase.
        2) Wire.
        3) Voltage.
        4) Ampacity.
        5) Bus bracing and protective device interrupting ratings.
    b. Manufacturer's operating and maintenance instructions for the motor control center and all component parts, including:
        1) Starters.
        2) Overload relays and heater elements.
        3) Variable frequency drives.
        4) Protective devices including, but not limited to, fuses, circuit breakers and protective relays.
        5) Pilot devices.
    c. Complete renewal parts list.

F. Test forms and reports:
1. Submit complete factory acceptance test procedures and all forms used during the test.

G. Manufacturer's Certificate of Installation and Functionality Compliance.

H. Manufacturer's Certificate of Installation and Functionality Compliance.

I. Record Documents:
   1. Elementary schematics:
      a. Furnish as-built elementary schematics indicating final:
         1) Wire numbers.
         2) Interfaces with other equipment.
      b. Provide one custom schematic diagram for each compartment:
         1) Include all remote devices.
         2) Show wire numbers on the schematics.
      c. Layout drawings: Provide complete dimensioned component and unit layout drawings.
   2. The Record Documents shall reflect all modifications made during the submittal review process and during construction.

J. Calculations:
   1. Detailed calculations or details of the actual physical testing performed on the motor control center to prove the motor control center is suitable for the seismic requirements at the Project Site.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. All portions of the motor control center, vertical bays, and components shall be UL listed and labeled.

1.07 DELIVERY, STORAGE AND HANDLING

A. As specified in Section 16050.

B. Ship the motor control center and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment.

C. Furnish temporary equipment heaters within the motor control center to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING

A. Conduct the initial fault current study as specified in Section 16305 and submit results for Engineer's review.

B. After successful review of the initial fault current study, as specified in Section 16305, submit complete equipment submittal.

C. Conduct factory acceptance test.

D. Submit Manufacturer's Certificate of Installation and Functionality Compliance.

E. Ship equipment to the Project Site after successful completion of factory acceptance test.

F. Assemble equipment in the field.

G. Conduct field acceptance test and submit results for Engineer's review.

H. Submit manufacturer's certification that the equipment has been properly installed and is fully functional for Engineer's review.

I. Conduct Owner's training sessions.

J. Commissioning and process start-up as specified in Section 01756.

1.10 SCHEDULING

A. As specified in Section 16050.

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTION (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following, no equal:
   1. Eaton/Cutler-Hammer:
      a. Freedom 2100.

2.02 EXISTING PRODUCTS

A. Existing motor control centers:
   1. Provide complete motor control center vertical sections or individual motor control center units to be added to existing motor control centers as specified in this Section and as indicated on the Drawings.

2. Provide additions that are of the same manufacturer, type, and electrical ratings as the existing motor control centers:
    a. Provide all hardware necessary to connect the busses of the new and existing motor control centers.
3. Provide enclosures to match the NEMA ratings and colors of the existing motor control centers.

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
1. Furnish motor control centers as specified in the Contract Documents and indicated on the Drawings.
2. Arrange the equipped sections to form continuous motor control center lineups as indicated on the Drawings:
    a. Identify any deviations from the Drawings in writing and submit for approval.
3. Provide wire markers at each end of every wire as specified in Section 16075.
4. Provide complete and functional motor control centers.
5. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.

B. Design and construct motor control center to operate at the voltage level and configuration indicated on the Drawings.

C. Bus system:
1. Material:
    a. Tin-plated copper.
    b. Short-circuit rating:
        1) As indicated on the Drawings.
    c. Bus bar supports:
        1) High impact strength, non-tracking glass-polyester material that is impervious to moisture and gases.
2. Horizontal power bus:
    a. Current-carrying capacity as indicated on the Drawings.
    b. Mounting:
        1) Mount horizontal bus bars edgewise, one above the other, and fully isolated from all wireways and units.
    c. Temperature rise:
        1) In accordance with UL 845.
        2) De-rate the temperature rating of the bus for the specified conditions of ambient temperature and altitude as specified in Section 16050.
3. Vertical power bus:
    a. Current-carrying capacity of not less than 600 amps.
    b. Mounting:
        1) Enclose the vertical bus in a polyester-glass cover with small openings to permit unit stabs to mate with the bus:
            a) Provide a shutter mechanism to cover the stab openings when plug-in units are removed.

2) Provide top and bottom bus covers for insulation and isolation of the ends of the bus.

c. Isolated from the unit compartments by a full height barrier.

4. Ground bus:
   a. Horizontal ground bus:
      1) Current-carrying capacity:
         a) 300 amps when the horizontal bus is 2,000 amps or less.
      2) Mounting:
         a) Full-width, firmly secured to each vertical section structure:
            (1) Located in the top or bottom wireway.
         b) Pre-drilled and furnished with lugs for connection to equipment ground wires:
            (1) Furnish a minimum of 10 lugs per vertical section of MCC.
   b. Vertical ground bus:
      1) Mounting:
         a) Furnish in each vertical section.
         b) Bolted to the horizontal ground bus.
         c) Install parallel to the vertical power bus.
         d) Mount vertical ground bus such that plug-in units engage the ground bus before any connection to the power bus is made. Upon removal of plug-in units, ground stabs are disconnected from the ground bus after the power stabs have been disconnected.
5. Bus splice bars:
   a. Provided to join the bus at the splits.
   b. Connected to each horizontal bus bar with a minimum of two bolts.
   c. Employ conical or spring washers at connections, designed to maintain constant pressure against the splice joint.
   d. Same ampacity rating as the horizontal bus.
6. Provide bus system configured for back-to-back MCCs, where required.

D. Enclosures:
   1. Each motor control center shall consist of 1 or more vertical sections bolted together:
      a. Freestanding.
      b. Totally enclosed.
      c. Dead-front assembly.
      d. Designed for modification and/or addition of future vertical sections.
      e. Form each vertical section of heavy gauge steel.
      f. Designed for back-to-back arrangement installation, where required and/or as indicated on the Drawings.
   2. Enclosure rating:
      a. Indoor:
         1) NEMA Type 12.
   3. Standard section dimensions:
      a. Nominal height: 90 inches.
      b. Nominal depth: 20 inches.
      c. Vertical section width as indicated on the Drawings.

4. Wireways:
    a. Provide each vertical section with a horizontal wireway at the top and bottom of the section:
        1) Arranged to provide a full-width metal enclosed wiring trough across the entire motor control center assembly.
    b. Provide each vertical section with a full-height vertical wireway.
    c. Completely isolated from the vertical and horizontal bus bars.
    d. Provide a removable, hinged door.
5. Shipping splits:
    a. No more than 3 vertical sections and not more than 60 inches in width.
    b. Solid bussing between vertical sections in a shipping split is not acceptable.
6. Lifting angles:
    a. Furnish each vertical section and/or shipping split with a removable lifting angle mounted to the top of the enclosure:
        1) Extending the entire width of the shipping split.
7. Mounting channels:
    a. Mount each vertical section and/or shipping split on an external 1.5-inch by 3-inch mounting channel.

E. Units:
1. A plug-in unit consists of:
    a. Unit assembly.
    b. Unit support pan.
    c. Unit door assembly.
2. Completely enclosed and isolated from adjacent units, buses, and wireways, except for conductor entries into the unit, by a metal enclosure.
3. Constructed so that any fault will be contained in the unit compartment.
4. Supported and guided by a removable unit support pan:
    a. Re-arrangement of units and the removal of a unit so that a new and possibly larger unit can be added without the removal of an in-service unit to gain access to the unit support pan.
5. Held in place by screws or other positive locking means after insertion.
6. Provide a test position with the unit supported in the structure but disengaged from the bus.
7. Integral plug-in ground stab.
8. Stabs:
    a. Free floating.
    b. Self-aligning.
    c. Backed by spring steel clips to ensure high pressure contacts:
    d. Electrolytically tin-plated copper.
9. Handle:
    a. Provide a flange mounted handle mechanism to operate each disconnect switch or circuit breaker.
    b. Door mounted operators or operator handles are not acceptable.
    c. Engaged with the disconnect device at all times as an integral part of the unit independent of the door position.
    d. Lockable in the “OFF” position with up to 3 padlocks.
    e. Mechanically interlocked so that the door cannot be opened with the handle in the “ON” position:
        1) Provide a means for qualified personnel to defeat this interlock.

f. Interlocked so the unit cannot be inserted or withdrawn with the handle in the “ON” position.
g. Lockable in the “ON” position:
1) This shall not prevent the circuit breaker from operating and opening the contacts in the event of a fault condition.
h. Color-coded to indicate position.
i. Located so the center of the grip when it is in its highest position is not more than 6 feet 7 inches above the finished floor, including the height of the housekeeping pad and mounting channels.

10. Where indicated on the Drawings, provide units for spaces and future equipment:
a. Equip these units to accept a future plug-in unit without modification to the vertical sections.

2.06 COMPONENTS

A. Provide components contained within the motor control center as specified in:
1. Section 16075.
2. Section 16123.
3. Section 16150.
4. Section 16262.
5. Section 16272.
6. Section 16285.
7. Section 16412.
8. Section 16422.
9. Section 16445.
10. Section 16494.
11. Section 17710.

2.07 ACCESSORIES

A. Wiring:
1. Wire the motor control center in accordance with the following NEMA Class and Type as defined by NEMA ICS 18-2001:
a. NEMA Class I-S:
1) Furnish wiring diagrams for individual units consisting of drawings that identify electrical devices, electrical connections, and indicate terminal numbering designations.
2) Furnish individual unit diagrams with each unit and include inter-wiring between units, i.e. electrical interlocking, etc., as specifically specified in the Contract Documents.
3) Provide custom drawings with unique terminal numbering designations in lieu of standard manufacturer drawings.
b. NEMA Type B wiring:
1) Control wiring:
a) Type B-T pull-apart terminal blocks.
2) Power wiring:
a) Type B-T for Size 1 starters.
b) Type B-T or B-D for Size 2 and 3 starters.
c) Type B for Size 4 and larger starters and feeder units.

B. Lugs and terminals:
   1. For all external connections of No. 6 AWG wire or larger:
      a. UL listed for copper or aluminum conductors.
   2. Compression type, requiring a hydraulic press and die for installation.
   3. Provide 20 percent spare control block terminals.

C. Nameplates:
   1. Provide nameplates as specified in Section 16075:
      a. Identifying the motor control center designation as indicated on the Drawings.
   2. Identifying each vertical section:
      a. Mounted and centered on the top horizontal wireway of the vertical section.
   3. Furnish individual nameplates for each unit indicated on the Drawings:
      a. 1 nameplate to identify the unit designation.
      b. 1 nameplate to identify the load served.
      c. Furnish space units with blank nameplates.
   4. Manufacturer's labels:
      a. Furnish each vertical section with a label identifying:
         1) Serial number.
         2) Bus rating.
         3) Vertical section reference number.
         4) Date of manufacture.
         5) Catalog number of section.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish metal surfaces and structural parts with phosphatizing, or equal, treatment before painting.

B. Finish interior surfaces including bus support angles, control unit back plates, and top and bottom barrier plates with baked white enamel.

C. Finish exterior of enclosure with manufacturer's standard gray.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories necessary to completely install the motor control center for the line, load, and control connections.
   2. Assemble and install the motor control center in the locations and with the layouts as indicated on the Drawings.
   3. Make bus splice connections.
   4. Perform work in accordance with manufacturer's instruction and shop drawings.
   5. Furnish all components, and equipment necessary to complete the installation.
   6. Replace hardware, lost or damaged during installation or handling, in order to provide a complete installation.
   7. Install the MCC on a 3-1/2-inch raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units:
         1) Remove the manufacturer's supplied mounting channels as required by the manufacturer's installation instructions.
      b. Weld and/or bolt the motor control center frame to leveling channels.

D. Provide openings in the top or bottom of the motor control center for conduit only:
   1. No additional openings will be accepted:
      a. Mis-cut holes will require that the entire vertical section or removable panel be replaced.
      b. No hole closers or patches will be accepted.

E. Bundle circuits together and terminate in each unit:
   1. Tie with nylon wire ties as specified in Section 16123.
   2. Label all wires at each end with wire markers as specified in Section 16075 as shown on the approved elementary schematics.

3.04 ERECTION, INSTALLATION, APPLICATION CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. Source testing (Factory Acceptance Tests):
   1. Owner and Engineer will witness the factory acceptance test as specified in Section 16050.

2. Test the complete motor control center at the manufacturer's establishment. Completely assemble, wire and test the motor control center:
    a. Detailed inspections before and after assembly to assure correctness of design and workmanship.
    b. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.
3. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

B. Provide the services of a manufacturer's representative to:
    1. Inspect, verify, and certify that the motor control center installation meets the manufacturer's requirements.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16445

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Panelboards serving feeder circuits and branch circuits.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16075 - Identification for Electrical Systems.
   5. Section 16285 - Surge Protective Devices.
   6. Section 16412 - Low Voltage Molded Case Circuit Breakers.

1.02 REFERENCES

A. As specified in Section 16050.

B. Underwriter's Laboratories, Inc. (UL):
   1. 67 - Standard for Panelboards.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and where indicated on the Drawings:
   1. Service voltage and configuration as indicated on the panel schedules.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Manufacturer of panelboard.
   2. Bill of material.
   3. Assembly ratings including:
      a. Voltage.
      b. Phase.
      c. Continuous current.
      d. Short circuit interrupting rating.
   4. NEMA enclosure type.
   5. Cable terminal sizes based upon actual feeder and sub-feeder conductors used.

6. Furnish circuit breaker submittals as specified in Section 16412.
7. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop drawings:
1. Drawings to contain:
    a. Overall panelboard dimensions, interior panel dimensions, and wiring gutter dimensions:
        1) Height.
        2) Length.
        3) Width.
    b. Weight.
    c. Anchoring locations.
    d. Breaker layout drawing with dimensions:
        1) Location of the main, branches, solid neutral, and ground.
    e. Conduit entry/exit locations:
        1) Identify all conduit entry/exit locations and restrictions.
    f. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for every panelboard.

D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. For equipment installed in structures designated as seismic design category A or B:
    a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
3. For equipment installed in structures designated as seismic design category C, D, E, or F:
    a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050.
    b. Submit anchoring drawings with supporting calculations.
    c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

E. Operations and maintenance manual:
1. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories:
    a. Including but not limited to:
        1) Instruction narratives and bulletins.
        2) Renewal parts lists.
        3) Time-current curves for all devices.

F. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the panelboard to prove the panelboard is suitable for the seismic requirements at the Project Site.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Panelboards shall be UL listed and labeled:
   1. Where indicated as service entrance equipment, panelboards shall be UL labeled and listed “Suitable for Service Entrance.”

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Eaton/Cutler-Hammer.
   2. General Electric Company.
   3. Schneider Electric/Square D Company.

B. Circuit breakers:
   1. Same manufacturer as the panelboard.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Provide panelboards with:
   1. Molded-case circuit breakers with trip ratings as shown on the panel schedules.
   2. Spares and spaces for future circuit breakers in panels as shown on the panel schedules.

B. Short circuit rating:
   1. Provide panelboards with short-circuit ratings as indicated on the Drawings.
   2. Testing method in accordance with UL 67.
   3. Mark each panelboard with its maximum short circuit rating at the supply voltage.
   4. Panelboards shall be fully rated.

2.06 COMPONENTS

A. Enclosure:
   1. NEMA enclosure type as indicated on the Drawings:
      a. Where not indicated on the Drawings, as specified in Section 16050 for the installed location.
   2. Minimum width: 20 inches.
   3. Gutter space in accordance with the NEC:
      a. Minimum of 4 inches of gutter space.
   4. Dead-front, no live parts when the panelboard is in service.
   5. Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.
   6. 4-piece front to provide ease of wiring access.
   7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull:
      a. Minimum 2 keys per panelboard.
      b. Key all panelboard locks alike:
         1) Match locks on existing panelboards to the extent possible.
   8. Circuit directory frame and card on the inside of the door.
   9. Door-in-door construction consists of a one-piece front with 2 doors:
      a. The smaller door provides access to all device handles and rating labels and shall be lockable.
      b. The larger door provides access to all conductors and wiring terminals.
   10. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.
   11. Outdoor locations: Provide NEMA Type 4X enclosures with a NEMA Type 4X stainless steel outer enclosure (with a hinged door) and a NEMA Type 1 interior panelboard, unless otherwise indicated.

B. Bus:
   1. General:
      a. Tin-plated copper.
   2. Phase bus:
      a. Full size and height without reduction.

b. Sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 50 degrees Celsius:
1) Limit current density to less than 1,000 amps per square inch.
c. Insulate all current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.

3. Ground bus:
a. Copper, solidly bonded.

4. Neutral bus:
a. Provide where indicated on the Drawings.
b. 100 percent rated.
c. Provide lugs for each outgoing feeder requiring a neutral connection.

5. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

C. Lugs:
1. UL listed for copper and aluminum wire:
a. Provide lugs rated for 75-degree Celsius terminations.
b. Provide bolted or compression main lug terminations as required for the incoming cable size.

D. Circuit breakers: As specified in Section 16412 and as indicated on the Drawings:
1. Provide all circuit breakers with bolt-on connections:
a. Plug-in circuit breakers are not allowed.

2.07 ACCESSORIES

A. Surge protective devices:
1. Furnish panelboards with surge protective devices as indicated on the Drawings.
2. As specified in Section 16285.

B. Nameplates:
1. As specified in Section 16075.
2. Install on outside of door.
3. Indicating:
a. Panel designation.
b. Voltage.
c. Number of phases and configuration.

C. Circuit identification labels:
1. Provide index cards behind heavy clear plastic in cardholders on the inside of the doors.
2. Type all information on the cards using designations in the panel schedules.
3. Laminated on both sides.

D. Pad locking mechanism:
1. Provide a pad locking attachment to allow circuit breakers to be locked in the off position.
2. At a minimum, provide 1 mechanism per panelboard:
a. Provide multiple mechanisms if required to accommodate all circuit breaker frame sizes in the panelboard.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat, and 2 coats of oven-baked enamel with manufacturer's standard gray.

B. Finish panelboards mounted in motor control centers to match the motor control center finish and color.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Surface, flush or MCC mounted as indicated on the Drawings.
   2. Mount rigidly to structural members with exposed surfaces plumb and level to within 1/32 inch.
   3. Perform work in accordance with the manufacturer's instructions and shop drawings.
   4. Provide all brackets, hangers, supports, and hardware for mounting as required.
   5. In all NEMA Type 4 and NEMA Type 4X locations, mount panelboards on 7/8-inch deep stainless steel preformed channel, with channel running vertically from top to bottom of panelboard:
      a. Use only stainless steel mounting hardware.
   6. Mount panelboard so that top operating handle is not more than 6 feet-7 inches above the operating floor.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. Factory testing:
   1. Perform standard factory tests on the panelboards:
   2. Test in accordance with the latest version of NEMA and UL standards.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES

A. Circuiting within the panelboard shall match the panel schedules as indicated on the Drawings.

B. Provide typewritten schedule in each panelboard.

END OF SECTION

SECTION 16494

LOW VOLTAGE FUSES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fuses: 600 volt class and lower.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.

1.02 REFERENCES

A. As specified in Section 16050.

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Fuses for overcurrent protection and/or current limiting applications as indicated on the Drawings.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. Catalog cut sheets.
   2. Complete fuse schedule.
   3. Manufacturer original 11-inch by 17-inch, time current curves for all fuses furnished.

C. Shop drawings:
   1. Include drawings of spare fuse cabinets.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. All low voltage fuses shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Spare parts:
   1. Provide 3 spare fuses for each size and type used or supplied under any Section of the Contract Documents.
   2. Provide spare fuse cabinet(s):
      a. Metal cabinet with hinged door and shelves or fuse holders.
      b. Gray enamel finish.
      c. Mount near equipment and label "Spare Fuses" on face of cabinet.
      d. Suitable pocket inside door of each cabinet with typewritten spare fuse inventory in clear plastic protective insert.
      e. Provide as many cabinets as required to hold entire spare fuse inventory.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Ferraz Shawmut.
   2. Littelfuse.
   3. Bussmann.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:
   1. Provide durable, readily visible label inside each fuse enclosure, clearly indicating the correct type, size, and ratings of replacement fuse:
      a. Label shall not cover or interfere with equipment manufacturer's instructions.

2. Affix a label indicating recommended torque for fuse mounting bolts or studs to the inside of fuse access doors.
3. To ensure selective coordination of protective devices:
    a. Provide fuses for new facilities by the same manufacturer.
    b. Provide fuses for renovations of the same manufacturer as existing fuses.
4. Provide fuses rated for the voltage and available short circuit current at which they are applied.

B. Fuses for services, switchboard mains, feeders, and branch circuits:
1. 600 amperes and less:
    a. Provide UL listed RK1 dual-element, time-delay fuses with ampere ratings as indicated on the Drawings except as may be modified by the Contract Documents.
2. 601 to 6,000 amperes:
    a. Provide UL listed Class L fuses.

C. Fuses for motor branch circuits:
1. Ampere ratings shall not exceed motor controller manufacturer's recommended values:
    a. If manufacturer does not have such standards, provide fuses as specified in this Section.
2. Provide Class RK1 fuses or fuses as indicated on the Drawings and as specified in the Contract Documents, rated in accordance with the fuse manufacturer's recommendations for backup running protection of motor circuits containing overload relays.
3. Determine fuse ratings for overload protection of motor branch circuits by actual full-load currents of motors provided.
4. Fuses in motor control centers may be time-delay Class J or Class CC fuses, if MCC manufacturer's standard designs use these fuse types:
    a. Time-delay Class J fuse ratings shall not exceed 150 percent of motor full load current except as permitted.
    b. Follow fuse manufacturer's recommendations for Class CC fuses.
    c. A motor having starting duty or other special characteristics requiring larger fuses than specified above, may have branch circuit fuse ratings increased as necessary to meet motor's requirements, but no larger than maximum permitted by the NEC:
        1) Increased requirements for an individual motor shall not be cause for increasing size of all fuses.
5. Provide Class L fuses for motor branch circuits requiring fuses over 600 amperes, sized at 150 percent of motor full load current except as permitted below:
    a. A motor having starting duty or other special characteristics requiring larger fuses than specified above, may have branch circuit fuse ratings increased as necessary to meet motor's requirements, but no larger than maximum permitted by the NEC:
        1) Increased requirements for an individual motor shall not be cause for increasing size of all fuses.

D. Fusing of control circuits:
1. Provide:
    a. RK1 fuses installed in UL listed Class CC fuse blocks as specified in the Contract Documents.

2. Provide minimum protection for control circuits in accordance with the latest revision of UL Standard 508 for Industrial Control.
3. Fuse both the primary and secondary circuit of control power transformers:
   a. Fuse ratings shall be in accordance with NEC requirements.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. General:
   1. Install fuses properly aligned, electrically and mechanically secure.
   2. Evenly torque mounting bolts and nuts to ASTM recommendations for type and diameter of mounting bolts or studs provided.
   3. Paralleling of fuses is not permitted.
   4. Install fuses so that the fuse nameplate and rating are easily readable in the equipment.

C. Replace fuses, on all phases, for any fuses that opened during start-up and testing.

D. After completion of testing, deliver spare fuses in quantities specified:
   1. Fuses shall be new, in manufacturer's original packaging, and stored in a clean, dry location.

E. Install spare fuse cabinets where instructed by the Owner.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16510

LIGHTING: LED LUMINAIRES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: LED luminaires, drivers, poles, and accessories.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16422 - Motor Starters.

1.02 REFERENCES

A. As specified in Section 16050.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

C. Illuminating Engineering Society of North America (IESNA):
   1. LM-79 - IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.
   2. LM-80 - IES Approved Method: Measuring Lumen Maintenance of LED Light Sources.
   3. TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources.

D. National Electrical Manufacturers Association (NEMA):
   1. 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.

E. Underwriters Laboratories (UL):
   1. 1598 - Luminaires.
   2. 8750 - Light Emitting Diode (LED) Equipment For Use In Lighting Products.

1.03 DEFINITIONS

A. As specified in Section 16050.

B. Specific definitions and abbreviations:
   1. CCT: Correlated color temperature - Scientific scale to describe how “warm” or how “cool” the light source is, measured in Kelvin. The lower the Kelvin temperature, the warmer the light feels, or appears.
   2. CRI: Color Rendering Index - A quantitative measure of the ability of a light source to reveal the colors of various objects faithfully in comparison with an ideal or natural light source.

3. Driver - Device that manages power and controls the current flow from AC to DC for an LED lighting product.
4. Efficacy - Lumen output of a light source per unit of power supplied to that source (lumens per watt).
5. EMI: Electromagnetic Interference - Electrical interference (noise) generated by electrical and electronic devices.
6. FC: Foot Candles - Measure of light level on a surface being illuminated.
7. L70 - The extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from initial values.
8. LED: Light emitting diode - A solid-state semiconductor device that produces light when electrical current flows through it.
9. LED light source - See LED luminaire.
10. LED luminaire - A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit.
11. Lumen - The international (SI) unit of luminous flux or quantity of light. The amount of light that is spread over a square foot of surface by one candle power when all parts of the surface are exactly one foot from the light source.
12. Lumen ambient temperature multiplier - LED light source relative lumen output when compared to a standard ambient temperature.
13. Lumen maintenance factor - How well an LED light source is able to retain its intensity when compared to new.
14. Luminaire - Lighting unit.
15. THD: Total harmonic distortion - The combined effect of harmonic Distortion on the AC waveform produced by a driver or other device.

1.04 SYSTEM DESCRIPTION

A. Provide luminaires, and accessories for all lighting systems, complete and operable, in accordance with the requirements of the Contract Documents.

B. Individual luminaire types are indicated on the Drawings and on the Luminaire Schedule.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Product data:
   1. LED Luminaires:
      a. Catalog literature for each luminaire specified, cross-referenced to the luminaire type on the Luminaire Schedule in the Drawings.
      b. Provide for each luminaire type:
         1) Materials.
         2) Type of diffuser.
         3) Hardware.
         4) Gasketing.
         5) Reflector.
         6) Chassis.
         7) Finish and color.

8) Driver type and protection.
9) LED luminaire:
    a) Initial lumen output at 40 degrees Celsius ambient.
    b) Correlated color temperature.
    c) Lumen maintenance factors.
    d) Lumen ambient temperature multipliers.
    e) Drive current.
    f) Efficacy.
10) Picture of luminaire.
11) Dimensioned drawings:
    a) Effective projected area rating for pole mounted luminaires.
12) Weight.
13) Photometric data:
    a) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
    b) Luminaire dirt depreciation factor.
    c) Candlepower distribution curves.
    d) Average luminaire brightness.
    e) Lumen output charts.
14) Furnish support method for interior luminaires weighing more than 30 pounds and all wall-mounted luminaires:
    a) Support methods shall be based on seismic requirements at the project site as specified in Section 16050.

c. Luminaire substitutions:
    1) Provide complete literature for each luminaire substitution.
    2) Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
        a) Photometric data:
            (1) IES file in standard IES format.
            (2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
            (3) Candlepower distribution curves.
            (4) Average luminaire brightness.
            (5) Lumen output charts.
            (6) Power requirements in watts and volt-amperes.
        b) Calculations:
            (1) Provide software generated calculations showing illuminance levels in foot candles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
                (a) Use surface reflectance values and luminaire light loss factors approved by the Engineer to perform all calculations.
        c) Specification sheets:
            (1) If lacking sufficient detail to indicate compliance with contract documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer's complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L70 life rating, and any modifications

necessary to meet the requirements of the contract documents.

3) Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
4) Substitutions shall comply with all applicable building and energy codes.

2. Driver: Provide for each driver type:
   a. Catalog number.
   b. Type of driver.
   c. Output wattage.
   d. Input voltage.
   e. Operating voltage range.
   f. Maximum input power.
   g. Efficiency.
   h. Operating line current.
   i. Power factor.
   j. Operating temperature range.
   k. Current output range in ambient temperatures of 30 degrees Celsius – 55 degrees Celsius.
   l. Surge suppression data.
3. Photocell:
   a. Provide for each photocell type:
      1) Switching capacity.
      2) Life expectancy when used on LED sources.
      3) The means of adjusting the lighting pickup level.
      4) Enclosure type.
      5) Mounting method.
4. Luminaire poles:
   a. Submit complete data for each pole type including but not limited to:
      1) Material.
      2) Finish and color.
      3) Handholes.
      4) Anchoring.
      5) Luminaire attachment methods and fittings.
      6) Pole height.
      7) Pole dimensions.
      8) Bolt hole circle layout and hardware.
      9) Accessories.
      10) Provide the EPA wind load rating.

C. Calculations:
   1. Provide complete design calculations and installation documents for pole mounting piers and poles mounted from structures:
      a. Include in the calculations the wind and seismic requirements at the project site.
      b. Calculations and design shall be performed by and signed by a Professional Engineer registered in the state where the project is being constructed.

D. Record documents:
   1. Update the Luminaire Schedule in the Drawings to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. Exterior and outdoor lighting system operation shall be demonstrated during the hours of darkness.

B. Lighting demonstration shall occur within 2 weeks before substantial completion.

1.11 WARRANTY

A. As specified in Section 16050.

B. LED luminaire:
   1. 5 year warranty from the date of installation including material, workmanship, photometrics, driver, and LED modules.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Furnish 1 complete spare LED luminaire, with driver, of each type used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Luminaires: One of the following or equal:
   1. As noted on the Luminaire Schedule.

B. Drivers: One of the following or equal:
   1. Philips Advance.
   2. Thomas Research.
   3. eldoLED.

C. Photo-electric cells: One of the following or equal:
   1. Cooper.
   2. Tork.
   3. Intermatic.

D. Substitutions:
   1. The lighting design and luminaire selection has been based upon the photometric data of the identified luminaire. It is the Contractor's responsibility to ensure and prove to the Engineer at time of submittal the substitutions meet the quality and photometric requirements of the original design.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. LED Luminaires:
   1. General:
      a. Pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
      b. Provide the luminaires furnished per the Luminaire Schedule in the Drawings:
         1) The Specifications noted herein are an addition or supplement to the Luminaire Schedule.
      c. Individual LEDs connected such that a catastrophic loss or the failure of 1 LED will not result in the loss of the entire luminaire.
   2. Minimum ambient temperature range of 0 degrees Celsius to 40 degrees Celsius.
   3. Minimum rated life:
      a. Office Areas: 70,000 hours when operated at 25 degrees Celsius.
      b. Process Areas: 60,000 hours when operated at 40 degrees Celsius.
   4. Minimum efficacy of 70 lumens/watt.
   5. Minimum Color Rendering Index of 70.
   6. Tested according to IESNA LM-79 and LM-80.
   7. Lumen maintenance projection in accordance with IESNA TM-21.
   8. RoHS compliant.
   9. Integral driver.
   10. Suitable for dry, damp, or wet locations as indicated on the Drawings or on the Luminaire Schedule:
      a. Wet or damp locations: UL 1598 listed.
   11. Designed as a complete LED assembly. Retrofit LED lamps in luminaires not designed specifically for LED light sources shall not be used.

12. Exterior/outdoor luminaires:
    a. Luminaires in combination with their mounting pole and bracket shall be capable of withstanding:
        1) Wind levels at the project site without damage.
        2) Seismic levels at the project site.
    b. Corrosion-resistant hardware and hinged doors or lens retainer.
    c. Luminaires furnished with integral photoelectrical control shall be of the luminaire manufacturer's standard design.
    d. California Energy Code Light Pollution Reduction Compliance:
        1) Provide all exterior luminaires with cutoff photometrics.
13. Luminaires in hazardous areas:
    a. In accordance with NEC Section 500 requirements.
    b. UL labeled and identified for hazardous area.
    c. Marking on Class I and II Division 1 and 2 areas shall identify the applicable material classification group.
    d. Marking shall include the temperature class (T code).

B. Photo-electric cells:
1. Photoelectric cells for control of multiple luminaires:
    a. Self-contained.
    b. Weatherproof.
    c. Provided with time-delay features.
    d. Sized to meet switching capacity of the circuit:
        1) Based on luminaire VA as indicated on the Drawings.
2. Photoelectric cell for control of a single luminaire:
    a. Integral to the luminaire.

C. Luminaire control:
1. Lighting control relays or contactors as specified in Section 16422.

D. Drivers:
1. Dimmable, with dimming signal protocol of 0-10 VDC or DALI.
2. Input power source:
    a. As indicated on the Drawings.
3. Drive current:
    a. As indicated in the Luminaire Schedule.
4. Power factor: greater than 0.90.
5. Efficiency: greater than 80 percent.
6. Total harmonic distortion (THD) of the input current less than 20 percent.
7. Rated life of 60,000 hours in an LED luminaire operated at an ambient temperature of 40 degrees Celsius.
8. Minimum operating temperature of 0 degrees Celsius.
9. Sound rating: Class A+ or quieter.
10. UL listed Class 2 Outdoor in accordance with UL 8750.
11. In accordance with IEEE C62.41 Category A for transient protection.
12. Driver must limit inrush current:
    a. Meet or exceed NEMA 410 driver inrush standard:
        1) 230 Amps per 10 Amp load with a maximum of 106 Amps squared-seconds at 120V.
        2) 430 Amps per 10 Amp load with a maximum of 370 Amps squared-seconds at 277V.

2.06 COMPONENTS

A. Luminaire poles:
   1. As indicated on the Luminaire Schedule.
   2. Anchor bolts:
      a. Use anchor bolts, bolts, or welded studs for anchors for resisting seismic and wind forces:
         1) Standard hex bolt head.
         2) Do not use anchor bolts fabricated from rod stock with an L or J-shape.
      b. Complete with leveling shims.
   3. Anchor base:
      a. Fabricated from the same type of material as the pole shaft.
      b. Base plate to telescope the pole shaft.
      c. Welded top and bottom along the entire perimeter.
      d. With slotted bolt holes on the bolt circles as submitted.
   4. Pole shaft:
      a. As indicated on the Luminaire Schedule.
   5. Handhole:
      a. Reinforced handhole located approximately 18 inches above the base.
      b. Complete with cover fabricated from the same material as the pole shaft and stainless steel attachment screws.
      c. With an integral ground connection nut, 1/2 inch by 13 inch UNC welded to the pole for connection to the grounding system.
   6. Shroud:
      a. Fabricated from the same type of material as the pole shaft.
      b. 1-piece formed channel section that shall conform to the pole shaft taper.
      c. Secured by a locking device with provisions for a padlock to prevent accidental lowering.
   7. Fastening hardware:
      a. All fasteners shall be stainless steel.
   8. Finish:
      a. As indicated on the Luminaire Schedule.

2.07 ACCESSORIES

A. Pole mounted convenience outlet:
   1. Where indicated, furnish a 120 Volt, GFCI protected receptacle:
      a. Integrally mounted in the pole shaft at 24 inches above the base.
   2. Complete with corrosion resistant and weatherproof cover.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install luminaires per the manufacturer's guidelines and submitted installation calculations to meet seismic and wind requirements at the project site.

C. Special techniques:
   1. Support luminaires from structural elements capable of carrying the total weight.
   2. Install luminaires plumb and square with building and wall intersections:
      a. Suspend pendant-mounted luminaries that are mounted from sloping ceilings with ball hangers, unless otherwise indicated on the Drawings.
      b. Install luminaires in machinery rooms after machines have been installed, so as to ensure no conflict with machinery, piping, or ductwork.
   3. In all cases, coordinate luminaire locations with work of other trades to prevent obstruction of light from the fixtures:
      a. Locate bottom of luminaire approximately at the bottom of ductwork, unless otherwise specified or indicated on the Drawings.
   4. Support luminaires weighing more than 25 pounds independently of the outlet box and the conduit.
   5. Provide ceiling or pendent mounted luminaires with a safety chain connecting the lens, driver, and other components to the building structure.
   6. Provide recessed luminaires with auxiliary safety supports attached directly to the building structure:
      a. The safety supports shall consist of number 12 AWG soft drawn galvanized wires.
   7. Install luminaires in accordance with the architectural reflected ceiling Drawings:
      a. Center luminaires on ceiling tiles unless otherwise indicated.
   8. Support luminaires installed in suspended grid ceilings, independently of the grid:
      a. Provide seismic restraint clips for all luminaires installed in suspended grid ceilings.

D. Luminaire poles:
   1. Set poles on anchor bolts and secured with double nuts on each bolt.
   2. Dry-pack the pole base, after the luminaire and pole has been leveled and plumbed.
   3. Bond metal poles to the plant grounding system, utilizing a ground lug connection within the pole:
      a. Route ground conductor through pier and pole base sleeve using Schedule 40 PVC conduit.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING

A. Aim and verify all exterior and outdoor luminaires alignment, during dark evening hours, as directed by Owner or the Engineer.

3.10 CLEANING

A. As specified in Section 16050.

B. Clean all lenses, diffusers, and reflectors.

C. Refinish all luminaires' trim, poles and support brackets, where finish has been damaged.

D. Clean all LED luminaires (new and old), used during construction for construction lighting, before substantial completion.

E. Clean and re-lamp all existing fluorescent and HID luminaires used during construction for construction lighting, before substantial completion.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES

A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION

SECTION 16920

PRE-FABRICATED WALK-IN ELECTRICAL ENCLOSURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pre-fabricated walk-in electrical enclosures, completely engineered and assembled.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01410 - Regulatory Requirements.
   3. Section 01756 - Commissioning.
   4. Section 03300 - Cast-In-Place Concrete.
   5. Section 16050 - Common Work Results for Electrical.
   6. Section 16123 - 600-Volt or Less Wires and Cables.
   7. Section 16130 - Conduits.
   8. Section 16140 - Wiring Devices.
   9. Section 16510 - Lighting: LED Luminaires.

1.02 REFERENCES

A. As specified in Section 16050.

B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
   1. 210/240 - Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.
   2. 270 - Sound Rating of Outdoor Unitary Equipment.
   3. 340/360 - Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.

C. Air Moving and Conditioning Association International, Inc. (AMCA):
   1. Standard 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.

D. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., (ASHRAE):
   1. Standard 15 - Safety Standard for Refrigeration Systems.
   2. Standard 52.2 - Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size.
   3. Standard 62 - Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings.

E. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

F. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems – Requirements.

G. National Electrical Manufacturer's Association (NEMA):
   1. NEMA Type TEFC enclosure in accordance with NEMA 250.

H. National Fire Protection Association:
   1. NFPA 70 - National Electric Code (NEC).
   2. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

I. Steel Structures Painting Council (SSPC):
   1. SP-1 - Solvent Cleaning.
   2. SP-2 - Hand Tool Cleaning.
   3. SP-3 - Solvent Cleaning.

J. Underwriters Laboratories Inc. (UL).

K. Title 24 of the California Code of Regulations (Title 24).

1.03 DEFINITIONS

A. As specified in Section 16050.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Designed and environmentally controlled to provide protection to all equipment it contains under the specified Project Site conditions:
      a. Size the enclosure to accommodate the actual equipment furnished including all Code required clearances and access.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. Furnish submittals for all electrical equipment contained within the enclosure as required by the section covering the equipment.

C. Product data:
   1. Manufacturer of enclosure.
   2. Manufacturer of component parts of enclosure.
   3. Weight of enclosure.
   4. Complete bill of material indicating quantity, description, and part number.
   5. Anchorage hardware.
   6. Enclosure infrastructure, including but not limited to:
      a. Lighting fixtures.
      b. Receptacles.
      c. Raceways.
      d. Wire.
      e. HVAC equipment.

D. Shop drawings:
   1. Layout drawings:
      a. Provide fully dimensioned and to scale equipment layout drawings which include:
         1) Enclosure plan view including layout of internal equipment.
         2) Enclosure elevations of front, back and both sides.
         3) Enclosure base/skid plan including mounting details, cable entry areas and floor openings, and door swing requirements.
   2. Wiring diagrams:
      a. Provide detailed raceway layout and wiring diagrams for all interconnections within the enclosure, including conduit sizes and wire fill.

E. Installation instructions:
   1. Provide written instructions detailing the complete installation of the enclosure, including rigging, moving, setting into place, and combination of shipping splits where applicable.
   2. Provide complete instructions and requirements for anchoring the enclosure to meet the seismic requirements at the Project Site as specified in Section 16050:
      a. Instructions and requirements must be stamped by a professional engineer licensed in the state where the Project is being constructed.

F. Calculations:
   1. Provide complete structural calculations indicating that the enclosure, and anchorage are suitable for the seismic and wind requirements at the project site:
      a. Calculations must be stamped by a structural engineer licensed in the state of California.
   2. Provide complete heating and cooling calculations indicating that the HVAC system supplied will maintain the internal enclosure temperature specified in this Section under the Project/Site Conditions as specified in Section 16050.
   3. Provide complete lighting calculations indicating that the lighting system provided meets the requirements specified in this Section.

G. Provide samples of available exterior finish colors to Owner for selection.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. The manufacturer of the enclosure shall be ISO 9001 certified.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050.

1.08 PROJECT/SITE CONDITIONS

A. As specified in Section 16050.

B. Environmental requirements:
   1. Provide enclosures that are suitable for operation under the project site conditions specified in the Contract Documents, including, but not limited to, material compatibility, site altitude, site seismic, ambient temperature, and humidity conditions.

1.09 SEQUENCING

A. Do not install conduit or ductbanks that will enter the enclosure from below until final approval of the enclosure submittal.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP

A. As specified in Section 16050.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Atkinson Industries.
   2. Eaton/Cutler-Hammer.
   3. General Electric.
   4. Powell Electrical Manufacturing Company.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:
   1. Metal construction; self-supporting and freestanding. Free from burrs and sharp edges.
   2. Interlocked, self-framing design, or framed design using minimum 3-inch square ASTM A500 structural grade steel tubing and welded connections.

B. Base:
   1. All welded, seamless construction utilizing ASTM A36 structural steel members sized by structural design calculations to meet or exceed the required static and dynamic loads.

2. Locate structural members to coordinate with the enclosed equipment, to properly support it and to allow maximum access to equipment floor openings for cable penetration.
3. Provide lifting lugs capable of lifting the fully equipped electrical enclosure at the specified lifting points with deflection not exceeding L/240.
4. Provide 2 copper grounding pads located at diagonally opposite corners of the structure:
    a. Mechanically bond ground pads to the base steel of the enclosure.
    b. Include two 3/8-inch -16 UNC threaded brass studs on each ground pad assembly to permit connection of a NEMA Type 2-hole cable lug.

C. Floor:
1. Constructed of minimum 1/4-inch thick ASTM A36 smooth steel plate securely welded to the structural steel members of the enclosure base.
2. Rated to withstand not less than 250 pounds per square foot distributed load, and rated to withstand the concentrated load of any equipment installed into the enclosure.
3. Where bottom access is required for electrical equipment, provide floor cutouts with gasketed removable 12-gauge galvanized steel cover plates.

D. Walls:
1. Constructed with an exterior wall of minimum 18-gauge steel and an interior wall of minimum 16-gauge steel.
2. Where wall penetrations are required, cutouts shall be completely framed by coverplates with neoprene gaskets.

E. Enclosure roof and ceiling:
1. Enclosures shall be constructed with a roof panel of minimum 18-gauge steel and a ceiling panel of minimum 16-gauge steel.
2. The roof shall be designed to withstand a minimum live load of 20 pounds per square foot, and shall be designed to support interior and exterior equipment loads without compromising roof load design.
3. Where roof penetrations are required, provide flashing, adequately sealed, to maintain the weatherproof integrity of the roof.

F. Insulation:
1. Walls and roof insulated to the R-11 level using fiberglass batt material installed between the inner and outer steel panels.
2. Floor insulated to the R-11 level using polyurethane foam installed on the underside of the floor.

G. Doors:
1. Personnel and equipment doors:
    a. Provide doors sized and located as indicated on the Drawings.
    b. Double wall steel construction with R-15 thermal insulation.
    c. Include interior panic hardware with exterior knob and cylinder lock, interior automatic closure devices and integrated hold open devices.
    d. Outwards opening with a minimum swing of 105 degrees.
    e. Provide drip shields above each door.
    f. Provide a 24-inch removable transom above each equipment door.

H. Wiring and raceways:
    1. Wire and cable as specified in Section 16123.
    2. Use one of the following raceway types to route wiring within the enclosure for all lights, receptacles, HVAC, and other equipment installed within the enclosure:
        a. Conduit as specified in Section 16130.

2.05 EQUIPMENT

A. Furnish, install, and test all equipment within the enclosure in conformance with the applicable equipment section.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. HVAC system:
    1. Provide an HVAC system designed to maintain an ambient temperature of between 60 and 80 degrees Fahrenheit under the worst case site conditions specified in Section 01610.
    2. Mounted to the wall or roof of the enclosure.
    3. HVAC equipment shall operate at 480 V, 3- phase and shall include a lockable circuit breaker or disconnect switch. It is the responsibility of the enclosure supplier to ensure that the overcurrent protection for all HVAC equipment is sized in accordance with NEC.
    4. Provide units in one piece, factory assembled, piped, internally wired, charged with refrigerant and compressor oil, and tested.
    5. Design requirements:
        a. Electrical components: UL listed and met the design and installation requirements of the NEC.
        b. Gas, water piping, drains, and venting: In accordance with building code, mechanical code, and plumbing code as specified in Section 01410 and in accordance with NFPA 90A.
        c. Fans: Rated in accordance with AMCA 210.
        d. Unit air conditioners: Rated in accordance with AHRI Standards 210/240 or 340/360 and AHRI 270. In accordance with the latest version of ASHRAE 15.
        e. Energy efficiency ratio (EER) of 10.3 as rated in accordance with AHRI 210/240 or 340/360 and 270.
    6. Compressors:
        a. Fully hermetically sealed, high efficiency, reciprocating or rotary or scroll type, with rubber grommet vibration isolation.
        b. Utilize HFC-134a or HFC -410a as the refrigerant.
    7. Fans:
        a. Indoor air fan:
            1) Direct driven with capacitor start motor: Fan centrifugal type, steel with corrosion resistant finish, statically and dynamically balanced.
            2) Bearings: Permanently sealed ball bearing type and permanently lubricated.

b. Outdoor condenser fan:
1) Propeller type, direct drive, aluminum blades, dynamically balanced.
2) Bearings: Permanently sealed ball bearing type and permanently lubricated.

8. Coils:
a. Evaporator and condenser coils: Seamless copper tubes with mechanically bonded aluminum plate fins.

9. Refrigerant components: Refrigerant circuit including:
a. Accumulator and filter/drier.
b. Expansion device.
c. Flow control valves.
d. Service and gauge connections on compressor suction and discharge, and liquid lines to charge, evacuate, and contain refrigerant.

10. Controls:
a. Provide system controls for a complete functioning system controlled by an electronic, automatic changeover thermostat. Thermostat shall be mounted on an insulated backing plate.

11. Electrical:
a. Provide for single external power connection.

12. Unit casing:
a. Slide out design unit casing manufactured galvanized steel with electrically bonded finish and outdoor components top coated with high solids polyester finish.
b. Weatherproof design, reinforced and braced for maximum rigidity.
c. Provided with:
1) Filter rack for filters accessible through the front of the unit.
2) Non-corrosive drain pan in accordance with ASHRAE Standard 62.
3) Horizontal drain connection.
4) Knockouts for power connections.
5) Provide wall sleeve of galvanized steel coated similar to unit casing.

13. Air filters: 25 to 30 percent efficiency when rated in accordance with ASHRAE Standard 52.2.

14. Extra materials:
a. Provide 2 extra sets of filters per unit installed.

B. Lighting:
1. Interior lighting:
a. Provide a lighting system capable of producing 40 foot candles of light at a level 3 feet above enclosure floor at the end of the expected luminaire life.
b. Industrial grade, totally enclosed, fully gasketed LED fixtures, UL listed for damp locations:
1) Operating voltage: 120 V.
c. Provide light switches at each door to control interior light fixtures.

2. Emergency lighting:
a. Provide one of the following:
1) Industrial grade emergency lighting fixture with thermoplastic enclosure, 12-volt nickel cadmium battery, and minimum 90-minute operating capacity, mounted above each exterior door:
a) Or LED equivalent.
2) Battery backup within the overhead lighting to supply the required egress lighting.

3. Exterior lighting:
    a. Provide an industrial grade, LED wall pack fixture with IES cutoff distribution, UL listed for wet locations, mounted above each exterior door, with battery backup.
    b. Exterior lighting fixtures shall be automatically controlled by a photocell with HAND-OFF-AUTO switch for photocell over-ride.
4. Provide lighting equipment conforming to Section 16510.

C. Receptacles:
1. Provide receptacles installed and tested by the enclosure supplier, located as indicated on the Drawings.
2. Provide receptacles conforming to Section 16140.

D. Padlocks:
1. Master Lock or equal.
2. Provide for each individual access door:
3. Weather-resistant, rated for outdoor use.
4. Single-keyed:
    a. Furnish 2 keys for each lock.
    b. For uniquely keyed locks, provide labels permanently affixed to the keys, padlocks, and sections indicating which keys correspond to which padlock.
5. Provide 2 spare padlocks and associated keys.

E. Structural pad:
1. Install a structural pad fully capable of supporting the enclosure and all equipment it contains based on the seismic and wind requirements at the Project Site. Minimum pad dimensions and reinforcement is show on the Drawings. Coordinate final pad dimensions with enclosure manufacturer and modify reinforcement as required.
2. Concrete materials and Work for the structural pad shall as specified in Section 03300.
3. If necessary, design of the structural pad shall be performed by a professional structural engineer licensed in the state of California.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. General:
1. Thoroughly clean and prepare all surfaces according to SSPC-SP-1 and either SSPC-SP-2 or SSPC-SP-3, as required to remove all oil, grease, soil, rust, and scale before applying any coatings or paint.

B. Base:
1. Sandblast the entire base to completely remove to rust and scale before painting.
2. Coat the base with an industrial grade, high solid, high build epoxy with a minimum dry film thickness of 4 mils.

C. Floor:
   1. Thoroughly coat the floor with an epoxy primer with a final dry film thickness of 2-3 mils and finish with a coat of non-skid manufacturer's standard gray epoxy with a dry film thickness of 2 to 3 mils.

D. Interior walls and ceiling:
   1. Either electrostatically apply a white polyester powder with a final baked on thickness between 2 and 4 mils or apply a white epoxy paint applied to a dry film thickness of between 2 and 3 mils.

E. Exterior walls and roof panels:
   1. Either electrostatically apply polyester powder with a final baked on thickness between 2 and 4 mils or apply a vinyl wash primer coat with a minimum dry film thickness of 1 mil followed by a final coat of epoxy paint with a dry film thickness of between 2 to 3 mils:
      a. Provide UV resistant coatings or paint on all exterior walls and roof panels.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050.

B. Install the enclosure per manufacturer's guidelines and submitted installation instructions to meet the seismic requirements at the project site.

C. Any components or panels damaged during installation shall be replaced.

D. Install enclosures so that their surfaces are plumb and level within 1/8 inch over their entire base.

E. Install gasket and sealing material under enclosures with floor slab cutouts for conduit and cables to prevent entry of dust, debris, or vermin into the enclosure and equipment contained therein.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16950

FIELD ELECTRICAL ACCEPTANCE TESTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Responsibilities for testing the electrical installation.
   2. Adjusting and calibration.
   3. Acceptance tests.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01756 - Commissioning.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16060 - Grounding and Bonding.

C. Copyright information:
   1. Some portions of this Section are copyrighted by the InterNational Electrical Testing Association, Inc (NETA). See NETA publication ATS for details.

1.02 REFERENCES

A. As specified in Section 16050.

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):
   1. D877 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   2. D923 - Standard Practices for Sampling Electrical Insulating Liquids.
   3. D971 - Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   4. D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   5. D1298 - Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   6. D1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   7. D1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   8. D1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
   9. D2285 - Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop Weight Method.
   10. D3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.

D. Institute of Electrical and Electronics Engineers (IEEE):

1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
2. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
3. 95 - IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2300 V and Above) With High Direct Voltage.
4. 421.3 - IEEE Standard for High-Potential Test Requirement for Excitation Systems for Synchronous Machines.
5. 450 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
6. 1106 - IEEE Recommended Prictice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications.
7. 1188 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
8. C57.13 - IEEE Standard Requirements for Instrument Transformers.
9. C57.13.1 – IEEE Guide for Field Testing of Relaying Current Transformers.
10. C57.13.3 - IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.
11. C57.104 - IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers.

E. Insulated Cable Engineer's Association (ICEA).

F. InterNational Electrical Testing Association (NETA).
   1. ATS-2009 Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

G. International Electrotechnical Commission (IEC).

H. Manufacturer's testing recommendations and instruction manuals.

I. National Fire Protection Association (NFPA):
   1. 70 – National Electrical Code (NEC).
   2. 110 - Standard for Emergency and Standby Power Systems.

J. National Institute of Standards and Technology (NIST).

K. Specification sections for the electrical equipment being tested.

L. Shop drawings.

1.03 DEFINITIONS

A. As specified in Sections 01756 and 16050.

B. Specific definitions:
   1. Testing laboratory: The organization performing acceptance tests.

1.04 SYSTEM DESCRIPTION

A. Testing of all electrical equipment installed under this Contract in accordance with the manufacturer's requirements and as specified in this Section.

B. Conduct all tests in the presence of the Engineer or the Engineer's representative:
   1. The Engineer will witness all visual, mechanical and electrical tests and inspections.

C. The testing and inspections shall verify that the equipment is operational within the tolerances required and expected by the manufacturer, and these Specifications.

D. Responsibilities:
   1. Contractor responsibilities:
      a. Ensure that all resources are made available for testing, and that all testing requirements are met.
   2. Electrical subcontractor responsibilities:
      a. Perform routine tests during installation.
      b. Demonstrate operation of electrical equipment.
      c. Commission the electrical installation.
      d. Provide the necessary services during testing, and provide these services to the testing laboratory, Contractor, and other subcontractors, including but not limited to:
         1) Providing electrical power as required.
         2) Operating of electrical equipment in conjunction with testing of other equipment.
         3) Activating and shutting down electrical circuits.
         4) Making and recording electrical measurements.
         5) Replacing blown fuses.
         6) Installing temporary jumpers.
   3. Testing laboratory responsibilities:
      a. Perform all acceptance tests specified in this Section.
      b. Provide all required equipment, materials, labor, and technical support during acceptance tests.

E. Upon completion of testing or calibration, attach a label to all serviced devices:
   1. The label shall indicate the date serviced and the company that performed the service.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 16050.

B. LAN cable test form:
   1. LAN cable test reports:
      a. Submit 3 copies of test reports showing the results of all tests specified in this Section:
         1) Test type.
         2) Test location.
         3) Test date.
         4) Cable number.
         5) Cable length.
         6) Certification that the cable meets or exceeds the specified standard.
      b. Furnish hard copy and electronic copy for all traces.

C. Manufacturers' testing procedures:
   1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer.

D. Test report:
   1. Include the following:
      a. Summary of Project.
      b. Description of equipment tested.
      c. Description of tests performed.
      d. Test results.
      e. Conclusions and recommendations.
      f. Completed test forms.
      g. List of test equipment used and calibration dates.
      h. LAN cable test reports.

E. Testing laboratory qualifications:
   1. Submit a complete resume and statement of qualifications from the proposed testing laboratory detailing their experiences in performing the tests specified:
      a. This statement will be used to determine whether the laboratory is acceptable, and shall include:
         1) Corporate history and references.
         2) Resume of individual performing test.
         3) Equipment list and test calibration data.

F. Division of responsibilities:
   1. Submit a list identifying who is responsible for performing each portion of the testing.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050.

B. Testing laboratory qualifications:
   1. The testing laboratory may be qualified testing personnel from the electrical subcontractor's staff or an independent testing company.
   2. Selection of the testing laboratory and testing personnel is subject to approval by the Engineer based on testing experience and certifications of the individuals and testing capabilities of the organization.

1.07 DELIVERY, STORAGE, AND PROTECTION (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050.

1.09 SEQUENCING

A. At least 30 days before commencement of the acceptance tests, submit the manufacturer's complete field testing procedures to the Engineer and to the testing laboratory, complete with expected test results and tolerances for all equipment to be tested.

B. Perform testing in the following sequence:
   1. Perform routine tests as the equipment is installed including:
      a. Insulation-resistance tests.
      b. Continuity tests.
      c. Rotational tests.

2. Adjusting and preliminary calibration.
3. Acceptance tests.
4. Demonstration.
5. Commissioning and plant start-up.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Test instrument calibration:
   1. Utilize a testing laboratory with a calibration program which maintains all applicable test instrumentation within rated accuracy.
   2. The accuracy shall be traceable to the NIST in an unbroken chain.
   3. Calibrate instruments in accordance with the following frequency schedule:
      a. Field instruments: 6 months maximum.
      b. Laboratory instruments: 12 months maximum.
      c. Leased specialty equipment where the accuracy is guaranteed by the lessor (such as Doble): 12 months maximum.
   4. Dated calibration labels shall be visible on all test equipment.
   5. Maintain an up-to-date instrument calibration record for each test instrument:
      a. The records shall show the date and results of each calibration or test.
   6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.

B. Do not begin testing until the following conditions have been met:
   1. All instruments required are available and in proper operating condition.
   2. All required dispensable materials such as solvents, rags, and brushes are available.
   3. All equipment handling devices such as cranes, vehicles, chain falls and other lifting equipment are available or scheduled.
   4. All instruction books, calibration curves, or other printed material to cover the electrical devices are available.
   5. Data sheets to record all test results are available.

C. Engine generator tests:

1. The following individuals must be present and remain at the site during the entire field testing of the engine generator:
    a. Manufacturer's field engineer for the voltage regulator.
    b. Manufacturer's field engineer for the governor and governor controller.
    c. Manufacturer's field engineer for the switchgear.
    d. Load bank operator.
    e. Electrical contractor.

3.03 INSTALLATION (NOT USED)

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

3.08 FIELD QUALITY CONTROL

A. Dry type transformers:
    1. Visual and mechanical inspection:
        a. Compare equipment nameplate data with the Contract Documents.
        b. Inspect physical and mechanical condition.
        c. Inspect anchorage, alignment, and grounding.
        d. Verify that resilient mounts are free and that any shipping brackets have been removed.
        e. Inspect equipment for cleanliness.
        f. Inspect bolted electrical connections for high resistance using one of the following methods:
            1) Use of low-resistance ohmmeter.
            2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
                a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
        g. Verify that as-left tap connections are as specified.
    2. Electrical tests:
        a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
        b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground:
            1) Apply voltage in accordance with manufacturer's published data.
                a) Refer to NETA ATS tables in the absence of manufacturer's published data.
        c. Calculate dielectric absorption ration or polarization index.
        d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral after energization and before loading.
    3. Test values:
        a. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:
   1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Tap connections are left as found unless otherwise specified.

d. Minimum insulation-resistance values of transformer insulation shall be in accordance with manufacturer's published data:
   1) Refer to NETA ATS tables in the absence of manufacturer's published data.
   2) Investigate insulation values less than the allowable minimum.

e. The dielectric absorption ratio or polarization index shall not be less than 1.0.

f. Turns-ratio results should not deviate more than 1/2 percent from either the adjacent coils or calculated ratio.

g. Phase-to-phase and phase-to-neutral secondary voltages shall be in agreement with nameplate data.

B. Low voltage cables, 600 volt maximum:

1. Visual and mechanical inspection:
   a. Compare cable data with the Drawings and Specifications.
   b. Inspect exposed sections of cable for physical damage and correct connection as indicated on the Drawings.
   c. Inspect bolted electrical connections for high resistance by 1 of the following methods:
      1) Use of low-resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
         a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
   d. Inspect compression applied connectors for correct cable match and indentation.
   e. Inspect for correct identification and arrangement.
   f. Inspect cable jacket insulation and condition.
2. Electrical tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors:
      1) Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable.
      2) Test duration shall be 1 minute.
   c. Perform continuity tests to insure correct cable connection.
   d. Verify uniform resistance of parallel conductors.
3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Insulation-resistance values shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.
2) Investigate values of insulation-resistance less than the allowable minimum.

c. Cable shall exhibit continuity.
d. Investigate deviations in resistance between parallel conductors.

C. Low voltage molded case and insulated case circuit breakers:
1. Visual and mechanical inspection:
a. Compare equipment nameplate data with the Contract Documents.
b. Inspect physical and mechanical condition.
c. Inspect anchorage and alignment.
d. Verify that all maintenance devices are available for servicing and operating the breaker.
e. Verify the unit is clean.
f. Verify the arc chutes are intact.
g. Inspect moving and stationary contacts for condition and alignment.
h. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
i. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturers published data.
j. Operate circuit breaker to ensure smooth operation.
k. Inspect bolted electrical connections for high resistance by one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
l. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
m. Verify cell fit and element alignment.
n. Verify racking mechanism operation.
o. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
p. Perform adjustments for final protective device settings in accordance with the coordination study.
q. Record as-found and as-left operation counter readings.
2. Electrical tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
b. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole:
1) Apply voltage in accordance with manufacturer's published data.
2) Refer to NETA ATS tables in the absence of manufacturer's published data.
c. Perform a contact/pole-resistance test.
d. Determine long-time pickup and delay by primary current injection.
e. Determine short-time pickup and delay by primary current injection.
f. Determine ground-fault pickup and delay by primary current injection.
g. Determine instantaneous pickup value by primary current injection.

h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
i. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function and trip unit battery condition:
   1) Reset all trip logs and indicators.
j. Verify operation of charging mechanism.

3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
   c. Insulation-resistance values shall be in accordance with manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
      2) Investigate values of insulation-resistance less than the allowable minimum.
   d. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
      1) If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
   e. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band including adjustment factors:
      1) If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
   f. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
   g. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
   h. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
   i. Pickup values and trip characteristics shall be within manufacturer's published tolerances.
   j. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
   k. Breaker open, close, trip, trip-free, antipump, and auxiliary features shall function as designed.
   l. The charging mechanism shall operate in accordance with manufacturer's published data.

D. Low voltage air power circuit breakers - ANSI class breakers:

1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify that all maintenance devices are available for servicing and operating the breaker.
    e. Verify the unit is clean.
    f. Verify the arc chutes are intact.
    g. Inspect moving and stationary contacts for condition and alignment.
    h. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
    i. Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism in accordance with manufacturer's published data.
    j. Inspect bolted electrical connections for high resistance by one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.
    k. Verify cell fit and element alignment.
    l. Verify racking mechanism operation.
    m. Lubrication requirements:
        1) Verify appropriate lubrication on moving current-carrying parts.
        2) Verify appropriate lubrication on moving and sliding surfaces.
    n. Perform adjustments for final protective device settings in accordance with the coordination study.
    o. Record as-found and as-left operation counter readings.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase to ground with the circuit breaker closed, and across each open pole:
        1) Test voltage shall be in accordance with manufacturer’s published data.
        2) Refer to NETA ATS tables in the absence of manufacturer’s published data.
    c. Perform a contact/pole-resistance test.
    d. Determine long-time pickup and delay by primary current injection.
    e. Determine short-time pickup and delay by primary current injection.
    f. Determine ground-fault pickup and delay by primary current injection.
    g. Determine instantaneous pickup value by primary current injection.
    h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer’s published data.
    i. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function and trip unit battery condition:
        1) Reset all trip logs and indicators.
    j. Verify operation of charging mechanism.
3. Test values:

a. Compare bolted connection resistance values to values of similar connections:
    1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b. Bolt-torque levels shall be in accordance with manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of manufacturer's published data.
c. Settings shall comply with coordination study requirements.
d. Operations counter shall advance 1 digit per close-open cycle.
e. Insulation-resistance values shall be in accordance with manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of manufacturer's published data.
    2) Investigate values of insulation-resistance less than the allowable minimum.
f. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
    1) If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
g. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band including adjustment factors:
    1) If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
h. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
i. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
j. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances:
    1) Refer to NETA ATS tables in the absence of manufacturer's published data.
k. Pickup values and trip characteristics shall be within manufacturer's published tolerances.
l. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data:
    1) Refer to NETA ATS tables in the absence of manufacturer's published data.
m. Auxiliary features shall operate in accordance with manufacturer's published data.
n. The charging mechanism shall operate in accordance with manufacturer's published data.

E. Instrument transformers:
    1. Visual and mechanical inspection:
        a. Compare equipment nameplate data with the Contract Documents.
        b. Inspect physical and mechanical condition.
        c. Verify correct connection of transformers with system requirements.
        d. Verify that adequate clearances exist between primary and secondary circuit wiring.

e. Verify the unit is clean.
f. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
        a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
g. Verify that all required grounding and shorting connections provide contact.
h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
i. Verify correct primary and secondary fuse sizes for voltage transformers.
j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
k. Verify instrument transformer polarities match the 3-line diagrams.

2. Electrical tests - current transformers:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1,000 VDC for 1 minute:
        1) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
    c. Perform a polarity test of each current transformer in accordance with IEEE C57.13.1.
    d. Perform a ratio verification test using the voltage or current method in accordance with IEEE C57.13.1.
    e. Perform an excitation test on current transformers used for relaying applications in with accordance with IEEE C57.13.1.
    f. Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1.
    g. Perform an excitation test on transformers used for relaying applications in accordance with IEEE C57.13.1.
    h. When applicable perform insulation-resistance tests on the primary winding with the secondary grounded:
        1) Test voltages shall be in accordance with NETA ATS tables.
    i. When applicable perform dielectric withstand tests on the primary winding with the secondary grounded:
        1) Test voltages shall be in accordance with NETA ATS tables.
    j. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
    k. Verify that current transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
        1) That grounding point should be located as specified by the Engineer in the Contract Documents.
3. Electrical tests - voltage transformers:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform insulation-resistance tests winding-to-winding and winding-to-ground:
        1) Test voltage shall be applied for 1 minute in accordance with NETA ATS requirements.

2) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

c. Perform a polarity test on each voltage transformer to verify the polarity marks on H_1- X_1 relationship as applicable.

d. Perform a turns ratio test on all tap positions.

e. Measure voltage circuit burdens at transformer terminals.

f. Perform a dielectric withstand test on the primary windings with the secondary windings grounded:

1) The dielectric voltage shall be in accordance with NETA ATS tables.

2) Apply the test voltage for 1 minute.

g. Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturers published data.

h. Verify that voltage transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:

1) That grounding point should be located as specified by the Engineer in the Contract Documents.

4. Test values:

a. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Insulation-resistance values of instrument transformers shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

d. Polarity results shall agree with transformer markings.

e. Ratio errors shall be in accordance with IEEE C57.13.

f. Excitation results for current transformers shall match the curve supplied by the manufacturer or be in accordance with IEEE C57.13.1.

g. Measured burdens shall be compared to instrument transformer ratings.

h. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the current transformer primary winding is considered to have passed the test.

i. Power-factor or dissipation-factor values shall be compared to manufacturer's published data:

1) In the absence manufacturer's published data the comparison shall be made to similar breakers.

j. Test results shall indicate that the circuits have only 1 grounding point.

F. Metering devices:

1. Visual and mechanical inspection:

a. Compare equipment nameplate data with the Contract Documents.

b. Inspect physical and mechanical condition.

c. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:

a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

d. Record model number, serial number, firmware revision, software revision, and rated control voltage.
e. Verify operation of display and indicating devices.
f. Record passwords.
g. Verify unit is grounded in accordance with manufacturer's instructions.
h. Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.
i. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts as applicable.
j. Verify the unit is clean.

2. Electrical tests:
   a. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
   b. Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.
   c. After initial system energization, confirm measurements and indications are consistent with loads present.
   d. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   e. Verify accuracy of meter at all cardinal points.
   f. Calibrate meters in accordance with manufacturer's published data.
   g. Verify that current transformer, and voltage transformer secondary circuits are intact.
3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
   c. Meter accuracy shall be in accordance with manufacturer's published data.
   d. Calibration results shall be within manufacturer's published tolerances.
   e. Instrument multipliers shall be in accordance with system design specifications.
   f. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.

G. Grounding systems:
1. Visual and mechanical inspection:
   a. Inspect ground system for compliance with that indicated on the Drawings, specified in Specifications, and in the NEC.
   b. Inspect physical and mechanical condition.
   c. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use of low-resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

d. Inspect anchorage.

2. Electrical tests:
a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
b. Perform fall of potential test or alternative test in accordance with IEEE 81 on the main grounding electrode or system.
c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, the system neutral and any derived neutral points.

3. Test values:
a. Grounding system electrical and mechanical connections shall be free of corrosion.
b. Compare bolted connection resistance values to values of similar connections:
1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
c. Bolt-torque levels shall be in accordance with manufacturer's published data:
1) Refer to NETA ATS tables in the absence of manufacturer's published data.
d. The resistance between the main grounding electrode and ground shall be as specified in Section 16060. Investigate point-to-point resistance values that exceed 0.5 ohm.

H. Rotating machinery:
1. Visual and mechanical inspection:
a. Compare equipment nameplate information with the Contract Documents.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Inspect air baffles, filter media, cooling fans, slip rings, brushes, brush rigging and shaft current discharge devices.
e. Inspect bolted electrical connections for high resistance using one of the following methods:
1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
f. Perform special tests such as gap spacing and machine alignment if applicable.
g. Manually rotate the rotor and check for problems with the bearings or shaft.
h. Rotate the shaft and measure and record the shaft extension runout.
i. Verify correct application of appropriate lubrication and lubrication systems.
j. Verify that resistance temperature detector (RTD) circuits conform to that indicated on the Drawings.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
b. Perform insulation-resistance test in accordance with IEEE 43:
   1) On motors 200 horsepower and smaller, test duration shall be 1 minute. Calculate dielectric absorption ratio.
   2) On motors larger than 200 horsepower, test duration shall be 10 minutes. Calculate polarization index.
c. Perform dc dielectric withstand voltage tests on machines rated at 2,300 volts and greater in accordance with IEEE 95.
   1) IEEE 95 for dc dielectric withstand voltage tests.
   2) NEMA MG1 for ac dielectric withstand voltage tests.
d. Perform phase-to-phase stator resistance test on machines rated at 2,300 volts and greater.
e. Perform insulation-resistance test on insulated bearings in accordance with manufacturer's published data.
f. Test surge protection devices as specified in this Section.
g. Test motor starter as specified in this Section.
h. Perform resistance tests on resistance temperature detector (RTD) circuits.
i. Verify operation of motor space heater.
j. Perform a rotation test to ensure correct shaft rotation.
k. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

3. Test values:
   a. Inspection:
      1) Air baffles shall be clean and installed in accordance with the manufacturer's published data.
      2) Filter media shall be clean and installed in accordance with the manufacturer's published data.
      3) Cooling fans shall operate.
      4) Slip ring alignment shall be within manufacturer's published tolerances.
      5) Brush alignment shall be within manufacturer's published tolerances.
      6) Brush rigging shall be within manufacturer's published tolerances.
   b. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   c. Bolt-torque levels shall be in accordance with manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
   d. Air-gap spacing and machine alignment shall be in accordance with manufacturer's published data.
   e. The recommended minimum insulation-resistance ($IR_{1\ min}$) test results in megohms shall be as specified in this Section.
      1) The polarization index value shall not be less than 2.0.
      2) The dielectric absorption ratio shall not be less than 1.4.
   f. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

g. Investigate phase-to-phase stator resistance values that deviate by more than 10 percent.
h. Power factor or dissipation factor values shall be compared to manufacturer's published data:
    1) In the absence of manufacturer's published data compare values of similar machines.
i. Tip-up values shall indicate no significant increase in power factor.
j. If no evidence of distress, insulation failure or waveform nesting is observed by the end of the total time of voltage application during the surge comparison test, the test specimen is considered to have passed the test.
k. Bearing insulation-resistance measurements shall be within manufacturer's published tolerances:
    1) In the absence of manufacturer's published data compare values of similar machines.
l. Test results of surge protection devices shall be as specified in this Section.
m. Test results of motor starter equipment shall be as specified in this Section.
n. RTD circuits shall conform to the design intent and machine protection device manufacturer's published data.
o. Heaters shall be operational.
p. Vibration amplitudes shall not exceed values in NETA ATS tables:
    1) If values exceed those in the NETA ATS tables, perform a complete vibration analysis.
q. Machine rotation should match required rotation of connected load.
r. Running phase-to-phase voltages should be within 1.0 percent. Running currents shall be balanced and proportional to load condition and nameplate data.

I. Motor starters, low voltage:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate information with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Inspect contactors:
        1) Verify mechanical operation.
        2) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.
    f. Motor-running protection:
        1) Verify overload element rating is correct for its application.
        2) If motor running protection is provided by fuses, verify correct fuse rating.
    g. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
            a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    h. Lubrication requirements:

1) Verify appropriate lubrication on moving current-carrying parts.
2) Verify appropriate lubrication on moving and sliding surfaces.

2. Electrical tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase to ground with the starter closed, and across each open pole for 1 minute:
      1) Test voltage shall be in accordance with manufacturer's published data.
      2) Refer to NETA ATS tables in the absence of manufacturer's published data.
   c. Test motor protection devices in accordance with manufacturer's published data.
   d. Test circuit breakers as specified in this Section.
   e. Perform operational tests by initiating control devices.
3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Bolt-torque levels shall be in accordance with manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
   c. Insulation-resistance values shall be in accordance with manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
      2) Investigate values of insulation-resistance less than the allowable minimum.
   d. Motor protection parameters shall be in accordance with manufacturer's published data.
   e. Circuit breaker test results shall as specified in this Section.
   f. Control devices shall perform in accordance with system design requirements.

J. Motor control centers, low voltage:
   1. Visual and mechanical inspection:
      a. Compare equipment nameplate data with the Contract Documents.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding and required clearances.
      d. Inspect equipment for cleanliness.
      e. Verify that circuit breaker/fuse sizes and types correspond to the approved submittals and coordination study.
      f. Verify that current and voltage transformer ratios correspond to that indicated on the Drawings.
      g. Inspect bolted electrical connections for high resistance using one of the following methods:
         1) Use of low-resistance ohmmeter.
         2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:

a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

h. Mechanical and electrical interlocks:
   1) Attempt closure on locked-open devices.
   2) Attempt to open locked-closed devices.
   3) Make/attempt key-exchanges in all positions.
i. Lubrication requirements:
   1) Verify appropriate lubrication on moving current-carrying parts.
   2) Verify appropriate lubrication on moving and sliding surfaces.
j. Inspect insulators for evidence of physical damage or contaminated surfaces.
k. Verify correct barrier and shutter installation and operation.
l. Exercise all active components.
m. Inspect all indicating devices for correct operation.
n. Verify that filters are in place and/or vents are clear.
o. Perform visual and mechanical inspection of instrument transformers as specified in this Section.
p. Inspect control power transformers:
   1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
   2) Verify that primary and secondary fuse/circuit breaker ratings match the submittal drawings.
q. Perform visual and mechanical inspection of circuit breakers as specified in this Section.
r. Perform visual and mechanical inspection of starters as specified in this Section.
s. Perform visual and mechanical inspection of variable frequency drives as specified in this Section.

2. Electrical tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for 1 minute:
      1) Perform test in accordance with NETA ATS tables.
   c. Perform an dielectric withstand test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data or NETA ATS tables. Apply the test voltage for 1 minute.
   d. Perform ground-resistance tests:
      1) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.
   e. Determine the accuracy of all meters.
   f. Control power transformers:
      1) Perform insulation-resistance tests, winding-to-winding and winding-to-ground:
         a) Test voltages shall be in accordance with NETA ATS tables or as specified by the manufacturer.
      2) Perform secondary wiring integrity test:
         a) Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:

(1) Verify correct potential at all devices.

3) Verify correct secondary voltage by energizing primary winding with system voltage:

a) Measure secondary voltage with the secondary wiring disconnected.

g. Verify operation of space heaters.

h. Perform electrical tests of circuit breakers as specified in this Section.

i. Perform electrical tests of starters as specified in this Section.

j. Perform electrical tests of variable frequency drives as specified in this Section.

3. Test values:

a. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Insulation-resistance values for bus and control power transformers shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

2) Investigate insulation values less than the allowable minimum.

3) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.

d. Bus insulation shall withstand the over potential test voltage applied.

e. Instrument transformer test values shall be as specified in this Section.

f. Investigate grounding system point-to-point resistance values that exceed 0.5 ohm.

g. Meter accuracy shall be in accordance with manufacturer's published data.

h. Control power transformers:

1) Insulation-resistance values of control power transformers shall be in accordance with manufacturer's published data:

a) Refer to NETA ATS tables in the absence of manufacturer's published data.

b) Investigate insulation values less than the allowable minimum.

c) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.

2) Secondary wiring shall be as indicated on the Drawings and specified in the Specifications.

3) Secondary voltage shall be as indicated on the Drawings.

i. Heaters shall be operational.

j. Test values for circuit breakers shall be as specified in this Section.

k. Test values for starters shall be as specified in this Section.

l. Test values for variable frequency drives shall be as specified in this Section.

K. Variable frequency drive systems:

1. Visual and mechanical inspection:

a. Compare equipment nameplate data with the Contract Documents.

b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Ensure vent path openings are free from debris and that heat transfer surfaces are clean.
f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
g. Motor running protection:
    1) Verify drive overcurrent setpoints are correct for their application.
    2) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.
    3) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor.
h. Inspect bolted electrical connections for high resistance using one of the following methods:
    1) Use of low-resistance ohmmeter.
    2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
i. Verify correct fuse sizing in accordance with manufacturer's published data.
j. Perform visual and mechanical inspection of input circuit breaker as specified in this Section.

2. Electrical tests:
    a. Perform resistance measurements through bolted connections with low resistance ohmmeter.
    b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
    c. Test for the following parameters in accordance with relay calibration procedures specified in this Section or as recommended by the manufacturer:
        1) Input phase loss protection.
        2) Input overvoltage protection.
        3) Output phase rotation.
        4) Overtemperature protection.
        5) Direct current overvoltage protection.
        6) Overfrequency protection.
        7) Drive overload protection.
        8) Fault alarm outputs.
    d. Perform continuity tests on bonding conductors as specified in this Section.
    e. Perform start-up of drive in accordance with manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.
    f. Perform operational tests by initiating control devices:
        1) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
        2) Verify operation of drive from remote start/stop and speed control signals.
    g. Perform electrical tests of input circuit breaker as specified in this Section.

3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with manufacturer's published data:
        1) Refer to NETA ATS tables in the absence of manufacturer's published data.
    c. Overload test trip times at 300 percent of overload element rating shall be in accordance with manufacturer's published time-current curve.
    d. Test values for input circuit breaker shall be as specified in this Section.
    e. Relay calibration results shall be as specified in this Section.
    f. Continuity of bonding conductors shall be as specified in this Section.
    g. Control devices shall perform in accordance with system requirements.
    h. Operational tests shall conform to system design requirements.

L. Surge arresters, low-voltage:
1. Visual and mechanical inspection:
    a. Compare equipment nameplate data with the Contract Documents.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and clearances.
    d. Verify the arresters are clean.
    e. Inspect bolted electrical connections for high resistance using one of the following methods:
        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
            a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
    f. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
    g. Verify that stroke counter is correctly mounted and electrically connected, if applicable.
    h. Record stroke counter reading.
2. Electrical tests:
    a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
    b. Perform an insulation-resistance test on each arrester, phase terminal- to- ground:
        1) Apply voltage in accordance with manufacturers published data.
        2) Refer to NETA ATS tables in the absence of manufacturer's published data.
    c. Test grounding connection as specified in this Section.
3. Test values:
    a. Compare bolted connection resistance values to values of similar connections:
        1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    b. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Insulation-resistance values shall be in accordance with manufacturer's published data:
   1) Refer to NETA ATS tables in the absence of manufacturer's published data.
   2) Investigate insulation values less than the allowable minimum.

d. Resistance between the arrester ground terminal and the ground system shall be less than 0.5 ohm.

M. Switches, air, low-voltage:

1. Visual and mechanical inspection
   a. Compare equipment nameplate data with the Contract Document.
   b. Inspect physical and mechanical condition.
   c. Inspect anchorage, alignment, grounding, and required clearances.
   d. Verify the unit is clean.
   e. Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.
   f. Verify that fuse sizes and types as indicated on the Drawings, short-circuit studies, and coordination study.
   g. Verify that each fuse has adequate mechanical support and contact integrity.
   h. Inspect bolted electrical connections for high resistance using one of the following methods:
      1) Use of a low resistance ohmmeter.
      2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
         a) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
   i. Verify operation and sequencing of interlocking systems.
   j. Verify correct phase barrier installation.
   k. Verify correct operation of all indicating and control devices.
   l. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical tests:
   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
   b. Measure contact resistance across each switchblade and fuseholder.
   c. Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data:
      1) In the absence of manufacturer's published data, use NETA ATS requirements.
   d. Measure fuse resistance.
   e. Verify cubicle space heater operation.
   f. Perform ground fault test as specified in this Section, if applicable.
   g. Perform tests on other protective devices as specified in this Section, if applicable.
3. Test values:
   a. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connection by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:
   1) Refer to NETA ATS tables in the absence of manufacturer's published data.

4. Test values – electrical:
   a. Compare bolted connection resistance values to values of similar connections:
      1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
   b. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
      1) If manufacturer's published data is not available, investigate values which deviate from those of similar bus connections and sections by more than 50 percent of the lowest value.
   c. Insulation-resistance values shall be in accordance with manufacturer's published data:
      1) Refer to NETA ATS tables in the absence of manufacturer's published data.
      2) Investigate insulation values less than the allowable minimum.
   d. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
   e. Heaters shall be operational.
   f. Ground fault tests shall be as specified in this Section.
   g. Results of protective device tests shall be as specified in this Section.

N. Fiber-optic cables:
   1. Visual and mechanical inspection:
      a. Compare cable, connector, and splice data with the Contract Documents:
      b. Inspect cable and connections for physical and mechanical damage.
      c. Verify that all connectors and splices are correctly installed.
   2. Electrical tests:
      a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer (OTDR):
         1) OTDR test performed on fiber cables less than 100 meters shall be performed with the aid of a launch cable.
         2) Adjust OTDR pulse width settings to a maximum setting of 1/1,000th of the cable length or 10 nanoseconds.
      b. Perform connector and splice integrity test using an optical time domain reflectometer.
      c. Perform cable attenuation loss measurement with an optical power loss test set:
         1) Perform attenuation tests with an Optical Loss Test Set capable and calibrated to show anomalies of 0.1 dB as a minimum.
         2) Test multimode fibers at 850 nanometer and 1,300 nanometer.
         3) Test single mode fibers at 1,310 nanometer and 1,550 nanometer.
      d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set:
         1) At the conclusion of all outdoor splices at 1 location, and before they are enclosed and sealed, all splices shall be tested with OTDR at the

optimal wavelengths (850 and 1,300 for multimode, 1,310 and 1,550 for single mode), in both directions. The splices shall be tested for integrity as well as attenuation.

e. Perform fiber links integrity and attenuation tests using each link shall be an OTDR and an Optical Loss Test Set:
   1) OTDR traces shall be from both directions on each fiber at the 2 optimal wavelengths, 850 nanometer and 1,300 nanometer for multimode fibers.
   2) Optical loss testing shall be done with handheld test sets in 1 direction at the 2 optimal wavelengths for the appropriate fiber type. Test equipment shall equal or exceed the accuracy and resolution of Agilent/HP 8147 high performance OTDR.

3. Test values:
   a. Cable and connections shall not have been subjected to physical or mechanical damage.
   b. Connectors and splices shall be installed in accordance with industry standards.
   c. The optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
   d. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations when no local site specifications are available.
   e. Individual fusion splice losses shall not exceed 0.1 dB. Measurement results shall be recorded, validated by trace, and filed with the records of the respective cable runs.

O. LAN cable testing:
   1. Visual and mechanical inspections:
      a. Compare cable type and connections with that indicated on the Drawings and specified in the Specifications.
      b. Inspect cable and connectors for physical and mechanical damage.
      c. Verify that all connectors are correctly installed.
   2. Pre-testing:
      a. Test individual cables before installation:
         1) Before physical placement of the cable, test each cable while on the spool with a LAN certification test device.
         2) Before the cable is installed, verify that the cable conforms to the manufacturer's attenuation specification and that no damage has been done to the cable during shipping or handling.
         3) The test shall be fully documented and the results submitted to the Engineer, including a hard copy of all traces, before placement of the cable.
         4) The Engineer shall be notified if a cable fails to meet specification and the cable shall not be installed unless otherwise directed by the Engineer.
   3. Electrical tests:
      a. Perform cable end-to-end testing on all installed cables after installation of connectors from both ends of the cable.
      b. Test shall include cable system performance tests and confirm the absence of wiring errors.
   4. Test results:

a. Cables shall meet or exceed TIA standards for a Category 5e installation.

5. Test equipment:
   a. LAN certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed Level III accuracy. Tests performed shall include:
      1) Near end cross talk.
      2) Attenuation.
      3) Equal level far end cross talk.
      4) Return loss.
      5) Ambient noise.
      6) Effective cable length.
      7) Propagation delay.
      8) Continuity/loop resistance.
   b. LAN certification test equipment shall be able to store and produce plots of the test results.
   c. Acceptable manufacturers: The following or equal:
      1) Agilent Technologies, WireScope 350.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050.

B. After the acceptance tests have been completed, dispose of all testing expendables, vacuum all cabinets, and sweep clean all surrounding areas.

3.11 PROTECTION

A. As specified in Section 16050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16990A

CONDUIT SCHEDULE
AREA 02

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. MFR: Manufacturer or vendor furnished cable.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 02

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

MIXED LIQUOR FLUMES

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-02-001	01E05	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: EAM-0441 TO: JUNCTION BOX 10 #14 >> EAM-0441 CONTROL	C-02-005
L-02-001	01E05	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-0451 TO: JUNCTION BOX 2 #12 >> FIT-0451 POWER	L-02-011
P-02-001	01E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EAM-0441 TO: DISC-0441 3 #12 >> EAM-0441 POWER	
S-02-001	01E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: EAM-0441 TO: JUNCTION BOX 2 2/CS-#16 >> EAM-0441 SIGNAL	S-02-005
C-02-002	01E05	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: EAM-0451 TO: JUNCTION BOX 10 #14 >> EAM-0451 CONTROL	C-02-005
P-02-002	01E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EAM-0451 TO: DISC-0451 3 #12 >> EAM-0451 POWER	
S-02-002	01E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: EAM-0451 TO: JUNCTION BOX 2 2/CS-#16 >> EAM-0451 SIGNAL	S-02-005
C-02-005	01E05 00EX03	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: JUNCTION BOX TO: MH-15 10 #14 >> EAM-0441 CONTROL 10 #14 >> EAM-0451 CONTROL 10 #14 >> SPARE (FUTURE EAM-0461 CONTROL)	C-02-012 C-02-001 C-02-002
P-02-005	01E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-0441 TO: JUNCTION BOX 3 #12 >> EAM-0441 POWER	P-02-011
S-02-005	01E05	1.5"	6	2/CS-#16		1	#14	XHHW-2	FR: JUNCTION BOX TO: JUNCTION BOX 2 2/CS-#16 >> EAM-0441 SIGNAL 2 2/CS-#16 >> EAM-0451 SIGNAL 2 2/CS-#16 >> SPARE (FUTURE EAM-0461 SIGNAL)	S-02-016 S-02-001 S-02-002
P-02-006	01E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISC-0451 TO: JUNCTION BOX 3 #12 >> EAM-0451 POWER	P-02-011
L-02-011	01E05 00EX03	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: JUNCTION BOX TO: MH-15 2 #12 >> FIT-0451 POWER 2 #12 >> SPARE (FUTURE FIT-0461 POWER)	L-02-012 L-02-001
P-02-011	01E05 00EX03	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: JUNCTION BOX TO: MH-15 3 #12 >> EAM-0441 POWER 3 #12 >> EAM-0451 POWER 3 #12 >> SPARE (FUTURE EAM-0461 POWER)	P-02-012 P-02-005 P-02-006
S-02-011	01E05	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: LE-0451 TO: FIT-0451 1 MFR >> LE-0451	
C-02-012	00EX03	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: MH-15 TO: PB-1P 10 #14 >> EAM-0441 CONTROL 10 #14 >> EAM-0451 CONTROL 10 #14 >> SPARE (FUTURE EAM-0461 CONTROL)	C-02-021 C-02-005 C-02-005 C-02-005
L-02-012	00EX03	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: MH-15 TO: PB-1P 2 #12 >> FIT-0451 POWER 2 #12 >> SPARE (FUTURE FIT-0461 POWER)	L-02-015 L-02-011 L-02-011
P-02-012	00EX03	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: MH-15 TO: PB-1P 3 #12 >> EAM-0441 POWER 3 #12 >> EAM-0451 POWER 3 #12 >> SPARE (FUTURE EAM-0461 POWER)	P-02-013 P-02-011 P-02-011 P-02-011
P-02-013	01E06	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-1P TO: CONDUIT TEE 3 #12 >> EAM-0441 POWER 3 #12 >> EAM-0451 POWER 3 #12 >> SPARE (FUTURE EAM-0461 POWER)	P-02-012 P-02-012 P-02-012

CONDUIT SCHEDULE AREA 02

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

MIXED LIQUOR FLUMES

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND							
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**			**DESCRIPTION**		**CONNECTING SEGMENTS**
L-02-015	01E06	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR:		PB-1P		
									TO:		LP-2G (IN MCC-2G)		
										2 #12	>> FIT-0451 POWER		L-02-012
										2 #12	>> SPARE (FUTURE FIT-0461 POWER)		L-02-012
P-02-015	01E06	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR:		CONDUIT TEE		
									TO:		MCC-2G		
										3 #12	>> EAM-0441 POWER		
										3 #12	>> SPARE (FUTURE EAM-0461 POWER)		
S-02-015	01E05	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR:		FIT-0451		S-02-016
									TO:		JUNCTION BOX		
										1 2/CS-#16	>> FIT-0451 SIGNAL		
P-02-016	01E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR:		CONDUIT TEE		
									TO:		MCC-2F		
										3 #12	>> EAM-0451 POWER		
S-02-016	01E05 00EX03	1.5"	8	2/CS-#16		1	#14	XHHW-2	FR:		JUNCTION BOX		S-02-017
									TO:		PB-2S		
										2 2/CS-#16	>> EAM-0441 SIGNAL		S-02-005
										2 2/CS-#16	>> EAM-0451 SIGNAL		S-02-005
										2 2/CS-#16	>> SPARE (FUTURE EAM-0461 SIGNAL)		S-02-005
										1 2/CS-#16	>> FIT-0451 SIGNAL		S-02-015
										1 2/CS-#16	>> SPARE (FUTURE FIT-0461 SIGNAL)		
S-02-017	00EX03	1.5"	8	2/CS-#16		1	#14	XHHW-2	FR:		PB-2S		S-02-021
									TO:		PB-1S		
										2 2/CS-#16	>> EAM-0441 SIGNAL		S-02-016
										2 2/CS-#16	>> EAM-0451 SIGNAL		S-02-016
										2 2/CS-#16	>> SPARE (FUTURE EAM-0461 SIGNAL)		S-02-016
										1 2/CS-#16	>> FIT-0451 SIGNAL		S-02-016
										1 2/CS-#16	>> SPARE (FUTURE FIT-0461 SIGNAL)		S-02-016
C-02-021	01E06	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR:		PB-1P		
									TO:		RTU-30		
										10 #14	>> EAM-0441 CONTROL		C-02-012
										10 #14	>> EAM-0451 CONTROL		C-02-012
										10 #14	>> SPARE (FUTURE EAM-0461 CONTROL)		C-02-012
S-02-021	01E06	1.5"	8	2/CS-#16		1	#14	XHHW-2	FR:		PB-1S		
									TO:		RTU-30		
										2 2/CS-#16	>> EAM-0441 SIGNAL		S-02-017
										2 2/CS-#16	>> EAM-0451 SIGNAL		S-02-017
										2 2/CS-#16	>> SPARE (FUTURE EAM-0461 SIGNAL)		S-02-017
										1 2/CS-#16	>> FIT-0451 SIGNAL		S-02-017
										1 2/CS-#16	>> SPARE (FUTURE FIT-0461 SIGNAL)		S-02-017

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990B

CONDUIT SCHEDULE
AREA 07

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */C#Y: Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
   4. */FO: Fiber optic cable (* indicates number of fibers).
   5. MFR: Manufacturer or vendor furnished cable.
   6. PULL: Pull Rope.
   7. VFD: Shielded VFD cable with integral ground.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
N-07-001	00EX02 07E02	2"	1		12/FO-MM	1	#14	XHHW-2	FR: RTU-208 TO: IPB-38 1 12/FO-MM >> RTU-208 NETWORK	N-07-002
P-07-001	07E02	0.75"	3	#8	XHHW-2	1	#10	XHHW-2	FR: LP8 XFMR TO: MTS-8 3 #8 >> LP8 XFMR POWER	
L-07-002	07E02	1"	4	#8	XHHW-2	1	#8	XHHW-2	FR: LP8 TO: LP8 XFMR 4 #8 >> LP8 XFMR POWER	
N-07-002	00EX02	2"	1		12/FO-MM	1	#14	XHHW-2	FR: IPB-38 TO: IPB-37 1 12/FO-MM >> RTU-208 NETWORK	N-07-003 N-07-001
P-07-002	07E02	0.75"	3	#8	XHHW-2	1	#10	XHHW-2	FR: MTS-8 TO: MCC-8A 3 #8 >> MTS-8 POWER	
N-07-003	00EX01 00EX02	2"	1		12/FO-MM	1	#14	XHHW-2	FR: IPB-37 TO: IPB-36 1 12/FO-MM >> RTU-208 NETWORK	N-07-004 N-07-002
P-07-003	07E02	0.75"	3	#8	XHHW-2	1	#10	XHHW-2	FR: MTS-8 TO: MCC-8B 3 #8 >> MTS-8 POWER	
N-07-004	00EX01	2"	1		12/FO-MM	1	#14	XHHW-2	FR: IPB-36 TO: IPB-35 1 12/FO-MM >> RTU-208 NETWORK	N-07-005 N-07-003
L-07-005	07E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: LC-8 TO: LP8 3 #12 >> LC-8 POWER	
N-07-005	00EX01	2"	1		12/FO-MM	1	#14	XHHW-2	FR: IPB-35 TO: PB-34 (EXISTING) 1 12/FO-MM >> RTU-208 NETWORK	N-07-006 N-07-004
N-07-006	00EX03	2"	1		12/FO-MM	1	#14	XHHW-2	FR: PB-34 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E762) 1 12/FO-MM >> RTU-208 NETWORK	N-07-007 N-07-005
X-07-006	00EX02 07E02	2"	1	PULL	ROPE				FR: STUB UP IN MCC NO. 8 ENCLOSURE TO: PB-38 1 PULL >> SPARE	
N-07-007	07E01	1.5"	1		12/FO-MM	1	#14	XHHW-2	FR: MCC-7 TRENCH TO: RTU-207 1 12/FO-MM >> RTU-208 NETWORK	N-07-006
X-07-007	00EX02 07E02	2"	1	PULL	ROPE				FR: STUB UP IN MCC NO. 8 ENCLOSURE TO: PB-38 1 PULL >> SPARE	
L-07-010	07E01	1"	4	#8	XHHW-2	1	#8	XHHW-2	FR: LP7B TO: LP7B XFMR 4 #8 >> LP7B POWER	
P-07-010	07E01	0.75"	3	#8	XHHW-2	1	#8	XHHW-2	FR: LP7B XFMR TO: MTS-7 3 #8 >> LP7B XMFR POWER	
L-07-011	07E01	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: LP7 TO: RTU-207A 2 #12 >> LP7 POWER 2 #12 >> LP7 POWER	
N-07-011	07E01	1.5"	1		12/FO-MM	1	#14	XHHW-2	FR: RTU-207A TO: RTU-207 1 12/FO-MM >> RTU-207A NETWORK	
P-07-011	07E01	0.75"	3	#8	XHHW-2	1	#8	XHHW-2	FR: MTS-7 TO: MCC-7A 3 #8 >> MTS-7 POWER	
L-07-012	07E01	0.75"	1	PULL	ROPE				FR: RTU-207A TO: LP7B 1 PULL >> SPARE	
P-07-012	07E01	0.75"	3	#8	XHHW-2	1	#8	XHHW-2	FR: MTS-7 TO: MCC-7B 3 #8 >> MTS-7 POWER	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	SKB
REVISION	0
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
P-07-013	07E01	1.5"	3	#1/0	XHHW-2	1	#6	XHHW-2	FR: MCC-7A TO: MCC-9A 3 #1/0 >> MCC-7A POWER	
P-07-014	07E01	1.5"	3	#1/0	XHHW-2	1	#6	XHHW-2	FR: MCC-7B TO: MCC-9B 3 #1/0 >> MCC-7B POWER	
P-07-015	07E01	1.5"	3	#3	XHHW-2	1	#8	XHHW-2	FR: MCC-7A TO: VFD-2711 3 #3 >> MCC-7A POWER	
P-07-016	07E01	1.5"	3	#3	XHHW-2	1	#8	XHHW-2	FR: MCC-7B TO: VFD-2711 3 #3 >> MCC-7B POWER	
C-07-021	07E01	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-2711 TO: CONDUIT TEE 8 #14 >> VFD-2711 CONTROL	C-07-023
S-07-021	07E01	1"	3	2/CS-#16		1	#14	XHHW-2	FR: VFD-2711 TO: CONDUIT TEE 3 2/CS-#16 >> VFD-2711 SIGNAL	S-07-023
C-07-022	07E01	0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VFD-2721 TO: CONDUIT TEE 8 #14 >> VFD-2721 CONTROL	C-07-023
S-07-022	07E01	1"	3	2/CS-#16		1	#14	XHHW-2	FR: VFD-2721 TO: CONDUIT TEE 3 2/CS-#16 >> VFD-2721 SIGNAL	S-07-023
C-07-023	07E01	1"	16	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: RTU-207A 8 #14 >> VFD-2711 CONTROL 8 #14 >> VFD-2721 CONTROL	C-07-021 C-07-022
S-07-023	07E01	1.5"	6	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: RTU-207A 3 2/CS-#16 >> VFD-2711 SIGNAL 3 2/CS-#16 >> VFD-2721 SIGNAL	S-07-021 S-07-022
C-07-025	07E01	1.5"	43	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-9A TO: RTU-207A 9 #14 >> MS-2341 CONTROL 9 #14 >> MS-2342 CONTROL 9 #14 >> MS-2343 CONTROL 8 #14 >> VFD-2345 CONTROL 8 #14 >> VFD-2356 CONTROL	
S-07-025	07E01	1"	4	2/CS-#16		1	#14	XHHW-2	FR: MCC-9A TO: RTU-207A 2 2/CS-#16 >> VFD-2345 SIGNAL 2 2/CS-#16 >> VFD-2356 SIGNAL	
C-07-026	07E01	1.5"	43	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-9B TO: RTU-207A 9 #14 >> MS-2351 CONTROL 9 #14 >> MS-2352 CONTROL 9 #14 >> MS-2353 CONTROL 8 #14 >> VFD-2355 CONTROL 8 #14 >> VFD-2346 CONTROL	
S-07-026	07E01	1"	4	2/CS-#16		1	#14	XHHW-2	FR: MCC-9B TO: RTU-207A 2 2/CS-#16 >> VFD-2355 SIGNAL 2 2/CS-#16 >> VFD-2346 SIGNAL	
C-07-027	07E01	1.5"	43	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-7B TO: CONDUIT TEE 9 #14 >> MS-2371 CONTROL 9 #14 >> MS-2372 CONTROL 9 #14 >> MS-2373 CONTROL 8 #14 >> VFD-2375 CONTROL 8 #14 >> VFD-2366 CONTROL	C-07-029
S-07-027	07E01	1"	4	2/CS-#16		1	#14	XHHW-2	FR: MCC-7B TO: CONDUIT TEE 2 2/CS-#16 >> VFD-2375 SIGNAL 2 2/CS-#16 >> VFD-2366 SIGNAL	S-07-029

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-07-028	07E01	2"	57	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-7A	C-07-029
									TO: CONDUIT TEE	
									9 #14 >> MS-2361 CONTROL	
									9 #14 >> MS-2362 CONTROL	
									9 #14 >> MS-2363 CONTROL	
									8 #14 >> VFD-2365 CONTROL	
									8 #14 >> VFD-2376 CONTROL	
									14 #14 >> MS-2651 CONTROL	
S-07-028	07E01	1"	4	2/CS-#16		1	#14	XHHW-2	FR: MCC-7A	S-07-029
									TO: CONDUIT TEE	
									2 2/CS-#16 >> VFD-2365 SIGNAL	
									2 2/CS-#16 >> VFD-2376 SIGNAL	
C-07-029	07E01	2.5"	100	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	
									TO: RTU-207	
									9 #14 >> MS-2371 CONTROL	C-07-027
									9 #14 >> MS-2372 CONTROL	C-07-027
									9 #14 >> MS-2373 CONTROL	C-07-027
									8 #14 >> VFD-2375 CONTROL	C-07-027
									8 #14 >> VFD-2366 CONTROL	C-07-027
									9 #14 >> MS-2361 CONTROL	C-07-028
									9 #14 >> MS-2362 CONTROL	C-07-028
									9 #14 >> MS-2363 CONTROL	C-07-028
									8 #14 >> VFD-2365 CONTROL	C-07-028
									8 #14 >> VFD-2376 CONTROL	C-07-028
									14 #14 >> MS-2651 CONTROL	C-07-028
S-07-029	07E01	1.5"	8	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	
									TO: RTU-207	
									2 2/CS-#16 >> VFD-2375 SIGNAL	S-07-027
									2 2/CS-#16 >> VFD-2366 SIGNAL	S-07-027
									2 2/CS-#16 >> VFD-2365 SIGNAL	S-07-028
									2 2/CS-#16 >> VFD-2376 SIGNAL	S-07-028
P-07-031	00EX02 07E02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: MCC-8A	P-07-032
									TO: PB-38	
									3 #4/0 >> MCC-8A POWER	
P-07-032	00EX02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-38	P-07-033
									TO: PB-37	
									3 #4/0 >> MCC-8A POWER	P-07-031
P-07-033	00EX01 00EX02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-37	P-07-034
									TO: PB-36	
									3 #4/0 >> MCC-8A POWER	P-07-032
P-07-034	00EX01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-36	P-07-035
									TO: PB-35	
									3 #4/0 >> MCC-8A POWER	P-07-033
P-07-035	00EX01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-35	P-07-036
									TO: PB-34 (EXISTING)	
									3 #4/0 >> MCC-8A POWER	P-07-034
P-07-036	00EX03	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-34 (EXISTING)	P-07-037
									TO: MCC-7 TRENCH (VIA EXISTING 07-E761)	
									3 #4/0 >> MCC-8A POWER	P-07-035
P-07-037	07E01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: MCC-7 TRENCH	
									TO: SWGR-7 (VIA EXISTING 07-E071)	
									3 #4/0 >> MCC-8A POWER	P-07-036
P-07-041	00EX02 07E02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: MCC-8A	P-07-042
									TO: PB-38	
									3 #4/0 >> MCC-8A POWER	
P-07-042	00EX02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-38	P-07-043
									TO: PB-37	
									3 #4/0 >> MCC-8A POWER	P-07-041
P-07-043	00EX01 00EX02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-37	P-07-044
									TO: PB-36	
									3 #4/0 >> MCC-8A POWER	P-07-042
P-07-044	00EX01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-36	P-07-045
									TO: PB-35	
									3 #4/0 >> MCC-8A POWER	P-07-043
P-07-045	00EX01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-35	P-07-046
									TO: PB-34 (EXISTING)	
									3 #4/0 >> MCC-8A POWER	P-07-044

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-07-046	00EX03	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-34 (EXISTING)	P-07-047
									TO: MCC-7 TRENCH (VIA EXISTING 07-E760)	
									3 #4/0 >> MCC-8A POWER	P-07-045
P-07-047	07E01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: MCC-7 TRENCH	
									TO: SWGR-7 (VIA EXISTING 07-E070)	
									3 #4/0 >> MCC-8A POWER	P-07-046
X-07-051	00EX02 07E02	2"	1	PULL	ROPE				FR: MCC-8A	X-07-052
									TO: PB-38	
									1 PULL >> SPARE	
X-07-052	00EX02	2"	1	PULL	ROPE				FR: PB-38	X-07-053
									TO: PB-37	
									1 PULL >> SPARE	X-07-051
X-07-053	00EX01 00EX02	2"	1	PULL	ROPE				FR: PB-37	X-07-054
									TO: PB-36	
									1 PULL >> SPARE	X-07-052
X-07-054	00EX01	2"	1	PULL	ROPE				FR: PB-36	X-07-055
									TO: PB-35	
									1 PULL >> SPARE	X-07-053
X-07-055	00EX01	2"	1	PULL	ROPE				FR: PB-35	X-07-056
									TO: PB-34 (EXISTING)	
									1 PULL >> SPARE	X-07-054
X-07-056	00EX03	2"	1	PULL	ROPE				FR: PB-34 (EXISTING)	
									TO: MCC-7 TRENCH (VIA EXISTING 07-E759)	
									1 PULL >> SPARE	X-07-055
P-07-061	00EX02 07E02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: MCC-8B	P-07-062
									TO: PB-38	
									3 #4/0 >> MCC-8B POWER	
P-07-062	00EX02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-38	P-07-063
									TO: PB-37	
									3 #4/0 >> MCC-8B POWER	P-07-061
P-07-063	00EX01 00EX02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-37	P-07-064
									TO: PB-36	
									3 #4/0 >> MCC-8B POWER	P-07-062
P-07-064	00EX01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-36	P-07-065
									TO: PB-35	
									3 #4/0 >> MCC-8B POWER	P-07-063
P-07-065	00EX01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-35	P-07-066
									TO: PB-34 (EXISTING)	
									3 #4/0 >> MCC-8B POWER	P-07-064
P-07-066	00EX03	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-34 (EXISTING)	P-07-067
									TO: MCC-7 TRENCH (VIA EXISTING 07-E765)	
									3 #4/0 >> MCC-8B POWER	P-07-065
P-07-067	07E01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: MCC-7 TRENCH	
									TO: SWGR-7 (VIA EXISTING 07-E075)	
									3 #4/0 >> MCC-8B POWER	P-07-066
P-07-071	00EX02 07E02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: MCC-8B	P-07-072
									TO: PB-38	
									3 #4/0 >> MCC-8B POWER	
P-07-072	00EX02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-38	P-07-073
									TO: PB-37	
									3 #4/0 >> MCC-8B POWER	P-07-071
P-07-073	00EX01 00EX02	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-37	P-07-074
									TO: PB-36	
									3 #4/0 >> MCC-8B POWER	P-07-072
P-07-074	00EX01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-36	P-07-075
									TO: PB-35	
									3 #4/0 >> MCC-8B POWER	P-07-073
P-07-075	00EX01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-35	P-07-076
									TO: PB-34 (EXISTING)	
									3 #4/0 >> MCC-8B POWER	P-07-074
P-07-076	00EX03	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: PB-34 (EXISTING)	P-07-077
									TO: MCC-7 TRENCH (VIA EXISTING 07-E764)	
									3 #4/0 >> MCC-8B POWER	P-07-075

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION
AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	SKB
REVISION	0
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
P-07-077	07E01	2"	3	#4/0	XHHW-2	1	#3	XHHW-2	FR: MCC-7 TRENCH TO: SWGR-7 (VIA EXISTING 07-E076) 3 #4/0 >> MCC-8B POWER	P-07-076
X-07-081	00EX02 07E02	2"	1	PULL	ROPE				FR: MCC-8B TO: PB-38 1 PULL >> SPARE	X-07-082
X-07-082	00EX02	2"	1	PULL	ROPE				FR: PB-38 TO: PB-37 1 PULL >> SPARE	X-07-083 X-07-081
X-07-083	00EX01 00EX02	2"	1	PULL	ROPE				FR: PB-37 TO: PB-36 1 PULL >> SPARE	X-07-084 X-07-082
X-07-084	00EX01	2"	1	PULL	ROPE				FR: PB-36 TO: PB-35 1 PULL >> SPARE	X-07-085 X-07-083
X-07-085	00EX01	2"	1	PULL	ROPE				FR: PB-35 TO: PB-34 (EXISTING) 1 PULL >> SPARE	X-07-086 X-07-084
X-07-086	00EX03	2"	1	PULL	ROPE				FR: PB-34 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E763) 1 PULL >> SPARE	X-07-085
C-07-091	07E02	2"	78	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-8A TO: RTU-208 9 #14 >> MS-2311 CONTROL 9 #14 >> MS-2312 CONTROL 9 #14 >> MS-2313 CONTROL 9 #14 >> MS-2331 CONTROL 9 #14 >> MS-2332 CONTROL 9 #14 >> MS-2333 CONTROL 8 #14 >> VFD-2315 CONTROL 8 #14 >> VFD-2326 CONTROL 8 #14 >> VFD-2335 CONTROL	
S-07-091	07E02	1.5"	6	2/CS-#16		1	#14	XHHW-2	FR: MCC-8A TO: RTU-208 2 2/CS-#16 >> VFD-2315 SIGNAL 2 2/CS-#16 >> VFD-2326 SIGNAL 2 2/CS-#16 >> VFD-2335 SIGNAL	
C-07-092	07E02	2"	51	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-8B TO: RTU-208 9 #14 >> MS-2321 CONTROL 9 #14 >> MS-2322 CONTROL 9 #14 >> MS-2323 CONTROL 8 #14 >> VFD-2325 CONTROL 8 #14 >> VFD-2316 CONTROL 8 #14 >> VFD-2336 CONTROL	
S-07-092	07E02	1.5"	6	2/CS-#16		1	#14	XHHW-2	FR: MCC-8B TO: RTU-208 2 2/CS-#16 >> VFD-2325 SIGNAL 2 2/CS-#16 >> VFD-2316 SIGNAL 2 2/CS-#16 >> VFD-2336 SIGNAL	
P-07-095	07E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MCC NO. 8 ENCLOSURE HVAC UNIT TO: DISCONNECT 3 #12 >> HVAC UNIT POWER	P-07-096
P-07-096	07E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: MCC-8B 3 #12 >> HVAC UNIT POWER	P-07-095
X-07-101	00EX02 07E02	2"	1	PULL	ROPE				FR: RTU-208 TO: IPB-38 1 PULL >> SPARE	X-07-102
X-07-102	00EX02	2"	1	PULL	ROPE				FR: IPB-38 TO: IPB-37 1 PULL >> SPARE	X-07-103 X-07-101
X-07-103	00EX01 00EX02	2"	1	PULL	ROPE				FR: IPB-37 TO: IPB-36 1 PULL >> SPARE	X-07-104 X-07-102

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
X-07-104	00EX01	2"	1	PULL	ROPE				FR: IPB-36 TO: IPB-35 1 PULL >> SPARE	X-07-105 X-07-103
X-07-105	00EX01	2"	1	PULL	ROPE				FR: IPB-35 TO: PB-34 (EXISTING) 1 PULL >> SPARE	 X-07-104
C-07-201	02E01	0.75"	3	#14	XHHW-2	1	#14	XHHW-2	FR: EDR-2651 TO: LCP-2652 3 #14 >> EDR-2651 CONTROL	C-07-216
C-07-202	02E01	0.75"	3	#14	XHHW-2	1	#14	XHHW-2	FR: EDR-2652 TO: LCP-2652 3 #14 >> EDR-2652 CONTROL	C-07-216
C-07-203	02E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: ZS-2651 TO: J-BOX 2 #14 >> ZS-2651 CONTROL	C-07-217
C-07-211	02E01	0.75"	2 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 2 #12 >> MWH-2651 POWER 2 #14 >> TSH-2651 CONTROL	C-07-213
P-07-211	02E01	0.75"	5 2	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: SC-2651 TO: CONDUIT TEE 3 #12 >> SC-2651 POWER 2 #12 >> MWH-2651 POWER 2 #14 >> TSH-2651 CONTROL	P-07-212
C-07-212	02E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: SC-2651 DRIVE ASSEMBLY TO: CONDUIT TEE 2 #14 >> XS-2651 CONTROL 2 #14 >> XSH-2651 CONTROL 2 #14 >> XSHH-2651 CONTROL	C-07-213
L-07-212	02E01	1"	2 2	#6 #12	XHHW-2 XHHW-2	1	#6	XHHW-2	FR: CLARIFIER POLE LIGHT TO: CONDUIT TEE 2 #12 >> CLARIFIER POLE LIGHT POWER 2 #6 >> CLARIFIER RECEPTACLES	L-07-214
P-07-212	02E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 3 #12 >> SC-2651 POWER	P-07-261 P-07-211
C-07-213	02E01	0.75"	2 8	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 2 #12 >> MWH-2651 POWER 2 #14 >> TSH-2651 CONTROL 2 #14 >> XS-2651 CONTROL 2 #14 >> XSH-2651 CONTROL 2 #14 >> XSHH-2651 CONTROL	C-07-215 C-07-211 C-07-211 C-07-212 C-07-212 C-07-212
L-07-213	02E01	1"	4 4	#10 #12	XHHW-2 XHHW-2	1	#10	XHHW-2	FR: CLARIFIER POLE LIGHT TO: CONDUIT TEE 4 #12 >> CLARIFIER POLE LIGHT POWER 4 #10 >> CLARIFIER RECEPTACLES	
C-07-214	02E01	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2651 TO: CONDUIT TEE 13 #14 >> LCP-2651 CONTROL 5 #14 >> LCP-2651 SPARE	C-07-215
L-07-214	02E01	1"	2 2	#6 #12	XHHW-2 XHHW-2	1	#6	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 2 #12 >> CLARIFIER POLE LIGHT POWER 2 #6 >> CLARIFIER RECEPTACLES	L-07-222 L-07-212 L-07-212
C-07-215	02E01	1.5"	2 26	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: J-BOX 2 #12 >> MWH-2651 POWER 2 #14 >> TSH-2651 CONTROL 2 #14 >> XS-2651 CONTROL 2 #14 >> XSH-2651 CONTROL 2 #14 >> XSHH-2651 CONTROL 13 #14 >> LCP-2651 CONTROL 5 #14 >> LCP-2651 SPARE	C-07-217 C-07-213 C-07-213 C-07-213 C-07-213 C-07-213 C-07-214 C-07-214

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-07-216	02E01	1"	16	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2652	C-07-217
									TO: J-BOX	
									3 #14 >> EDR-2651 CONTROL	C-07-201
									3 #14 >> EDR-2652 CONTROL	C-07-202
									10 #14 >> LCP-2652 CONTROL	
C-07-217	02E01	2"	2	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX	C-07-218
	00EX03		44	#14	XHHW-2				TO: PB-33 (EXISTING)	
									2 #14 >> ZS-2651 CONTROL	C-07-203
									2 #12 >> MWH-2651 POWER	C-07-215
									2 #14 >> TSH-2651 CONTROL	C-07-215
									2 #14 >> XS-2651 CONTROL	C-07-215
									2 #14 >> XSH-2651 CONTROL	C-07-215
									2 #14 >> XSHH-2651 CONTROL	C-07-215
									13 #14 >> LCP-2651 CONTROL	C-07-215
									5 #14 >> LCP-2651 SPARE	C-07-215
									3 #14 >> EDR-2651 CONTROL	C-07-216
									3 #14 >> EDR-2652 CONTROL	C-07-216
									10 #14 >> LCP-2652 CONTROL	C-07-216
C-07-218	00EX03	2"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PB-33 (EXISTING)	
	00EX04		44	#14	XHHW-2				TO: MCC-7A (VIA MCC-7 TRENCH & EXISTING 07-E714)	
									2 #14 >> ZS-2651 CONTROL	C-07-217
									2 #12 >> MWH-2651 POWER	C-07-217
									2 #14 >> TSH-2651 CONTROL	C-07-217
									2 #14 >> XS-2651 CONTROL	C-07-217
									2 #14 >> XSH-2651 CONTROL	C-07-217
									2 #14 >> XSHH-2651 CONTROL	C-07-217
									13 #14 >> LCP-2651 CONTROL	C-07-217
									5 #14 >> LCP-2651 SPARE	C-07-217
									3 #14 >> EDR-2651 CONTROL	C-07-217
									3 #14 >> EDR-2652 CONTROL	C-07-217
									10 #14 >> LCP-2652 CONTROL	C-07-217
L-07-221	02E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2651	L-07-222
									TO: CONDUIT TEE	
									2 #12 >> AIT-2651 POWER	
S-07-221	02E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-2651	S-07-251
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2651 SIGNAL	
L-07-222	02E01	1"	2	#6	XHHW-2	1	#6	XHHW-2	FR: CONDUIT TEE	L-07-231
			4	#12	XHHW-2				TO: CONDUIT TEE	
									2 #12 >> CLARIFIER POLE LIGHT POWER	L-07-214
									2 #6 >> CLARIFIER RECEPTACLES	L-07-214
									2 #12 >> AIT-2651 POWER	L-07-221
L-07-223	02E01	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: CLARIFIER POLE LIGHT	
			2	#12	XHHW-2				TO: CONDUIT TEE	
									2 #12 >> CLARIFIER POLE LIGHT POWER	
									2 #10 >> CLARIFIER RECEPTACLES	
L-07-224	02E01	1"	4	#10	XHHW-2	1	#10	XHHW-2	FR: CLARIFIER POLE LIGHT	
			4	#12	XHHW-2				TO: CONDUIT TEE	
									4 #12 >> CLARIFIER POLE LIGHT POWER	
									4 #10 >> CLARIFIER RECEPTACLES	
L-07-231	02E01	2"	2	#6	XHHW-2	1	#6	XHHW-2	FR: CONDUIT TEE	L-07-232
	00EX03		4	#12	XHHW-2				TO: PB-33 (EXISTING)	
									2 #12 >> CLARIFIER POLE LIGHT POWER	L-07-222
									2 #6 >> CLARIFIER RECEPTACLES	L-07-222
									2 #12 >> AIT-2651 POWER	L-07-222
L-07-232	00EX03	2"	2	#6	XHHW-2	1	#6	XHHW-2	FR: PB-33 (EXISTING)	
	00EX04		4	#12	XHHW-2				TO: LP7 AND LC-7 (VIA MCC-7 TRENCH & EXISTING 07-E701)	
									2 #12 >> CLARIFIER POLE LIGHT POWER	L-07-231
									2 #6 >> CLARIFIER RECEPTACLES	L-07-231
									2 #12 >> AIT-2651 POWER	L-07-231
C-07-241	02E01	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: SUBMERSIBLE PUMP TERMINATION BOX	
									TO: VCP-2650	
									2 #14 >> ME/TE-2655 CONTROL	
									2 #14 >> ME/TE-2656 CONTROL	
S-07-241	02E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LT-2651 TERMINATION BOX	
									TO: VCP-2650	
									1 2/CS-#16 >> LT-2651 SIGNAL	
C-07-242	02E01	2"	8	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-2650	C-07-359
	00EX03								TO: PB-33 (EXISTING)	
									8 #14 >> VCP-2650 CONTROL	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	SKB
REVISION	0
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
S-07-242	02E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: VCP-2650 TO: CONDUIT TEE 1 2/CS-#16 >> VCP-2650 SIGNAL	S-07-251
S-07-251	02E01 00EX03	2"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: IPB-33 1 2/CS-#16 >> AIT-2651 SIGNAL 1 2/CS-#16 >> VCP-2650 SIGNAL	S-07-637 S-07-221 S-07-242
P-07-255	02E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: SUBMERSIBLE PUMP TERMINATION BOX TO: VCP-2650 3 #12 >> PMP-2655 POWER	
P-07-256	02E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: SUBMERSIBLE PUMP TERMINATION BOX TO: VCP-2650 3 #12 >> PMP-2656 POWER	
P-07-257	02E01	1"	3	#6	XHHW-2	1	#8	XHHW-2	FR: VCP-2650 TO: CONDUIT TEE 3 #6 >> VCP-2650 POWER	P-07-261
P-07-261	02E01 00EX03	2"	3 3	#6 #12	XHHW-2 XHHW-2	1	#10	XHHW-2	FR: CONDUIT TEE TO: PB-33 (EXISTING) 3 #12 >> SC-2651 POWER 3 #6 >> VCP-2650 POWER	P-07-262 P-07-212 P-07-257
P-07-262	00EX03 00EX04	2"	3 3	#6 #12	XHHW-2 XHHW-2	1	#10	XHHW-2	FR: PB-33 (EXISTING) TO: MCC-7A (VIA MCC-7 TRENCH & EXISTING 07-E712) 3 #12 >> SC-2651 POWER 3 #6 >> VCP-2650 POWER	P-07-261 P-07-261
X-07-271	02E01 00EX03	2"	1	PULL	ROPE				FR: STUB UP AT CLARIFIER NO.4 TO: PB-33 (EXISTING) 1 PULL >> SPARE	
X-07-275	02E01 00EX03	2"	1	PULL	ROPE				FR: STUB UP AT CLARIFIER NO.4 TO: IPB-33 (EXISTING) 1 PULL >> SPARE	
C-07-301	03E01	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-2700 TO: CONDUIT TEE 10 #14 >> VCP-2700 CONTROL	C-07-358
P-07-301	03E01 00EX03	2"	3	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-2700 TO: PB-33 (EXISTING) 3 #12 >> VCP-2700 POWER	P-07-302
P-07-302	00EX03 00EX04	2"	3	#12	XHHW-2	1	#12	XHHW-2	FR: PB-33 (EXISTING) TO: MCC-7B (VIA MCC-7 TRENCH & EXISTING 07-E711) 3 #12 >> VCP-2700 POWER	P-07-301
P-07-305	03E01	2"	1	MFR	CABLE	1	#14	XHHW-2	FR: PMP-2701 TO: VCP-2700 1 MFR >> PMP-2701 POWER	
P-07-306	03E01	2"	1	MFR	CABLE	1	#14	XHHW-2	FR: PMP-2702 TO: VCP-2700 1 MFR >> PMP-2702 POWER	
C-07-311	03E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-2711 TERMINATION BOX TO: LCP-2711 2 #12 >> TE/ME-2711 CONTROL	
L-07-311	03E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-2711 TO: CONDUIT TEE 2 #12 >> FIT-2711 POWER	L-07-332
P-07-311	03E01 00EX03	2"	1	3/C-#4-VFD	VFD			INTEGRAL	FR: PMP-2711 TERMINATION BOX TO: PB-33 (EXISTING) 1 3/C-#4-VFD >> PMP-2711 POWER	P-07-315
S-07-311	03E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-2711 TO: CONDUIT TEE 1 2/CS-#16 >> FIT-2711 SIGNAL	S-07-332
C-07-312	03E01	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2711 TO: CONDUIT TEE 9 #14 >> LCP-2711 CONTROL 3 #14 >> LCP-2711 CONTROL (SPARE)	C-07-324
S-07-312	03E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LCP-2711 TO: CONDUIT TEE 1 2/CS-#16 >> LCP-2711 SIGNAL	S-07-324

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	SKB
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CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
P-07-315	00EX03 00EX04	2"	1	3/C-#4-VFD	VFD			INTEGRAL	FR: PB-33 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E704) 1 3/C-#4-VFD >> PMP-2711 POWER	P-07-316 P-07-311
P-07-316	07E01	2"	1	3/C-#4-VFD	VFD			INTEGRAL	FR: MCC-7 TRENCH TO: VFD-2711 1 3/C-#4-VFD >> PMP-2711 POWER	 P-07-315
C-07-321	03E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: PMP-2721 TERMINATION BOX TO: LCP-2721 2 #12 >> TE/ME-2721 CONTROL	
P-07-321	03E01 00EX03	2"	1	3/C-#4-VFD	VFD			INTEGRAL	FR: PMP-2721 TERMINATION BOX TO: PB-33 (EXISTING) 1 3/C-#4-VFD >> PMP-2721 POWER	P-07-325
C-07-322	03E01	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2721 TO: J-BOX 9 #14 >> LCP-2721 CONTROL 3 #14 >> LCP-2721 CONTROL (SPARE)	C-07-323
S-07-322	03E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: LCP-2721 TO: J-BOX 1 2/CS-#16 >> LCP-2721 SIGNAL	S-07-323
C-07-323	03E01	1.5"	24	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: CONDUIT TEE 9 #14 >> LCP-2721 CONTROL 3 #14 >> LCP-2721 CONTROL (SPARE) 9 #14 >> LCP-2731 CONTROL (FUTURE) 3 #14 >> LCP-2731 CONTROL (FUTURE)	C-07-324 C-07-322 C-07-322
S-07-323	03E01	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: J-BOX TO: CONDUIT TEE 1 2/CS-#16 >> LCP-2721 SIGNAL 1 2/CS-#16 >> LCP-2731 SIGNAL (FUTURE)	S-07-324 S-07-322
C-07-324	03E01 00EX03	2"	36	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: PB-33 (EXISTING) 9 #14 >> LCP-2711 CONTROL 3 #14 >> LCP-2711 CONTROL (SPARE) 9 #14 >> LCP-2721 CONTROL 3 #14 >> LCP-2721 CONTROL (SPARE) 9 #14 >> LCP-2731 CONTROL (FUTURE) 3 #14 >> LCP-2731 CONTROL (FUTURE)	C-07-325 C-07-312 C-07-312 C-07-323 C-07-323 C-07-323 C-07-323
S-07-324	03E01 00EX03	2"	3	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: IPB-33 (EXISTING) 1 2/CS-#16 >> LCP-2711 SIGNAL 1 2/CS-#16 >> LCP-2721 SIGNAL 1 2/CS-#16 >> LCP-2731 SIGNAL (FUTURE)	S-07-637 S-07-312 S-07-323 S-07-323
C-07-325	00EX03 00EX04	2"	36	#14	XHHW-2	1	#14	XHHW-2	FR: PB-33 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E692) 9 #14 >> LCP-2711 CONTROL 3 #14 >> LCP-2711 CONTROL (SPARE) 9 #14 >> LCP-2721 CONTROL 3 #14 >> LCP-2721 CONTROL (SPARE) 9 #14 >> LCP-2731 CONTROL (FUTURE) 3 #14 >> LCP-2731 CONTROL (FUTURE)	 C-07-324 C-07-324 C-07-324 C-07-324 C-07-324 C-07-324
P-07-325	00EX03 00EX04	2"	1	3/C-#4-VFD	VFD			INTEGRAL	FR: PB-33 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E709) 1 3/C-#4-VFD >> PMP-2721 POWER	P-07-326 P-07-321
P-07-326	07E01	2"	1	3/C-#4-VFD	VFD			INTEGRAL	FR: MCC-7 TRENCH TO: VFD-2721 1 3/C-#4-VFD >> PMP-2721 POWER	 P-07-325
C-07-327	07E01	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-7 TRENCH TO: VFD-2711 9 #14 >> LCP-2711 CONTROL 3 #14 >> LCP-2711 CONTROL (SPARE)	 C-07-312 C-07-312
C-07-328	07E01	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-7 TRENCH TO: VFD-2721 9 #14 >> LCP-2721 CONTROL 3 #14 >> LCP-2721 CONTROL (SPARE)	 C-07-322 C-07-322
C-07-329	07E01	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-7 TRENCH TO: VFD-2731 (CAP AT FUTURE LOCATION) 9 #14 >> LCP-2731 CONTROL (FUTURE) 3 #14 >> LCP-2731 CONTROL (FUTURE)	 C-07-323 C-07-323

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
L-07-331	03E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-2731 TO: CONDUIT TEE 2 #12 >> FIT-2731 POWER	L-07-332
P-07-331	03E01 00EX03	2"	1	PULL	ROPE				FR: STUB UP AT RAS PUMP STATION NO. 2 TO: PB-33 (EXISTING) 1 PULL >> PMP-2721 POWER (FUTURE)	P-07-335
S-07-331	03E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-2731 TO: CONDUIT TEE 1 2/CS-#16 >> FIT-2731 SIGNAL	S-07-332
L-07-332	03E01 00EX03	2"	4	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: PB-33 (EXISTING) 2 #12 >> FIT-2711 POWER 2 #12 >> FIT-2731 POWER	L-07-359 L-07-311 L-07-331
S-07-332	03E01 00EX03	2"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: IPB-33 (EXISTING) 1 2/CS-#16 >> FIT-2711 SIGNAL 1 2/CS-#16 >> FIT-2731 SIGNAL	S-07-637 S-07-311 S-07-331
P-07-335	00EX03 00EX04	2"	1	PULL	ROPE				FR: PB-33 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E710) 1 PULL >> PMP-2721 POWER (FUTURE)	P-07-336 P-07-331
P-07-336	07E01	1"	1	PULL	ROPE				FR: MCC-7 TRENCH TO: VFD-2731 (CAP AT FUTURE LOCATION) 1 PULL >> PMP-2721 POWER (FUTURE)	P-07-335
L-07-341	03E01 00EX03	2"	8	#10	XHHW-2	1	#10	XHHW-2	FR: RAS PUMP STATION NO. 2 POLE LIGHT TO: PB-33 (EXISTING) 6 #10 >> RAS PUMP STATION NO. 2 LIGHTS 2 #10 >> RAS PUMP STATION NO. 2 RECEPTS	L-07-342
L-07-342	00EX03 00EX04	2"	8	#10	XHHW-2	1	#10	XHHW-2	FR: PB-33 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E700) 6 #10 >> RAS PUMP STATION NO. 2 LIGHTS 2 #10 >> RAS PUMP STATION NO. 2 RECEPTS	L-07-343 L-07-341 L-07-341
L-07-343	07E01	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR: MCC-7 TRENCH TO: LP7B 2 #10 >> RAS PUMP STATION NO. 2 RECEPTS	L-07-342
L-07-344	07E01	0.75"	6	#10	XHHW-2	1	#10	XHHW-2	FR: MCC-7 TRENCH TO: LC-7 6 #10 >> RAS PUMP STATION NO. 2 LIGHTS	L-07-342
X-07-345	03E01 00EX03	2"	1	PULL	ROPE				FR: STUB UP AT RAS PUMP STATION NO. 2 TO: PB-33 (EXISTING) 1 PULL >> SPARE	
L-07-351	03E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FE-2651 TO: FIT-2651 2 #12 >> FE-2651 POWER	
S-07-351	03E01	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-2651 TO: FIT-2651 1 MFR >> FE-2651 SIGNAL	
L-07-352	03E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-2651 TO: J-BOX 2 #12 >> FIT-2651 POWER	L-07-358
S-07-352	03E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-2651 TO: J-BOX 1 2/CS-#16 >> FIT-2651 SIGNAL	S-07-358
L-07-355	03E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: HAM-2651 TO: VCP-2651 2 #12 >> HAM-2651 POWER	
S-07-355	03E01	0.75"	1	MFR	CABLE	1	#14	XHHW-2	FR: HAM-2651 TO: VCP-2651 1 MFR >> HAM-2651 SIGNAL	
C-07-356	03E01	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: VCP-2651 TO: J-BOX 10 #14 >> VCP-2651 CONTROL	C-07-357
L-07-356	03E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: VCP-2651 TO: J-BOX 2 #12 >> VCP-2651 POWER	L-07-358

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-07-356	03E01	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: VCP-2651 TO: J-BOX 2 2/CS-#16 >> VCP-2651 SIGNAL	S-07-358
C-07-357	03E01	1.5"	20	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: CONDUIT TEE 10 #14 >> VCP-2651 CONTROL 10 #14 >> VCP-2661 CONTROL (FUTURE)	C-07-358 C-07-356 C-07-367
C-07-358	03E01 00EX03	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: PB-33 (EXISTING) 10 #14 >> VCP-2700 CONTROL 10 #14 >> VCP-2651 CONTROL 10 #14 >> VCP-2661 CONTROL (FUTURE)	C-07-359 C-07-301 C-07-357 C-07-357
L-07-358	03E01 00EX03	2"	8	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX TO: PB-33 (EXISTING) 2 #12 >> FIT-2651 POWER 2 #12 >> VCP-2651 POWER 2 #12 >> FIT-2661 POWER (FUTURE) 2 #12 >> VCP-2661 POWER (FUTURE)	L-07-359 L-07-352 L-07-356 L-07-367 L-07-367
S-07-358	03E01 00EX03	2"	6	2/CS-#16		1	#14	XHHW-2	FR: J-BOX TO: IPB-33 (EXISTING) 1 2/CS-#16 >> FIT-2651 SIGNAL 2 2/CS-#16 >> VCP-2651 SIGNAL 1 2/CS-#16 >> FIT-2661 SIGNAL (FUTURE) 2 2/CS-#16 >> VCP-2661 SIGNAL (FUTURE)	S-07-637 S-07-352 S-07-356 S-07-367 S-07-367
C-07-359	00EX03 00EX04	2"	38	#14	XHHW-2	1	#14	XHHW-2	FR: PB-33 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E702) 8 #14 >> VCP-2650 CONTROL 10 #14 >> VCP-2700 CONTROL 10 #14 >> VCP-2651 CONTROL 10 #14 >> VCP-2661 CONTROL (FUTURE)	C-07-360 C-07-242 C-07-358 C-07-358 C-07-358
L-07-359	00EX03 00EX04	2"	12	#12	XHHW-2	1	#12	XHHW-2	FR: PB-33 (EXISTING) TO: MCC-7 TRENCH (VIA EXISTING 07-E703) 2 #12 >> FIT-2711 POWER 2 #12 >> FIT-2731 POWER 2 #12 >> FIT-2651 POWER 2 #12 >> VCP-2651 POWER 2 #12 >> FIT-2661 POWER (FUTURE) 2 #12 >> VCP-2661 POWER (FUTURE)	L-07-360 L-07-332 L-07-332 L-07-358 L-07-358 L-07-358 L-07-358
C-07-360	07E01	1.5"	38	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-7 TRENCH TO: RTU-207 8 #14 >> VCP-2650 CONTROL 10 #14 >> VCP-2700 CONTROL 10 #14 >> VCP-2651 CONTROL 10 #14 >> VCP-2661 CONTROL (FUTURE)	C-07-359 C-07-359 C-07-359 C-07-359
L-07-360	07E01	0.75"	8	#12	XHHW-2	1	#12	XHHW-2	FR: MCC-7 TRENCH TO: LP7B 2 #12 >> FIT-2651 POWER 2 #12 >> VCP-2651 POWER 2 #12 >> FIT-2661 POWER (FUTURE) 2 #12 >> VCP-2661 POWER (FUTURE)	L-07-359 L-07-359 L-07-359 L-07-359
X-07-363	03E01 00EX03	2"	1	PULL	ROPE				FR: STUB UP AT RAS PUMP STATION NO. 2 TO: IPB-33 (EXISTING) 1 PULL >> SPARE	
C-07-367	03E01	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: J-BOX 10 #14 >> VCP-2661 CONTROL (FUTURE)	C-07-357
L-07-367	03E01	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX TO: J-BOX 2 #12 >> FIT-2661 POWER (FUTURE) 2 #12 >> VCP-2661 POWER (FUTURE)	L-07-358
S-07-367	03E01	1"	3	2/CS-#16		1	#14	XHHW-2	FR: J-BOX TO: J-BOX 1 2/CS-#16 >> FIT-2661 SIGNAL (FUTURE) 2 2/CS-#16 >> VCP-2661 SIGNAL (FUTURE)	S-07-358
X-07-401	00EX02 07E02	2"	1	PULL	ROPE				FR: PB-38 TO: MCC-8A 1 PULL >> SPARE	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
X-07-402	00EX02 07E02	2"	1	PULL	ROPE				FR: PB-38 TO: MCC-8A 1 PULL >> SPARE	
X-07-406	00EX02 07E02	2"	1	PULL	ROPE				FR: PB-38 TO: MCC-8B 1 PULL >> SPARE	
X-07-407	00EX02 07E02	2"	1	PULL	ROPE				FR: PB-38 TO: MCC-8B 1 PULL >> SPARE	
C-07-411	04E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2315 TERMINATION BOX TO: LCP-2315 2 #14 >> ME/TE-2315 CONTROL	
L-07-411	04E01 04E02	0.75"	2 2	#10 #12	XHHW-2 XHHW-2	1	#4	XHHW-2	FR: A BASIN NO. 1 LIGHTS/RECEPTACLES TO: A BASIN NO. 1 LIGHTS/RECEPTACLES 2 #10 >> A BASIN NO.1 LIGHTS 2 #12 >> A BASIN NO.1 RECEPTACLES	L-07-412
P-07-411	04E01 04E02	1.5"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PMP-2315 TERMINATION BOX TO: PULLBOX 1 3/C-#10-VFD >> PMP-2315 POWER	P-07-421
C-07-412	04E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2316 TERMINATION BOX TO: LCP-2316 2 #14 >> ME/TE-2316 CONTROL	
L-07-412	04E01	1.5"	2 2	#4 #10	XHHW-2 XHHW-2	1	#4	XHHW-2	FR: A BASIN NO. 1 LIGHTS/RECEPTACLES TO: PULLBOX 2 #10 >> A BASIN NO.1 LIGHTS 2 #4 >> A BASIN NO.1 RECEPTACLES	L-07-413 L-07-411 L-07-411
P-07-412	04E01 04E02	1.5"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PMP-2316 TERMINATION BOX TO: PULLBOX 1 3/C-#10-VFD >> PMP-2316 POWER	P-07-422
C-07-413	04E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2316 TO: LCP-2315 6 #14 >> LCP-2316 CONTROL	C-07-414
L-07-413	04E01	1.5"	2 2	#4 #10	XHHW-2 XHHW-2	1	#4	XHHW-2	FR: PULLBOX TO: PULLBOX 2 #10 >> A BASIN NO.1 LIGHTS 2 #4 >> A BASIN NO.1 RECEPTACLES	L-07-431 L-07-412 L-07-412
P-07-413	04E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2311 TERMINATION BOX TO: J-BOX 3 #12 >> MIX-2311 POWER	P-07-415
C-07-414	04E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2315 TO: J-BOX 6 #14 >> LCP-2315 CONTROL 6 #14 >> LCP-2316 CONTROL	C-07-417 C-07-413
P-07-414	04E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2312 TERMINATION BOX TO: J-BOX 3 #12 >> MIX-2312 POWER	P-07-415
C-07-415	04E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2311 TERMINATION BOX TO: LCP-2311 2 #14 >> ME/TE-2311 CONTROL	
P-07-415	04E01 04E02	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX TO: J-BOX 3 #12 >> MIX-2311 POWER 3 #12 >> MIX-2312 POWER	P-07-417 P-07-413 P-07-414
C-07-416	04E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2311 TO: J-BOX 6 #14 >> LCP-2311 CONTROL	C-07-417
P-07-416	04E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2313 TERMINATION BOX TO: J-BOX 3 #12 >> MIX-2313 POWER	P-07-417
C-07-417	04E01 04E02	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: J-BOX 6 #14 >> LCP-2315 CONTROL 6 #14 >> LCP-2316 CONTROL 6 #14 >> LCP-2311 CONTROL	C-07-420 C-07-414 C-07-414 C-07-416

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-07-417	04E01	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX	P-07-418
									TO: PULLBOX	
									3 #12 >> MIX-2311 POWER	P-07-415
									3 #12 >> MIX-2312 POWER	P-07-415
									3 #12 >> MIX-2313 POWER	P-07-416
C-07-418	04E01 04E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2312 TERMINATION BOX	
									TO: LCP-2312	
									2 #14 >> ME/TE-2312 CONTROL	
P-07-418	04E01	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX	P-07-419
									TO: PULLBOX	
									3 #12 >> MIX-2311 POWER	P-07-417
									3 #12 >> MIX-2312 POWER	P-07-417
									3 #12 >> MIX-2313 POWER	P-07-417
C-07-419	04E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2312	C-07-420
									TO: J-BOX	
									6 #14 >> LCP-2312 CONTROL	
P-07-419	00EX02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX	P-07-433
									TO: PB-37	
									3 #12 >> MIX-2311 POWER	P-07-418
									3 #12 >> MIX-2312 POWER	P-07-418
									3 #12 >> MIX-2313 POWER	P-07-418
C-07-420	04E01	1.5"	24	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX	C-07-423
									TO: J-BOX	
									6 #14 >> LCP-2315 CONTROL	C-07-417
									6 #14 >> LCP-2316 CONTROL	C-07-417
									6 #14 >> LCP-2311 CONTROL	C-07-417
									6 #14 >> LCP-2312 CONTROL	C-07-419
C-07-421	04E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2313 TERMINATION BOX	
									TO: LCP-2313	
									2 #14 >> TE/ME-2313 CONTROL	
P-07-421	04E01	1.5"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX	P-07-423
									TO: PULLBOX	
									1 3/C-#10-VFD >> PMP-2315 POWER	P-07-411
C-07-422	04E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2313	C-07-423
									TO: J-BOX	
									6 #14 >> LCP-2313 CONTROL	
P-07-422	04E01	1.5"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX	P-07-424
									TO: PULLBOX	
									1 3/C-#10-VFD >> PMP-2316 POWER	P-07-412
C-07-423	04E01	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX	C-07-424
									TO: PULLBOX	
									6 #14 >> LCP-2315 CONTROL	C-07-420
									6 #14 >> LCP-2316 CONTROL	C-07-420
									6 #14 >> LCP-2311 CONTROL	C-07-420
									6 #14 >> LCP-2312 CONTROL	C-07-420
									6 #14 >> LCP-2313 CONTROL	C-07-422
P-07-423	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX	P-07-431
									TO: PB-37	
									1 3/C-#10-VFD >> PMP-2315 POWER	P-07-421
C-07-424	04E01	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX	C-07-431
									TO: PULLBOX	
									6 #14 >> LCP-2315 CONTROL	C-07-423
									6 #14 >> LCP-2316 CONTROL	C-07-423
									6 #14 >> LCP-2311 CONTROL	C-07-423
									6 #14 >> LCP-2312 CONTROL	C-07-423
									6 #14 >> LCP-2313 CONTROL	C-07-423
P-07-424	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX	P-07-432
									TO: PB-37	
									1 3/C-#10-VFD >> PMP-2316 POWER	P-07-422
L-07-425	04E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-202 (EXISTING)	L-07-426
									TO: JB-202	
									2 #12 >> AIT-202 (EXISTING) POWER	
S-07-425	04E02	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-202 (EXISTING)	S-07-426
									TO: JB-202	
									1 2/CS-#16 >> AIT-202 (EXISTING) SIGNAL	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
X-07-425	00EX02	2"	1	PULL	ROPE				FR: PULLBOX	
									TO: PB-37	
									1 PULL >> SPARE	
L-07-426	04E02	1"	4	#12	XHHW-2	1	#12	XHHW-2	FR: JB-202	
									TO: J-BOX	
									2 #12 >> AIT-202 (EXISTING) POWER	L-07-425
									2 #12 >> AIT-2312 POWER	L-07-427
S-07-426	04E02	1"	2	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: JB-202	
									TO: J-BOX	
									1 2/CS-#16 >> AIT-202 (EXISTING) SIGNAL	S-07-425
									1 2/CS-#16 >> AIT-2312 SIGNAL	S-07-427
X-07-426	00EX02	2"	1	PULL	ROPE				FR: PULLBOX	
									TO: IPB-37	
									1 PULL >> SPARE	
L-07-427	04E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2312	L-07-426
									TO: J-BOX	
									2 #12 >> AIT-2312 POWER	
S-07-427	04E02	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-2312	S-07-426
									TO: J-BOX	
									1 2/CS-#16 >> AIT-2312 SIGNAL	
X-07-427	00EX02 07E02	2"	1	PULL	ROPE				FR: PB-38	
									TO: MCC-8A	
									1 PULL >> SPARE	
L-07-428	04E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2313	L-07-429
									TO: J-BOX	
									2 #12 >> AIT-2313 POWER	
S-07-428	04E02	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-2313	S-07-429
									TO: J-BOX	
									1 2/CS-#16 >> AIT-2313 SIGNAL	
X-07-428	00EX02 07E02	2"	1	PULL	ROPE				FR: IPB-38	
									TO: RTU-208	
									1 PULL >> SPARE	
L-07-429	04E01 04E02	1"	4	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX	L-07-430
									TO: PULLBOX	
									2 #12 >> AIT-202 (EXISTING) POWER	L-07-425
									2 #12 >> AIT-2313 POWER	L-07-428
S-07-429	04E01 04E02	1"	2	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: J-BOX	S-07-430
									TO: PULLBOX	
									1 2/CS-#16 >> AIT-202 (EXISTING) SIGNAL	S-07-425
									1 2/CS-#16 >> AIT-2313 SIGNAL	S-07-428
L-07-430	04E01	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX	L-07-431
									TO: PULLBOX	
									2 #12 >> AIT-202 (EXISTING) POWER	L-07-429
									2 #12 >> AIT-2313 POWER	L-07-429
S-07-430	04E01	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: PULLBOX	S-07-431
									TO: PULLBOX	
									1 2/CS-#16 >> AIT-202 (EXISTING) SIGNAL	S-07-429
									1 2/CS-#16 >> AIT-2313 SIGNAL	S-07-429
C-07-431	00EX02	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX	C-07-432
									TO: PB-37	
									6 #14 >> LCP-2315 CONTROL	C-07-424
									6 #14 >> LCP-2316 CONTROL	C-07-424
									6 #14 >> LCP-2311 CONTROL	C-07-424
									6 #14 >> LCP-2312 CONTROL	C-07-424
									6 #14 >> LCP-2313 CONTROL	C-07-424
L-07-431	00EX02	2"	2	#4	XHHW-2	1	#4	XHHW-2	FR: PULLBOX	L-07-432
			2	#10	XHHW-2				TO: PB-37	
			4	#12	XHHW-2				2 #10 >> A BASIN NO.1 LIGHTS	L-07-413
									2 #4 >> A BASIN NO.1 RECEPTACLES	L-07-413
									2 #12 >> AIT-202 (EXISTING) POWER	L-07-430
									2 #12 >> AIT-2313 POWER	L-07-430
P-07-431	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PB-37	P-07-435
									TO: PB-38	
									1 3/C-#10-VFD >> PMP-2315 POWER	P-07-423

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND						
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**			**CONNECTING SEGMENTS**
S-07-431	00EX02	2"	2	2/CS-#16		1	#14	XHHW-2	FR:		PULLBOX	S-07-432
									TO:		IPB-37	
										1 2/CS-#16	>> AIT-202 (EXISTING) SIGNAL	S-07-430
										1 2/CS-#16	>> AIT-2313 SIGNAL	S-07-430
C-07-432	00EX02	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR:		PB-37	C-07-435
									TO:		PB-38	
										6 #14	>> LCP-2315 CONTROL	C-07-431
										6 #14	>> LCP-2316 CONTROL	C-07-431
										6 #14	>> LCP-2311 CONTROL	C-07-431
										6 #14	>> LCP-2312 CONTROL	C-07-431
										6 #14	>> LCP-2313 CONTROL	C-07-431
L-07-432	00EX02	2"	2	#4	XHHW-2	1	#4	XHHW-2	FR:		PB-37	L-07-495
			2	#10	XHHW-2				TO:		PB-38	
			4	#12	XHHW-2					2 #10	>> A BASIN NO.1 LIGHTS	L-07-431
										2 #4	>> A BASIN NO.1 RECEPTACLES	L-07-431
										2 #12	>> AIT-202 (EXISTING) POWER	L-07-431
										2 #12	>> AIT-2313 POWER	L-07-431
P-07-432	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR:		PB-37	P-07-436
									TO:		PB-38	
										1 3/C-#10-VFD	>> PMP-2316 POWER	P-07-424
S-07-432	00EX02	2"	2	2/CS-#16		1	#14	XHHW-2	FR:		IPB-37	S-07-495
									TO:		IPB-38	
										1 2/CS-#16	>> AIT-202 (EXISTING) SIGNAL	S-07-431
										1 2/CS-#16	>> AIT-2313 SIGNAL	S-07-431
P-07-433	00EX02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR:		PB-37	P-07-437
									TO:		PB-38	
										3 #12	>> MIX-2311 POWER	P-07-419
										3 #12	>> MIX-2312 POWER	P-07-419
										3 #12	>> MIX-2313 POWER	P-07-419
C-07-435	00EX02	2"	54	#14	XHHW-2	1	#14	XHHW-2	FR:		PB-38	
	07E02								TO:		MCC-8A	
										6 #14	>> LCP-2315 CONTROL	C-07-432
										6 #14	>> LCP-2311 CONTROL	C-07-432
										6 #14	>> LCP-2312 CONTROL	C-07-432
										6 #14	>> LCP-2313 CONTROL	C-07-432
										6 #14	>> LCP-2326 CONTROL	C-07-462
										6 #14	>> LCP-2335 CONTROL	C-07-491
										6 #14	>> LCP-2331 CONTROL	C-07-491
										6 #14	>> LCP-2332 CONTROL	C-07-491
										6 #14	>> LCP-2333 CONTROL	C-07-491
P-07-435	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR:		PB-38	
	07E02								TO:		MCC-8A	
										1 3/C-#10-VFD	>> PMP-2315 POWER	P-07-431
P-07-436	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR:		PB-38	
	07E02								TO:		MCC-8B	
										1 3/C-#10-VFD	>> PMP-2316 POWER	P-07-432
P-07-437	00EX02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR:		PB-38	
	07E02								TO:		MCC-8A	
										3 #12	>> MIX-2311 POWER	P-07-433
										3 #12	>> MIX-2312 POWER	P-07-433
										3 #12	>> MIX-2313 POWER	P-07-433
C-07-441	04E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR:		PMP-2325 TERMINATION BOX	
									TO:		LCP-2325	
										2 #14	>> ME/TE-2325 CONTROL	
L-07-441	04E03	0.75"	2	#10	XHHW-2	1	#10	XHHW-2	FR:		A BASIN NO.2 LIGHTS/RECEPTACLES	L-07-442
	04E04		2	#12	XHHW-2				TO:		A BASIN NO.2 LIGHTS/RECEPTACLES	
										2 #10	>> A BASIN NO.2 LIGHTS	
										2 #12	>> A BASIN NO.2 RECEPTACLES	
P-07-441	04E03	1.5"	1	3/C-#10-VFD	XHHW-2			INTEGRAL	FR:		PMP-2325 TERMINATION BOX	P-07-451
	04E04								TO:		PULLBOX	
										1 3/C-#10-VFD	>> PMP-2325 POWER	
C-07-442	04E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR:		PMP-2326 TERMINATION BOX	
									TO:		LCP-2326	
										2 #14	>> ME/TE-2326 CONTROL	
L-07-442	04E03	1.5"	2	#4	XHHW-2	1	#4	XHHW-2	FR:		A BASIN NO.2 LIGHTS/RECEPTACLES	L-07-443
			2	#10	XHHW-2				TO:		PULLBOX	
										2 #10	>> A BASIN NO.2 LIGHTS	L-07-441
										2 #4	>> A BASIN NO.2 RECEPTACLES	L-07-441

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-07-442	04E03 04E04	1.5"	1	3/C-#10-VFD	XHHW-2			INTEGRAL	FR: PMP-2326 TERMINATION BOX TO: PULLBOX 1 3/C-#10-VFD >> PMP-2326 POWER	P-07-452
C-07-443	04E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2326 TO: LCP-2325 6 #14 >> LCP-2326 CONTROL	C-07-444
L-07-443	04E03	1.5"	2 2	#4 #10	XHHW-2 XHHW-2	1	#4	XHHW-2	FR: PULLBOX TO: PULLBOX 2 #10 >> A BASIN NO.2 LIGHTS 2 #4 >> A BASIN NO.2 RECEPTACLES	L-07-461 L-07-442 L-07-442
P-07-443	04E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2321 TERMINATION BOX TO: J-BOX 3 #12 >> MIX-2321 POWER	P-07-445
C-07-444	04E04	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2325 TO: J-BOX 6 #14 >> LCP-2325 CONTROL 6 #14 >> LCP-2326 CONTROL	C-07-447 C-07-443
P-07-444	04E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2322 TERMINATION BOX TO: J-BOX 3 #12 >> MIX-2322 POWER	P-07-445
C-07-445	04E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2321 TERMINATION BOX TO: LCP-2321 2 #14 >> ME/TE-2321 CONTROL	
P-07-445	04E03	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX TO: J-BOX 3 #12 >> MIX-2321 POWER 3 #12 >> MIX-2322 POWER	P-07-447 P-07-443 P-07-444
C-07-446	04E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2321 TO: J-BOX 6 #14 >> LCP-2321 CONTROL	C-07-447
P-07-446	04E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2323 TERMINATION BOX TO: J-BOX 3 #12 >> MIX-2323 POWER	P-07-447
C-07-447	04E03 04E04	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: J-BOX 6 #14 >> LCP-2325 CONTROL 6 #14 >> LCP-2326 CONTROL 6 #14 >> LCP-2321 CONTROL	C-07-450 C-07-444 C-07-444 C-07-446
P-07-447	04E03	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX TO: PULLBOX 3 #12 >> MIX-2321 POWER 3 #12 >> MIX-2322 POWER 3 #12 >> MIX-2323 POWER	P-07-448 P-07-445 P-07-445 P-07-446
C-07-448	04E03 04E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2322 TERMINATION BOX TO: LCP-2322 2 #14 >> ME/TE-2322 CONTROL	
P-07-448	04E03	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX TO: PULLBOX 3 #12 >> MIX-2321 POWER 3 #12 >> MIX-2322 POWER 3 #12 >> MIX-2323 POWER	P-07-449 P-07-447 P-07-447 P-07-447
C-07-449	04E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2322 TO: J-BOX 6 #14 >> LCP-2322 CONTROL	C-07-450
P-07-449	00EX02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX TO: PB-37 3 #12 >> MIX-2321 POWER 3 #12 >> MIX-2322 POWER 3 #12 >> MIX-2323 POWER	P-07-463 P-07-448 P-07-448 P-07-448
C-07-450	04E03	1.5"	24	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: J-BOX 6 #14 >> LCP-2325 CONTROL 6 #14 >> LCP-2326 CONTROL 6 #14 >> LCP-2321 CONTROL 6 #14 >> LCP-2322 CONTROL	C-07-453 C-07-447 C-07-447 C-07-447 C-07-449

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-07-451	04E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2323 TERMINATION BOX TO: LCP-2323 2 #14 >> TE/ME-2323 CONTROL	
P-07-451	04E03	1.5"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX TO: PULLBOX 1 3/C-#10-VFD >> PMP-2325 POWER	P-07-453 P-07-441
C-07-452	04E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2323 TO: J-BOX 6 #14 >> LCP-2323 CONTROL	C-07-453
P-07-452	04E03	1.5"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX TO: PULLBOX 1 3/C-#10-VFD >> PMP-2326 POWER	P-07-454 P-07-442
C-07-453	04E03	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: PULLBOX 6 #14 >> LCP-2325 CONTROL 6 #14 >> LCP-2326 CONTROL 6 #14 >> LCP-2321 CONTROL 6 #14 >> LCP-2322 CONTROL 6 #14 >> LCP-2323 CONTROL	C-07-454 C-07-450 C-07-450 C-07-450 C-07-450 C-07-452
P-07-453	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX TO: PB-37 1 3/C-#10-VFD >> PMP-2325 POWER	P-07-461 P-07-451
C-07-454	04E03	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX TO: PULLBOX 6 #14 >> LCP-2325 CONTROL 6 #14 >> LCP-2326 CONTROL 6 #14 >> LCP-2321 CONTROL 6 #14 >> LCP-2322 CONTROL 6 #14 >> LCP-2323 CONTROL	 C-07-453 C-07-453 C-07-453 C-07-453 C-07-453
P-07-454	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX TO: PB-37 1 3/C-#10-VFD >> PMP-2326 POWER	P-07-462 P-07-452
L-07-455	04E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-212 (EXISTING) TO: JB-212 2 #12 >> AIT-212 (EXISTING) POWER	L-07-456
S-07-455	04E04	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-212 (EXISTING) TO: JB-212 1 2/CS-#16 >> AIT-212 (EXISTING) SIGNAL	S-07-456
X-07-455	00EX02	2"	1	PULL	ROPE				FR: PULLBOX TO: PB-38 1 PULL >> SPARE	
L-07-456	04E04	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: JB-212 TO: J-BOX 2 #12 >> AIT-212 (EXISTING) POWER 2 #12 >> AIT-2322 POWER	 L-07-455 L-07-457
S-07-456	04E04	0.75"	2	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: JB-212 TO: J-BOX 1 2/CS-#16 >> AIT-212 (EXISTING) SIGNAL 1 2/CS-#16 >> AIT-2322 SIGNAL	 S-07-455 S-07-457
X-07-456	00EX02	2"	1	PULL	ROPE				FR: PULLBOX TO: IPB-37 1 PULL >> SPARE	
L-07-457	04E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2322 TO: J-BOX 2 #12 >> AIT-2322 POWER	L-07-456
S-07-457	04E04	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-2322 TO: J-BOX 1 2/CS-#16 >> AIT-2322 SIGNAL	S-07-456
X-07-457	00EX02 07E02	2"	1	PULL	ROPE				FR: PB-38 TO: MCC-8B 1 PULL >> SPARE	
L-07-458	04E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2323 TO: J-BOX 2 #12 >> AIT-2323 POWER	L-07-459

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-07-458	04E04	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-2323	S-07-459
									TO: J-BOX	
									1 2/CS-#16 >> AIT-2323 SIGNAL	
X-07-458	00EX02 07E02	2"	1	PULL	ROPE				FR: IPB-38	
									TO: RTU-208	
									1 PULL >> SPARE	
L-07-459	04E03 04E04	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX	L-07-461
									TO: PULLBOX	
									2 #12 >> AIT-212 (EXISTING) POWER	L-07-455
									2 #12 >> AIT-2323 POWER	L-07-458
S-07-459	04E03 04E04	0.75"	2	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: J-BOX	S-07-460
									TO: PULLBOX	
									1 2/CS-#16 >> AIT-212 (EXISTING) SIGNAL	S-07-455
									1 2/CS-#16 >> AIT-2323 SIGNAL	S-07-458
S-07-460	04E03	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: PULLBOX	S-07-461
									TO: PULLBOX	
									1 2/CS-#16 >> AIT-212 (EXISTING) SIGNAL	S-07-459
									1 2/CS-#16 >> AIT-2323 SIGNAL	S-07-459
C-07-461	00EX02	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX	C-07-462
									TO: PB-37	
									6 #14 >> LCP-2325 CONTROL	C-07-453
									6 #14 >> LCP-2326 CONTROL	C-07-453
									6 #14 >> LCP-2321 CONTROL	C-07-453
									6 #14 >> LCP-2322 CONTROL	C-07-453
									6 #14 >> LCP-2323 CONTROL	C-07-453
L-07-461	00EX02	2"	2	#4	XHHW-2	1	#4	XHHW-2	FR: PULLBOX	L-07-462
			2	#10	XHHW-2				TO: PB-37	
			4	#12	XHHW-2				2 #10 >> A BASIN NO.2 LIGHTS	L-07-443
									2 #4 >> A BASIN NO.2 RECEPTACLES	L-07-443
									2 #12 >> AIT-212 (EXISTING) POWER	L-07-459
									2 #12 >> AIT-2323 POWER	L-07-459
P-07-461	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PB-37	P-07-465
									TO: PB-38	
									1 3/C-#10-VFD >> PMP-2325 POWER	P-07-453
S-07-461	00EX02	2"	2	2/CS-#16		1	#14	XHHW-2	FR: PULLBOX	S-07-462
									TO: IPB-37	
									1 2/CS-#16 >> AIT-212 (EXISTING) SIGNAL	S-07-460
									1 2/CS-#16 >> AIT-2323 SIGNAL	S-07-460
C-07-462	00EX02	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PB-37	C-07-435
									TO: PB-38	
									6 #14 >> LCP-2325 CONTROL	C-07-461
									6 #14 >> LCP-2326 CONTROL	C-07-461
									6 #14 >> LCP-2321 CONTROL	C-07-461
									6 #14 >> LCP-2322 CONTROL	C-07-461
									6 #14 >> LCP-2323 CONTROL	C-07-461
L-07-462	00EX02	2"	2	#4	XHHW-2	1	#4	XHHW-2	FR: PB-37	L-07-495
			2	#10	XHHW-2				TO: PB-38	
			4	#12	XHHW-2				2 #10 >> A BASIN NO.2 LIGHTS	L-07-461
									2 #4 >> A BASIN NO.2 RECEPTACLES	L-07-461
									2 #12 >> AIT-212 (EXISTING) POWER	L-07-461
									2 #12 >> AIT-2323 POWER	L-07-461
P-07-462	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PB-37	P-07-466
									TO: PB-38	
									1 3/C-#10-VFD >> PMP-2326 POWER	P-07-454
S-07-462	00EX02	2"	2	2/CS-#16		1	#14	XHHW-2	FR: IPB-37	S-07-495
									TO: IPB-38	
									1 2/CS-#16 >> AIT-212 (EXISTING) SIGNAL	S-07-461
									1 2/CS-#16 >> AIT-2323 SIGNAL	S-07-461
P-07-463	00EX02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-37	P-07-467
									TO: PB-38	
									3 #12 >> MIX-2321 POWER	P-07-449
									3 #12 >> MIX-2322 POWER	P-07-449
									3 #12 >> MIX-2323 POWER	P-07-449

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-07-465	00EX02 07E02	2"	36	#14	XHHW-2	1	#14	XHHW-2	FR: PB-38 TO: MCC-8B	
									6 #14 >> LCP-2316 CONTROL	C-07-432
									6 #14 >> LCP-2325 CONTROL	C-07-462
									6 #14 >> LCP-2321 CONTROL	C-07-462
									6 #14 >> LCP-2322 CONTROL	C-07-462
									6 #14 >> LCP-2323 CONTROL	C-07-462
									6 #14 >> LCP-2336 CONTROL	C-07-491
P-07-465	00EX02 07E02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PB-38 TO: MCC-8B	
									1 3/C-#10-VFD >> PMP-2325 POWER	P-07-461
P-07-466	00EX02 07E02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PB-38 TO: MCC-8A	
									1 3/C-#10-VFD >> PMP-2326 POWER	P-07-462
P-07-467	00EX02 07E02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-38 TO: MCC-8B	
									3 #12 >> MIX-2321 POWER	P-07-463
									3 #12 >> MIX-2322 POWER	P-07-463
									3 #12 >> MIX-2323 POWER	P-07-463
C-07-471	04E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2335 TERMINATION BOX TO: LCP-2335	
									2 #14 >> ME/TE-2335 CONTROL	
L-07-471	04E05 04E06	0.75"	2 2	#10 #12	XHHW-2 XHHW-2	1	#10	XHHW-2	FR: A BASIN NO.3 LIGHTS/RECEPTACLES TO: A BASIN NO.3 LIGHTS/RECEPTACLES	L-07-472
									2 #10 >> A BASIN NO.3 LIGHTS	
									2 #12 >> A BASIN NO.3 RECEPTACLES	
P-07-471	04E05 04E06	1.5"	1	3/C-#10-VFD	XHHW-2			INTEGRAL	FR: PMP-2335 TERMINATION BOX TO: PULLBOX	P-07-481
									1 3/C-#10-VFD >> PMP-2335 POWER	
C-07-472	04E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2336 TERMINATION BOX TO: LCP-2336	
									2 #14 >> ME/TE-2336 CONTROL	
L-07-472	04E05	1"	2 2	#6 #10	XHHW-2 XHHW-2	1	#6	XHHW-2	FR: A BASIN NO.3 LIGHTS/RECEPTACLES TO: PULLBOX	L-07-473
									2 #10 >> A BASIN NO.3 LIGHTS	L-07-471
									2 #6 >> A BASIN NO.3 RECEPTACLES	L-07-471
P-07-472	04E05 04E06	1.5"	1	3/C-#10-VFD	XHHW-2			INTEGRAL	FR: PMP-2336 TERMINATION BOX TO: PULLBOX	P-07-482
									1 3/C-#10-VFD >> PMP-2336 POWER	
C-07-473	04E06	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2336 TO: LCP-2335	C-07-474
									6 #14 >> LCP-2336 CONTROL	
L-07-473	04E05	1"	2 2	#6 #10	XHHW-2 XHHW-2	1	#6	XHHW-2	FR: PULLBOX TO: PULLBOX	L-07-491
									2 #10 >> A BASIN NO.3 LIGHTS	L-07-472
									2 #6 >> A BASIN NO.3 RECEPTACLES	L-07-472
P-07-473	04E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2331 TERMINATION BOX TO: J-BOX	P-07-475
									3 #12 >> MIX-2331 POWER	
C-07-474	04E06	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2335 TO: J-BOX	C-07-477
									6 #14 >> LCP-2335 CONTROL	
									6 #14 >> LCP-2336 CONTROL	C-07-473
P-07-474	04E06	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2332 TERMINATION BOX TO: J-BOX	P-07-475
									3 #12 >> MIX-2332 POWER	
C-07-475	04E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2331 TERMINATION BOX TO: LCP-2331	
									2 #14 >> ME/TE-2331 CONTROL	
P-07-475	04E05	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX TO: J-BOX	P-07-477
									3 #12 >> MIX-2331 POWER	P-07-473
									3 #12 >> MIX-2332 POWER	P-07-474
C-07-476	04E06	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2331 TO: J-BOX	C-07-477
									6 #14 >> LCP-2331 CONTROL	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-07-476	04E05	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2333 TERMINATION BOX	P-07-477
									TO: J-BOX	
									3 #12 >> MIX-2333 POWER	
C-07-477	04E05 04E06	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX	C-07-480
									TO: J-BOX	
									6 #14 >> LCP-2335 CONTROL	C-07-474
									6 #14 >> LCP-2336 CONTROL	C-07-474
									6 #14 >> LCP-2331 CONTROL	C-07-476
P-07-477	04E05	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX	P-07-478
									TO: PULLBOX	
									3 #12 >> MIX-2331 POWER	P-07-475
									3 #12 >> MIX-2332 POWER	P-07-475
									3 #12 >> MIX-2333 POWER	P-07-476
C-07-478	04E05 04E06	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2332 TERMINATION BOX	
									TO: LCP-2332	
									2 #14 >> ME/TE-2332 CONTROL	
P-07-478	04E05	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX	P-07-493
									TO: PULLBOX	
									3 #12 >> MIX-2331 POWER	P-07-477
									3 #12 >> MIX-2332 POWER	P-07-477
									3 #12 >> MIX-2333 POWER	P-07-477
C-07-479	04E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2332	C-07-480
									TO: J-BOX	
									6 #14 >> LCP-2332 CONTROL	
C-07-480	04E05	1.5"	24	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX	C-07-483
									TO: J-BOX	
									6 #14 >> LCP-2335 CONTROL	C-07-477
									6 #14 >> LCP-2336 CONTROL	C-07-477
									6 #14 >> LCP-2331 CONTROL	C-07-477
									6 #14 >> LCP-2332 CONTROL	C-07-479
C-07-481	04E05	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2333 TERMINATION BOX	
									TO: LCP-2333	
									2 #14 >> TE/ME-2333 CONTROL	
P-07-481	04E05	1.5"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX	P-07-491
									TO: PULLBOX	
									1 3/C-#10-VFD >> PMP-2335 POWER	P-07-471
C-07-482	04E05	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2333	C-07-483
									TO: J-BOX	
									6 #14 >> LCP-2333 CONTROL	
P-07-482	04E05	1.5"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX	P-07-492
									TO: PULLBOX	
									1 3/C-#10-VFD >> PMP-2336 POWER	P-07-472
C-07-483	04E05	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX	C-07-484
									TO: PULLBOX	
									6 #14 >> LCP-2335 CONTROL	C-07-480
									6 #14 >> LCP-2336 CONTROL	C-07-480
									6 #14 >> LCP-2331 CONTROL	C-07-480
									6 #14 >> LCP-2332 CONTROL	C-07-480
									6 #14 >> LCP-2333 CONTROL	C-07-482
C-07-484	04E05	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX	C-07-491
									TO: PULLBOX	
									6 #14 >> LCP-2335 CONTROL	C-07-483
									6 #14 >> LCP-2336 CONTROL	C-07-483
									6 #14 >> LCP-2331 CONTROL	C-07-483
									6 #14 >> LCP-2332 CONTROL	C-07-483
									6 #14 >> LCP-2333 CONTROL	C-07-483
L-07-485	04E06	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-222 (EXISTING)	L-07-486
									TO: JB-222	
									2 #12 >> AIT-222 (EXISTING) POWER	
S-07-485	04E06	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-222 (EXISTING)	S-07-486
									TO: JB-222	
									1 2/CS-#16 >> AIT-222 (EXISTING) SIGNAL	
X-07-485	00EX02	2"	1	PULL	ROPE				FR: PULLBOX	
									TO: PB-38	
									1 PULL >> SPARE	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
L-07-486	04E06	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: JB-222 TO: J-BOX 2 #12 >> AIT-222 (EXISTING) POWER 2 #12 >> AIT-2332 POWER	 L-07-485 L-07-487
S-07-486	04E06	0.75"	2	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: JB-222 TO: J-BOX 1 2/CS-#16 >> AIT-222 (EXISTING) SIGNAL 1 2/CS-#16 >> AIT-2332 SIGNAL	 S-07-485 S-07-487
X-07-486	00EX02	2"	1	PULL	ROPE				FR: PULLBOX TO: IPB-38 1 PULL >> SPARE	
L-07-487	04E06	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2332 TO: J-BOX 2 #12 >> AIT-2332 POWER	L-07-486
S-07-487	04E06	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-2332 TO: J-BOX 1 2/CS-#16 >> AIT-2332 SIGNAL	S-07-486
X-07-487	00EX02 07E02	2"	1	PULL	ROPE				FR: PB-38 TO: LP8 1 PULL >> SPARE	
L-07-488	04E06	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2333 TO: J-BOX 2 #12 >> AIT-2333 POWER	L-07-489
S-07-488	04E06	0.75"	1	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: AIT-2333 TO: J-BOX 1 2/CS-#16 >> AIT-2333 SIGNAL	S-07-489
X-07-488	00EX02 07E02	2"	1	PULL	ROPE				FR: IPB-38 TO: RTU-208 1 PULL >> SPARE	
L-07-489	04E05 04E06	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX TO: PULLBOX 2 #12 >> AIT-222 (EXISTING) POWER 2 #12 >> AIT-2333 POWER	L-07-491 L-07-485 L-07-488
S-07-489	04E05 04E06	0.75"	2	2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: PULLBOX 1 2/CS-#16 >> AIT-222 (EXISTING) SIGNAL 1 2/CS-#16 >> AIT-2333 SIGNAL	S-07-490 S-07-485 S-07-488
S-07-490	04E05	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: PULLBOX TO: PULLBOX 1 2/CS-#16 >> AIT-222 (EXISTING) SIGNAL 1 2/CS-#16 >> AIT-2333 SIGNAL	S-07-491 S-07-489 S-07-489
C-07-491	00EX02	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX TO: PB-38 6 #14 >> LCP-2335 CONTROL 6 #14 >> LCP-2336 CONTROL 6 #14 >> LCP-2331 CONTROL 6 #14 >> LCP-2332 CONTROL 6 #14 >> LCP-2333 CONTROL	C-07-435 C-07-484 C-07-484 C-07-484 C-07-484 C-07-484
L-07-491	00EX02	2"	2 2 4	#6 #10 #12	XHHW-2 XHHW-2 XHHW-2	1	#6	XHHW-2	FR: PULLBOX TO: PB-38 2 #10 >> A BASIN NO.3 LIGHTS 2 #6 >> A BASIN NO.3 RECEPTACLES 2 #12 >> AIT-222 (EXISTING) POWER 2 #12 >> AIT-2333 POWER	L-07-495 L-07-473 L-07-473 L-07-489 L-07-489
P-07-491	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX TO: PB-38 1 3/C-#10-VFD >> PMP-2335 POWER	P-07-495 P-07-481
S-07-491	00EX02	2"	2	2/CS-#16		1	#14	XHHW-2	FR: PULLBOX TO: IPB-38 1 2/CS-#16 >> AIT-222 (EXISTING) SIGNAL 1 2/CS-#16 >> AIT-2333 SIGNAL	S-07-495 S-07-490 S-07-490
P-07-492	00EX02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PULLBOX TO: PB-38 1 3/C-#10-VFD >> PMP-2336 POWER	P-07-496 P-07-482

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P-07-493	00EX02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX	P-07-497
									TO: PB-38	
									3 #12 >> MIX-2331 POWER	P-07-478
									3 #12 >> MIX-2332 POWER	P-07-478
									3 #12 >> MIX-2333 POWER	P-07-478
L-07-495	00EX02 07E02	2"	12	#12	XHHW-2	1	#4	XHHW-2	FR: PB-38	
									TO: LP8	
									2 #12 >> AIT-202 (EXISTING) POWER	L-07-432
									2 #12 >> AIT-2313 POWER	L-07-432
									2 #12 >> AIT-212 (EXISTING) POWER	L-07-462
									2 #12 >> AIT-2323 POWER	L-07-462
									2 #12 >> AIT-222 (EXISTING) POWER	L-07-491
									2 #12 >> AIT-2333 POWER	L-07-491
P-07-495	00EX02 07E02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PB-38	
									TO: MCC-8A	
									1 3/C-#10-VFD >> PMP-2335 POWER	P-07-491
S-07-495	00EX02 07E02	2"	6	2/CS-#16		1	#14	XHHW-2	FR: IPB-38	
									TO: RTU-208	
									1 2/CS-#16 >> AIT-202 (EXISTING) SIGNAL	S-07-432
									1 2/CS-#16 >> AIT-2313 SIGNAL	S-07-432
									1 2/CS-#16 >> AIT-212 (EXISTING) SIGNAL	S-07-462
									1 2/CS-#16 >> AIT-2323 SIGNAL	S-07-462
									1 2/CS-#16 >> AIT-222 (EXISTING) SIGNAL	S-07-491
									1 2/CS-#16 >> AIT-2333 SIGNAL	S-07-491
L-07-496	00EX02 07E02	2"	4 2	#4 #6	XHHW-2 XHHW-2	1	#4	XHHW-2	FR: PB-38	
									TO: LP8	
									2 #4 >> A BASIN NO.1 RECEPTACLES	L-07-431
									2 #4 >> A BASIN NO.2 RECEPTACLES	L-07-461
									2 #6 >> A BASIN NO.3 RECEPTACLES	L-07-491
P-07-496	00EX02 07E02	2"	1	3/C-#10-VFD	VFD			INTEGRAL	FR: PB-38	
									TO: MCC-8B	
									1 3/C-#10-VFD >> PMP-2336 POWER	P-07-492
L-07-497	00EX02 07E02	2"	6	#10	XHHW-2	1	#4	XHHW-2	FR: PB-38	
									TO: LC-8	
									2 #10 >> A BASIN NO.1 LIGHTS	L-07-431
									2 #10 >> A BASIN NO.2 LIGHTS	L-07-461
									2 #10 >> A BASIN NO.3 LIGHTS	L-07-491
P-07-497	00EX02 07E02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-38	
									TO: MCC-8A	
									3 #12 >> MIX-2331 POWER	P-07-493
									3 #12 >> MIX-2332 POWER	P-07-493
									3 #12 >> MIX-2333 POWER	P-07-493
C-07-511	05E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2345 TERMINATION BOX	
									TO: LCP-2345	
									2 #14 >> TE/ME-2345 CONTROL	
P-07-511	05E04	1.5"	1	3/C-#12-VFD	VFD			INTEGRAL	FR: PMP-2345 TERMINATION BOX	P-07-521
									TO: PULLBOX	
									1 3/C-#12-VFD >> PMP-2345 POWER	
C-07-512	05E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2346 TERMINATION BOX	
									TO: LCP-2346	
									2 #14 >> TE/ME-2346 CONTROL	
P-07-512	05E04	1.5"	1	3/C-#12-VFD	VFD			INTEGRAL	FR: PMP-2346 TERMINATION BOX	P-07-551
									TO: PULLBOX	
									1 3/C-#12-VFD >> PMP-2346 POWER	
C-07-513	05E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2345	C-07-514
									TO: LCP-2346	
									6 #14 >> LCP-2345 CONTROL	
P-07-513	05E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2341 TERMINATION BOX	P-07-515
									TO: CONDUIT TEE	
									3 #12 >> MIX-2341 POWER	
C-07-514	05E04	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2346	C-07-561
									TO: CONDUIT TEE	
									6 #14 >> LCP-2345 CONTROL	C-07-513
									6 #14 >> LCP-2346 CONTROL	
P-07-514	05E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2342 TERMINATION BOX	P-07-515
									TO: CONDUIT TEE	
									3 #12 >> MIX-2342 POWER	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-07-515	05E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2341 TERMINATION BOX	
									TO: LCP-2341	
									2 #14 >> ME/TE-2341 CONTROL	
P-07-515	05E02	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	P-07-517
									TO: CONDUIT TEE	
									3 #12 >> MIX-2341 POWER	P-07-513
									3 #12 >> MIX-2342 POWER	P-07-514
C-07-516	05E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2341	C-07-520
									TO: CONDUIT TEE	
									6 #14 >> LCP-2341 CONTROL	
P-07-516	05E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2343 TERMINATION BOX	P-07-517
									TO: CONDUIT TEE	
									3 #12 >> MIX-2343 POWER	
P-07-517	05E01	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	P-07-527
									TO: PULLBOX	
									3 #12 >> MIX-2341 POWER	P-07-515
									3 #12 >> MIX-2342 POWER	P-07-515
									3 #12 >> MIX-2343 POWER	P-07-516
C-07-518	05E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2342 TERMINATION BOX	
									TO: LCP-2342	
									2 #14 >> ME/TE-2342 CONTROL	
C-07-519	05E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2342	C-07-520
									TO: CONDUIT TEE	
									6 #14 >> LCP-2342 CONTROL	
C-07-520	05E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-07-523
									TO: CONDUIT TEE	
									6 #14 >> LCP-2341 CONTROL	C-07-516
									6 #14 >> LCP-2342 CONTROL	C-07-519
C-07-521	05E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2343 TERMINATION BOX	
									TO: LCP-2343	
									2 #14 >> ME/TE-2343 CONTROL	
P-07-521	00EX01	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: PULLBOX	P-07-565
									TO: PB-35	
									1 3/C-#12-VFD >> PMP-2345 POWER	P-07-511
									1 3/C-#12-VFD >> PMP-2356 POWER	P-07-542
C-07-522	05E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2343	C-07-523
									TO: CONDUIT TEE	
									6 #14 >> LCP-2343 CONTROL	
C-07-523	05E01	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-07-533
									TO: PULLBOX	
									6 #14 >> LCP-2341 CONTROL	C-07-520
									6 #14 >> LCP-2342 CONTROL	C-07-520
									6 #14 >> LCP-2343 CONTROL	C-07-522
L-07-525	05E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2341 (EXISTING)	L-07-526
									TO: JB-2341	
									2 #12 >> AIT-2341 (EXISTING) POWER	
S-07-525	05E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-2341 (EXISTING)	S-07-526
									TO: JB-2341	
									1 2/CS-#16 >> AIT-2341 (EXISTING) SIGNAL	
L-07-526	05E03 05E04	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: JB-2341	
									TO: CONDUIT TEE	
									2 #12 >> AIT-2341 (EXISTING) POWER	L-07-525
									2 #12 >> AIT-2342 POWER	L-07-527
S-07-526	05E03 05E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: JB-2341	
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2341 (EXISTING) SIGNAL	S-07-525
									1 2/CS-#16 >> AIT-2342 SIGNAL	S-07-527
L-07-527	05E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2342	L-07-526
									TO: CONDUIT TEE	
									2 #12 >> AIT-2342 POWER	
P-07-527	00EX01	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX	P-07-566
									TO: PB-35	
									3 #12 >> MIX-2341 POWER	P-07-517
									3 #12 >> MIX-2342 POWER	P-07-517
									3 #12 >> MIX-2343 POWER	P-07-517

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-07-527	05E03	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-2342 TO: CONDUIT TEE 1 2/CS-#16 >> AIT-2342 SIGNAL	S-07-526
L-07-528	05E03 05E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2343 TO: CONDUIT TEE 2 #12 >> AIT-2343 POWER	L-07-562
S-07-528	05E03 05E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-2343 TO: CONDUIT TEE 1 2/CS-#16 >> AIT-2343 SIGNAL	S-07-562
L-07-529	05E03	0.75"	8	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 2 #12 >> AIT-2342 POWER 2 #12 >> AIT-2343 POWER 2 #12 >> AIT-2353 POWER 2 #12 >> AIT-2351 (EXISTING) POWER	L-07-527 L-07-562 L-07-562 L-07-562
S-07-529	05E03	1"	4	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 1 2/CS-#16 >> AIT-2342 SIGNAL 1 2/CS-#16 >> AIT-2343 SIGNAL 1 2/CS-#16 >> AIT-2353 SIGNAL 1 2/CS-#16 >> AIT-2351 (EXISTING) SIGNAL	S-07-527 S-07-562 S-07-562 S-07-562
L-07-531	05E03	0.75"	8	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: PULLBOX 2 #12 >> AIT-2341 (EXISTING) POWER 2 #12 >> AIT-2343 POWER 2 #12 >> AIT-2353 POWER 2 #12 >> AIT-2351 (EXISTING) POWER	L-07-532 L-07-525 L-07-562 L-07-562 L-07-562
S-07-531	05E03	1"	4	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE TO: PULLBOX 1 2/CS-#16 >> AIT-2341 (EXISTING) SIGNAL 1 2/CS-#16 >> AIT-2343 SIGNAL 1 2/CS-#16 >> AIT-2353 SIGNAL 1 2/CS-#16 >> AIT-2351 (EXISTING) SIGNAL	S-07-532 S-07-525 S-07-562 S-07-562 S-07-562
L-07-532	00EX01	2"	8	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX TO: PB-35 2 #12 >> AIT-2341 (EXISTING) POWER 2 #12 >> AIT-2343 POWER 2 #12 >> AIT-2353 POWER 2 #12 >> AIT-2351 (EXISTING) POWER	L-07-533 L-07-531 L-07-531 L-07-531 L-07-531
S-07-532	00EX01	2"	4	2/CS-#16		1	#14	XHHW-2	FR: PULLBOX TO: PB-35 1 2/CS-#16 >> AIT-2341 (EXISTING) SIGNAL 1 2/CS-#16 >> AIT-2343 SIGNAL 1 2/CS-#16 >> AIT-2353 SIGNAL 1 2/CS-#16 >> AIT-2351 (EXISTING) SIGNAL	S-07-533 S-07-531 S-07-531 S-07-531 S-07-531
C-07-533	00EX01	2"	18	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX TO: PB-35 6 #14 >> LCP-2341 CONTROL 6 #14 >> LCP-2342 CONTROL 6 #14 >> LCP-2343 CONTROL	C-07-565 C-07-523 C-07-523 C-07-523
L-07-533	00EX01	2"	8	#12	XHHW-2	1	#12	XHHW-2	FR: PB-35 TO: PB-34 (EXISTING) 2 #12 >> AIT-2341 (EXISTING) POWER 2 #12 >> AIT-2343 POWER 2 #12 >> AIT-2353 POWER 2 #12 >> AIT-2351 (EXISTING) POWER	L-07-568 L-07-532 L-07-532 L-07-532 L-07-532
S-07-533	00EX01	2"	4	2/CS-#16		1	#14	XHHW-2	FR: PB-35 TO: PB-34 (EXISTING) 1 2/CS-#16 >> AIT-2341 (EXISTING) SIGNAL 1 2/CS-#16 >> AIT-2343 SIGNAL 1 2/CS-#16 >> AIT-2353 SIGNAL 1 2/CS-#16 >> AIT-2351 (EXISTING) SIGNAL	S-07-568 S-07-532 S-07-532 S-07-532 S-07-532
X-07-534	00EX01	2"	1	PULL	ROPE				FR: AERATION BASIN NO. 4 TO: PB-35 1 PULL >> SPARE	X-07-537
X-07-535	00EX01	2"	1	PULL	ROPE				FR: AERATION BASIN NO. 4 TO: PB-35 1 PULL >> SPARE	X-07-538

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
X-07-536	00EX01	2"	1	PULL	ROPE				FR: AERATION BASIN NO. 4 TO: PB-35 1 PULL >> SPARE	X-07-539
X-07-537	00EX01	2"	1	PULL	ROPE				FR: PB-35 TO: PB-34 (EXISTING) 1 PULL >> SPARE	X-07-534
X-07-538	00EX01	2"	1	PULL	ROPE				FR: PB-35 TO: PB-34 (EXISTING) 1 PULL >> SPARE	X-07-535
X-07-539	00EX01	2"	1	PULL	ROPE				FR: PB-35 TO: PB-34 (EXISTING) 1 PULL >> SPARE	X-07-536
C-07-541	05E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2355 TERMINATION BOX TO: LCP-2355 2 #14 >> TE/ME-2355 CONTROL	
P-07-541	05E02	1.5"	1	3/C-#12-VFD	VFD			INTEGRAL	FR: PMP-2355 TERMINATION BOX TO: PULLBOX 1 3/C-#12-VFD >> PMP-2355 POWER	P-07-551
C-07-542	05E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2356 TERMINATION BOX TO: LCP-2356 2 #14 >> TE/ME-2356 CONTROL	
P-07-542	05E02	1.5"	1	3/C-#12-VFD	VFD			INTEGRAL	FR: PMP-2356 TERMINATION BOX TO: PULLBOX 1 3/C-#12-VFD >> PMP-2356 POWER	P-07-521
C-07-543	05E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2355 TO: LCP-2356 6 #14 >> LCP-2355 CONTROL	C-07-544
P-07-543	05E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2351 TERMINATION BOX TO: CONDUIT TEE 3 #12 >> MIX-2351 POWER	P-07-545
C-07-544	05E02 05E04	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2356 TO: CONDUIT TEE 6 #14 >> LCP-2355 CONTROL 6 #14 >> LCP-2356 CONTROL	C-07-561 C-07-543
P-07-544	05E02	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2352 TERMINATION BOX TO: CONDUIT TEE 3 #12 >> MIX-2352 POWER	P-07-545
C-07-545	05E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2351 TERMINATION BOX TO: LCP-2351 2 #14 >> ME/TE-2351 CONTROL	
P-07-545	05E02	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 3 #12 >> MIX-2351 POWER 3 #12 >> MIX-2352 POWER	P-07-547 P-07-543 P-07-544
C-07-546	05E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2351 TO: CONDUIT TEE 6 #14 >> LCP-2351 CONTROL	C-07-550
P-07-546	05E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2353 TERMINATION BOX TO: CONDUIT TEE 6 #14 >> MIX-2353 POWER	P-07-547
P-07-547	05E01	1"	6 6	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: PULLBOX 3 #12 >> MIX-2351 POWER 3 #12 >> MIX-2352 POWER 6 #14 >> MIX-2353 POWER	P-07-557 P-07-545 P-07-545 P-07-546
C-07-548	05E02	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2352 TERMINATION BOX TO: LCP-2352 2 #14 >> LCP-2352 CONTROL	
C-07-549	05E02	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2352 TO: CONDUIT TEE 6 #14 >> LCP-2352 CONTROL	C-07-550

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND						
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**		**DESCRIPTION**		**CONNECTING SEGMENTS**
C-07-550	05E02	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR:	CONDUIT TEE		C-07-553
									TO:	CONDUIT TEE		
									6	#14	>> LCP-2351 CONTROL	C-07-546
									6	#14	>> LCP-2352 CONTROL	C-07-549
C-07-551	05E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR:	MIX-2353 TERMINATION BOX		
									TO:	LCP-2353		
									2	#14	>> LCP-2353 CONTROL	
P-07-551	00EX01	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR:	AERATION BASIN NO. 4		P-07-569
									TO:	PB-35		
									1	3/C-#12-VFD	>> PMP-2346 POWER	P-07-512
									1	3/C-#12-VFD	>> PMP-2355 POWER	P-07-541
C-07-552	05E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR:	LCP-2353		C-07-553
									TO:	CONDUIT TEE		
									6	#14	>> LCP-2353 CONTROL	
C-07-553	05E01	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR:	CONDUIT TEE		C-07-563
									TO:	PULLBOX		
									6	#14	>> LCP-2351 CONTROL	C-07-550
									6	#14	>> LCP-2352 CONTROL	C-07-550
									6	#14	>> LCP-2353 CONTROL	C-07-552
L-07-555	05E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR:	AIT-2351 (EXISTING)		L-07-556
									TO:	JB-2351		
									2	#12	>> AIT-2351 (EXISTING) POWER	
S-07-555	05E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR:	AIT-2351 (EXISTING)		S-07-556
									TO:	JB-2351		
									1	2/CS-#16	>> AIT-2351 (EXISTING) SIGNAL	
L-07-556	05E01 05E02	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR:	JB-2351		
									TO:	CONDUIT TEE		
									2	#12	>> AIT-2351 (EXISTING) POWER	L-07-555
									2	#12	>> AIT-2352 POWER	L-07-557
S-07-556	05E01 05E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR:	JB-2351		
									TO:	CONDUIT TEE		
									1	2/CS-#16	>> AIT-2351 (EXISTING) SIGNAL	S-07-555
									1	2/CS-#16	>> AIT-2352 SIGNAL	S-07-557
L-07-557	05E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR:	AIT-2352		L-07-556
									TO:	CONDUIT TEE		
									2	#12	>> AIT-2352 POWER	
P-07-557	00EX01	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR:	AERATION BASIN NO. 4		P-07-567
									TO:	PB-35		
									3	#12	>> MIX-2351 POWER	P-07-547
									3	#12	>> MIX-2352 POWER	P-07-547
									3	#12	>> MIX-2353 POWER	P-07-547
S-07-557	05E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR:	AIT-2352		S-07-556
									TO:	CONDUIT TEE		
									1	2/CS-#16	>> AIT-2352 SIGNAL	
L-07-558	05E01 05E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR:	AIT-2353		L-07-561
									TO:	CONDUIT TEE		
									2	#12	>> AIT-2353 POWER	
S-07-558	05E01 05E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR:	AIT-2353		S-07-561
									TO:	CONDUIT TEE		
									1	2/CS-#16	>> AIT-2353 SIGNAL	
L-07-559	05E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR:	CONDUIT TEE		L-07-561
									TO:	CONDUIT TEE		
									2	#12	>> AIT-2351 (EXISTING) POWER	L-07-555
S-07-559	05E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR:	CONDUIT TEE		S-07-561
									TO:	CONDUIT TEE		
									1	2/CS-#16	>> AIT-2351 (EXISTING) SIGNAL	S-07-555
C-07-561	05E04	1.5"	24	#14	XHHW-2	1	#14	XHHW-2	FR:	CONDUIT TEE		C-07-562
									TO:	PULLBOX		
									6	#14	>> LCP-2345 CONTROL	C-07-514
									6	#14	>> LCP-2346 CONTROL	C-07-514
									6	#14	>> LCP-2355 CONTROL	C-07-544
									6	#14	>> LCP-2356 CONTROL	C-07-544
L-07-561	05E01 05E03	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR:	CONDUIT TEE		L-07-562
									TO:	CONDUIT TEE		
									2	#12	>> AIT-2353 POWER	L-07-558
									2	#12	>> AIT-2351 (EXISTING) POWER	L-07-559

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-07-561	05E01 05E03	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-07-562
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2353 SIGNAL	S-07-558
									1 2/CS-#16 >> AIT-2351 (EXISTING) SIGNAL	S-07-559
C-07-562	00EX01	2"	24	#14	XHHW-2	1	#14	XHHW-2	FR: AERATION BASIN NO. 4	C-07-569
									TO: PB-35	
									6 #14 >> LCP-2345 CONTROL	C-07-561
									6 #14 >> LCP-2346 CONTROL	C-07-561
									6 #14 >> LCP-2355 CONTROL	C-07-561
									6 #14 >> LCP-2356 CONTROL	C-07-561
L-07-562	05E03	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	L-07-529
									TO: CONDUIT TEE	
									2 #12 >> AIT-2343 POWER	L-07-528
									2 #12 >> AIT-2353 POWER	L-07-561
									2 #12 >> AIT-2351 (EXISTING) POWER	L-07-561
S-07-562	05E03	1"	3	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-07-529
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2343 SIGNAL	S-07-528
									1 2/CS-#16 >> AIT-2353 SIGNAL	S-07-561
									1 2/CS-#16 >> AIT-2351 (EXISTING) SIGNAL	S-07-561
C-07-563	00EX01	2"	18	#14	XHHW-2	1	#14	XHHW-2	FR: AERATION BASIN NO. 4	C-07-566
									TO: PB-35	
									6 #14 >> LCP-2351 CONTROL	C-07-553
									6 #14 >> LCP-2352 CONTROL	C-07-553
									6 #14 >> LCP-2353 CONTROL	C-07-553
C-07-565	00EX01	2"	18	#14	XHHW-2	1	#14	XHHW-2	FR: PB-35	C-07-571
									TO: PB-34 (EXISTING)	
									6 #14 >> LCP-2341 CONTROL	C-07-533
									6 #14 >> LCP-2342 CONTROL	C-07-533
									6 #14 >> LCP-2343 CONTROL	C-07-533
P-07-565	00EX01	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: PB-35	P-07-573
									TO: PB-34 (EXISTING)	
									1 3/C-#12-VFD >> PMP-2345 POWER	P-07-521
									1 3/C-#12-VFD >> PMP-2356 POWER	P-07-521
C-07-566	00EX01	2"	18	#14	XHHW-2	1	#14	XHHW-2	FR: PB-35	C-07-572
									TO: PB-34 (EXISTING)	
									6 #14 >> LCP-2351 CONTROL	C-07-563
									6 #14 >> LCP-2352 CONTROL	C-07-563
									6 #14 >> LCP-2353 CONTROL	C-07-563
P-07-566	00EX01	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-35	P-07-571
									TO: PB-34 (EXISTING)	
									3 #12 >> MIX-2341 POWER	P-07-527
									3 #12 >> MIX-2342 POWER	P-07-527
									3 #12 >> MIX-2343 POWER	P-07-527
P-07-567	00EX01	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-35	P-07-572
									TO: PB-34 (EXISTING)	
									3 #12 >> MIX-2351 POWER	P-07-557
									3 #12 >> MIX-2352 POWER	P-07-557
									3 #12 >> MIX-2353 POWER	P-07-557
L-07-568	00EX03	2"	8	#12	XHHW-2	1	#12	XHHW-2	FR: PB-34 (EXISTING)	L-07-569
									TO: MCC-7 TRENCH (VIA EXISTING 07-E753)	
									2 #12 >> AIT-2341 (EXISTING) POWER	L-07-533
									2 #12 >> AIT-2343 POWER	L-07-533
									2 #12 >> AIT-2353 POWER	L-07-533
									2 #12 >> AIT-2351 (EXISTING) POWER	L-07-533
S-07-568	00EX03	2"	4	2/CS-#16		1	#14	XHHW-2	FR: PB-34 (EXISTING)	S-07-569
									TO: MCC-7 TRENCH (VIA EXISTING 07-E754)	
									1 2/CS-#16 >> AIT-2341 (EXISTING) SIGNAL	S-07-533
									1 2/CS-#16 >> AIT-2343 SIGNAL	S-07-533
									1 2/CS-#16 >> AIT-2353 SIGNAL	S-07-533
									1 2/CS-#16 >> AIT-2351 (EXISTING) SIGNAL	S-07-533
C-07-569	00EX01	2"	24	#14	XHHW-2	1	#14	XHHW-2	FR: PB-35	C-07-571
									TO: PB-34 (EXISTING)	
									6 #14 >> LCP-2345 CONTROL	C-07-562
									6 #14 >> LCP-2346 CONTROL	C-07-562
									6 #14 >> LCP-2355 CONTROL	C-07-562
									6 #14 >> LCP-2356 CONTROL	C-07-562

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	SKB
REVISION	0
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
L-07-569	07E01	0.75"	8	#12	XHHW-2	1	#12	XHHW-2	FR: MCC-7 TRENCH	
									TO: LP7B	
									2 #12 >> AIT-2341 (EXISTING) POWER	L-07-568
									2 #12 >> AIT-2343 POWER	L-07-568
									2 #12 >> AIT-2353 POWER	L-07-568
									2 #12 >> AIT-2351 (EXISTING) POWER	L-07-568
P-07-569	00EX01	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: PB-35	P-07-574
									TO: PB-34 (EXISTING)	
									1 3/C-#12-VFD >> PMP-2346 POWER	P-07-551
									1 3/C-#12-VFD >> PMP-2355 POWER	P-07-551
S-07-569	07E01	1"	4	2/CS-#16		1	#14	XHHW-2	FR: MCC-7 TRENCH	
									TO: RTU-207A	
									1 2/CS-#16 >> AIT-2341 (EXISTING) SIGNAL	S-07-568
									1 2/CS-#16 >> AIT-2343 SIGNAL	S-07-568
									1 2/CS-#16 >> AIT-2353 SIGNAL	S-07-568
									1 2/CS-#16 >> AIT-2351 (EXISTING) SIGNAL	S-07-568
C-07-571	00EX03	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PB-34 (EXISTING)	C-07-581
									TO: MCC-7 TRENCH (VIA EXISTING 07-E758)	
									6 #14 >> LCP-2341 CONTROL	C-07-565
									6 #14 >> LCP-2342 CONTROL	C-07-565
									6 #14 >> LCP-2343 CONTROL	C-07-565
									6 #14 >> LCP-2345 CONTROL	C-07-569
									6 #14 >> LCP-2356 CONTROL	C-07-569
P-07-571	00EX03	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-34 (EXISTING)	P-07-581
									TO: MCC-7 TRENCH (VIA EXISTING 07-E756)	
									3 #12 >> MIX-2341 POWER	P-07-566
									3 #12 >> MIX-2342 POWER	P-07-566
									3 #12 >> MIX-2343 POWER	P-07-566
C-07-572	00EX03	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PB-34 (EXISTING)	C-07-582
									TO: MCC-7 TRENCH (VIA EXISTING 07-E755)	
									6 #14 >> LCP-2351 CONTROL	C-07-566
									6 #14 >> LCP-2352 CONTROL	C-07-566
									6 #14 >> LCP-2353 CONTROL	C-07-566
									6 #14 >> LCP-2346 CONTROL	C-07-569
									6 #14 >> LCP-2355 CONTROL	C-07-569
P-07-572	00EX03	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-34 (EXISTING)	P-07-582
									TO: MCC-7 TRENCH (VIA EXISTING 07-E757)	
									3 #12 >> MIX-2351 POWER	P-07-567
									3 #12 >> MIX-2352 POWER	P-07-567
									3 #12 >> MIX-2353 POWER	P-07-567
P-07-573	00EX03	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: PB-34 (EXISTING)	P-07-583
									TO: MCC-7 TRENCH (VIA EXISTING 07-E752)	
									1 3/C-#12-VFD >> PMP-2345 POWER	P-07-565
									1 3/C-#12-VFD >> PMP-2356 POWER	P-07-565
P-07-574	00EX03	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: PB-34 (EXISTING)	P-07-584
									TO: MCC-7 TRENCH (VIA EXISTING 07-E751)	
									1 3/C-#12-VFD >> PMP-2346 POWER	P-07-569
									1 3/C-#12-VFD >> PMP-2355 POWER	P-07-569
C-07-581	07E01	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-7 TRENCH	
									TO: MCC-9A	
									6 #14 >> LCP-2341 CONTROL	C-07-571
									6 #14 >> LCP-2342 CONTROL	C-07-571
									6 #14 >> LCP-2343 CONTROL	C-07-571
									6 #14 >> LCP-2345 CONTROL	C-07-571
									6 #14 >> LCP-2356 CONTROL	C-07-571
P-07-581	07E01	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: MCC-7 TRENCH	
									TO: MCC-9A	
									3 #12 >> MIX-2341 POWER	P-07-571
									3 #12 >> MIX-2342 POWER	P-07-571
									3 #12 >> MIX-2343 POWER	P-07-571
C-07-582	07E01	1.5"	30	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-7 TRENCH	
									TO: MCC-9B	
									6 #14 >> LCP-2351 CONTROL	C-07-572
									6 #14 >> LCP-2352 CONTROL	C-07-572
									6 #14 >> LCP-2353 CONTROL	C-07-572
									6 #14 >> LCP-2346 CONTROL	C-07-572
									6 #14 >> LCP-2355 CONTROL	C-07-572

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	SKB
REVISION	0
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
P-07-582	07E01	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: MCC-7 TRENCH	
									TO: MCC-9B	
									3 #12 >> MIX-2351 POWER	P-07-572
									3 #12 >> MIX-2352 POWER	P-07-572
									3 #12 >> MIX-2353 POWER	P-07-572
P-07-583	07E01	1.5"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: MCC-7 TRENCH	
									TO: MCC-9A	
									1 3/C-#12-VFD >> PMP-2345 POWER	P-07-573
									1 3/C-#12-VFD >> PMP-2356 POWER	P-07-573
P-07-584	07E01	1.5"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: MCC-7 TRENCH	
									TO: MCC-9B	
									1 3/C-#12-VFD >> PMP-2346 POWER	P-07-574
									1 3/C-#12-VFD >> PMP-2355 POWER	P-07-574
C-07-611	06E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2365 TERMINATION BOX	
									TO: LCP-2365	
									2 #14 >> ME/TE-2365 CONTROL	
P-07-611	06E01	1.5"	1	3/C-#12-VFD	VFD			INTEGRAL	FR: PMP-2365 TERMINATION BOX	P-07-621
									TO: PULLBOX	
									1 3/C-#12-VFD >> PMP-2365 POWER	
C-07-612	06E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2366 TERMINATION BOX	
									TO: LCP-2366	
									2 #14 >> ME/TE-2366 CONTROL	
P-07-612	06E01	1.5"	1	3/C-#12-VFD	VFD			INTEGRAL	FR: PMP-2366 TERMINATION BOX	P-07-651
									TO: PULLBOX	
									1 3/C-#12-VFD >> PMP-2366 POWER	
C-07-613	06E01	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2365	C-07-614
									TO: LCP-2366	
									6 #14 >> LCP-2365 CONTROL	
P-07-613	06E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2361 TERMINATION BOX	P-07-615
									TO: CONDUIT TEE	
									3 #12 >> MIX-2361 POWER	
C-07-614	06E01	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2366	C-07-661
									TO: CONDUIT TEE	
									6 #14 >> LCP-2365 CONTROL	C-07-613
									6 #14 >> LCP-2366 CONTROL	
P-07-614	06E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2362 TERMINATION BOX	P-07-615
									TO: CONDUIT TEE	
									3 #12 >> MIX-2362 POWER	
C-07-615	06E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2361 TERMINATION BOX	
									TO: LCP-2361	
									2 #14 >> ME/TE-2361 CONTROL	
P-07-615	06E03 06E04	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	P-07-617
									TO: CONDUIT TEE	
									3 #12 >> MIX-2361 POWER	P-07-613
									3 #12 >> MIX-2362 POWER	P-07-614
C-07-616	06E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2361	C-07-620
									TO: CONDUIT TEE	
									6 #14 >> LCP-2361 CONTROL	
P-07-616	06E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2363 TERMINATION BOX	P-07-617
									TO: CONDUIT TEE	
									3 #12 >> MIX-2363 POWER	
P-07-617	06E02 06E04	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	P-07-627
									TO: PULLBOX	
									3 #12 >> MIX-2361 POWER	P-07-615
									3 #12 >> MIX-2362 POWER	P-07-615
									3 #12 >> MIX-2363 POWER	P-07-616
C-07-618	06E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2362 TERMINATION BOX	
									TO: LCP-2362	
									2 #14 >> ME/TE-2362 CONTROL	
C-07-619	06E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2362	C-07-620
									TO: CONDUIT TEE	
									6 #14 >> LCP-2362 CONTROL	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND						
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**		**DESCRIPTION**		**CONNECTING SEGMENTS**
C-07-620	06E03 06E04	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: TO:	CONDUIT TEE CONDUIT TEE		C-07-623
									6	#14	>> LCP-2361 CONTROL	C-07-616
									6	#14	>> LCP-2362 CONTROL	C-07-619
C-07-621	06E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: TO:	MIX-2363 TERMINATION BOX LCP-2363		
									2	#14	>> ME/TE-2363 CONTROL	
P-07-621	00EX03	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: TO:	PULLBOX PB-33 (EXISTING)		P-07-673
									1	3/C-#12-VFD	>> PMP-2365 POWER	P-07-611
									1	3/C-#12-VFD	>> PMP-2376 POWER	P-07-642
C-07-622	06E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: TO:	LCP-2363 CONDUIT TEE		C-07-623
									6	#14	>> LCP-2363 CONTROL	
C-07-623	06E02 06E04	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR: TO:	CONDUIT TEE PULLBOX		C-07-633
									6	#14	>> LCP-2361 CONTROL	C-07-620
									6	#14	>> LCP-2362 CONTROL	C-07-620
									6	#14	>> LCP-2363 CONTROL	C-07-622
L-07-625	06E01	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: TO:	AIT-2361 (EXISTING) JB-2361		L-07-626
									2	#12	>> AIT-2361 (EXISTING) POWER	
S-07-625	06E01	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TO:	AIT-2361 (EXISTING) JB-2361		S-07-626
									1	2/CS-#16	>> AIT-2361 (EXISTING) SIGNAL	
L-07-626	06E01 06E02	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: TO:	JB-2361 CONDUIT TEE		
									2	#12	>> AIT-2361 (EXISTING) POWER	L-07-625
									2	#12	>> AIT-2362 POWER	L-07-627
S-07-626	06E01 06E02	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: TO:	JB-2361 CONDUIT TEE		
									1	2/CS-#16	>> AIT-2361 (EXISTING) SIGNAL	S-07-625
									1	2/CS-#16	>> AIT-2362 SIGNAL	S-07-627
L-07-627	06E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: TO:	AIT-2362 CONDUIT TEE		L-07-626
									2	#12	>> AIT-2362 POWER	
P-07-627	00EX03 06E02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: TO:	PULLBOX PB-33 (VIA EXISTING CONDUIT 07-E592)		P-07-671
									3	#12	>> MIX-2361 POWER	P-07-617
									3	#12	>> MIX-2362 POWER	P-07-617
									3	#12	>> MIX-2363 POWER	P-07-617
S-07-627	06E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TO:	AIT-2362 CONDUIT TEE		S-07-626
									1	2/CS-#16	>> AIT-2362 SIGNAL	
L-07-628	06E01 06E02	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: TO:	AIT-2363 CONDUIT TEE		L-07-662
									2	#12	>> AIT-2363 POWER	
S-07-628	06E01 06E02	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: TO:	AIT-2363 CONDUIT TEE		S-07-662
									1	2/CS-#16	>> AIT-2363 SIGNAL	
L-07-629	06E02	0.75"	8	#12	XHHW-2	1	#12	XHHW-2	FR: TO:	CONDUIT TEE CONDUIT TEE		
									2	#12	>> AIT-2362 POWER	L-07-627
									2	#12	>> AIT-2363 POWER	L-07-662
									2	#12	>> AIT-2373 POWER	L-07-662
									2	#12	>> AIT-2371 (EXISTING) POWER	L-07-662
S-07-629	06E02	1"	4	2/CS-#16		1	#14	XHHW-2	FR: TO:	CONDUIT TEE CONDUIT TEE		
									1	2/CS-#16	>> AIT-2362 SIGNAL	S-07-627
									1	2/CS-#16	>> AIT-2363 SIGNAL	S-07-662
									1	2/CS-#16	>> AIT-2373 SIGNAL	S-07-662
									1	2/CS-#16	>> AIT-2371 (EXISTING) SIGNAL	S-07-662

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION
AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	SKB
REVISION	0
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
L-07-631	06E02	0.75"	8	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	L-07-632
									TO: PULLBOX	
									2 #12 >> AIT-2361 (EXISTING) POWER	L-07-625
									2 #12 >> AIT-2363 POWER	L-07-662
									2 #12 >> AIT-2373 POWER	L-07-662
									2 #12 >> AIT-2371 (EXISTING) POWER	L-07-662
S-07-631	06E02	1"	4	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-07-632
									TO: PULLBOX	
									1 2/CS-#16 >> AIT-2361 (EXISTING) SIGNAL	S-07-625
									1 2/CS-#16 >> AIT-2363 SIGNAL	S-07-662
									1 2/CS-#16 >> AIT-2373 SIGNAL	S-07-662
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	S-07-662
L-07-632	00EX03 06E02	2"	8	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX	
									TO: PB-33 (EXISTING)	
									2 #12 >> AIT-2361 (EXISTING) POWER	L-07-631
									2 #12 >> AIT-2363 POWER	L-07-631
									2 #12 >> AIT-2373 POWER	L-07-631
									2 #12 >> AIT-2371 (EXISTING) POWER	L-07-631
S-07-632	00EX03 06E02	2"	4	2/CS-#16		1	#14	XHHW-2	FR: PULLBOX	S-07-637
									TO: IPB-33 (EXISTING)	
									1 2/CS-#16 >> AIT-2361 (EXISTING) SIGNAL	S-07-631
									1 2/CS-#16 >> AIT-2363 SIGNAL	S-07-631
									1 2/CS-#16 >> AIT-2373 SIGNAL	S-07-631
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	S-07-631
C-07-633	00EX03 06E02	2"	18	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX	C-07-671
									TO: PB-33 (VIA EXISTING CONDUIT 07-E590)	
									6 #14 >> LCP-2361 CONTROL	C-07-623
									6 #14 >> LCP-2362 CONTROL	C-07-623
									6 #14 >> LCP-2363 CONTROL	C-07-623
X-07-634	00EX03	2"	1	PULL	ROPE				FR: PULLBOX	
									TO: PB-33 (EXISTING)	
									1 PULL >> SPARE	
S-07-637	00EX03 00EX04	2"	17	2/CS-#16		1	#14	XHHW-2	FR: IPB-33 (EXISTING)	S-07-638
									TO: IPB-34 (EXISTING) (VIA EXISTING 07-E716)	
									1 2/CS-#16 >> AIT-2651 SIGNAL	S-07-251
									1 2/CS-#16 >> VCP-2650 SIGNAL	S-07-251
									1 2/CS-#16 >> LCP-2711 SIGNAL	S-07-324
									1 2/CS-#16 >> LCP-2721 SIGNAL	S-07-324
									1 2/CS-#16 >> LCP-2731 SIGNAL (FUTURE)	S-07-324
									1 2/CS-#16 >> FIT-2711 SIGNAL	S-07-332
									1 2/CS-#16 >> FIT-2731 SIGNAL	S-07-332
									1 2/CS-#16 >> FIT-2651 SIGNAL	S-07-358
									2 2/CS-#16 >> VCP-2651 SIGNAL	S-07-358
									1 2/CS-#16 >> FIT-2661 SIGNAL (FUTURE)	S-07-358
									2 2/CS-#16 >> VCP-2661 SIGNAL (FUTURE)	S-07-358
									1 2/CS-#16 >> AIT-2361 (EXISTING) SIGNAL	S-07-632
									1 2/CS-#16 >> AIT-2363 SIGNAL	S-07-632
									1 2/CS-#16 >> AIT-2373 SIGNAL	S-07-632
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	S-07-632
S-07-638	00EX04	2"	17	2/CS-#16		1	#14	XHHW-2	FR: IPB-34 (EXISTING)	
									TO: RTU-207 (VIA EXISTING 07-E716)	
									1 2/CS-#16 >> AIT-2651 SIGNAL	S-07-637
									1 2/CS-#16 >> VCP-2650 SIGNAL	S-07-637
									1 2/CS-#16 >> LCP-2711 SIGNAL	S-07-637
									1 2/CS-#16 >> LCP-2721 SIGNAL	S-07-637
									1 2/CS-#16 >> LCP-2731 SIGNAL (FUTURE)	S-07-637
									1 2/CS-#16 >> FIT-2711 SIGNAL	S-07-637
									1 2/CS-#16 >> FIT-2731 SIGNAL	S-07-637
									1 2/CS-#16 >> FIT-2651 SIGNAL	S-07-637
									2 2/CS-#16 >> VCP-2651 SIGNAL	S-07-637
									1 2/CS-#16 >> FIT-2661 SIGNAL (FUTURE)	S-07-637
									2 2/CS-#16 >> VCP-2661 SIGNAL (FUTURE)	S-07-637
									1 2/CS-#16 >> AIT-2361 (EXISTING) SIGNAL	S-07-637
									1 2/CS-#16 >> AIT-2363 SIGNAL	S-07-637
									1 2/CS-#16 >> AIT-2373 SIGNAL	S-07-637
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	S-07-637
C-07-641	06E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2375 TERMINATION BOX	
									TO: LCP-2375	
									2 #14 >> ME/TE-2375 CONTROL	
P-07-641	06E01 06E03	1.5"	1	3/C-#12-VFD	VFD			INTEGRAL	FR: PMP-2375 TERMINATION BOX	P-07-651
									TO: PULLBOX	
									1 3/C-#12-VFD >> PMP-2375 POWER	

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION
AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	SKB
REVISION	0
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	DWG	SIZE	#	SIZE	TYPE	#	SIZE	TYPE	DESCRIPTION	CONNECTING SEGMENTS
C-07-642	06E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: PMP-2376 TERMINATION BOX TO: LCP-2376 2 #14 >> ME/TE-2376 CONTROL	
P-07-642	06E01 06E03	1.5"	1	3/C-#12-VFD	VFD			INTEGRAL	FR: PMP-2376 TERMINATION BOX TO: PULLBOX 1 3/C-#12-VFD >> PMP-2376 POWER	P-07-621
C-07-643	06E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2375 TO: LCP-2376 6 #14 >> LCP-2375 CONTROL	C-07-644
P-07-643	06E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2371 TERMINATION BOX TO: CONDUIT TEE 3 #12 >> MIX-2371 POWER	P-07-645
C-07-644	06E01 06E03	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2376 TO: CONDUIT TEE 6 #14 >> LCP-2375 CONTROL 6 #14 >> LCP-2376 CONTROL	C-07-661 C-07-643
P-07-644	06E03	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2372 TERMINATION BOX TO: CONDUIT TEE 3 #12 >> MIX-2372 POWER	P-07-645
C-07-645	06E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2371 TERMINATION BOX TO: LCP-2371 2 #14 >> ME/TE-2371 CONTROL	
P-07-645	06E03 06E04	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 3 #12 >> MIX-2371 POWER 3 #12 >> MIX-2372 POWER	P-07-647 P-07-643 P-07-644
C-07-646	06E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2371 TO: CONDUIT TEE 6 #14 >> LCP-2371 CONTROL	C-07-650
P-07-646	06E04	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: MIX-2373 TERMINATION BOX TO: CONDUIT TEE 3 #12 >> MIX-2373 POWER	P-07-647
P-07-647	06E02 06E04	1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: PULLBOX 3 #12 >> MIX-2371 POWER 3 #12 >> MIX-2372 POWER 3 #12 >> MIX-2373 POWER	P-07-657 P-07-645 P-07-645 P-07-646
C-07-648	06E03	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2372 TERMINATION BOX TO: LCP-2372 2 #14 >> LCP-2372 CONTROL	
C-07-649	06E03	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2372 TO: CONDUIT TEE 6 #14 >> LCP-2372 CONTROL	C-07-650
C-07-650	06E03 06E04	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 6 #14 >> LCP-2371 CONTROL 6 #14 >> LCP-2372 CONTROL	C-07-653 C-07-646 C-07-649
C-07-651	06E04	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: MIX-2373 TERMINATION BOX TO: LCP-2373 2 #14 >> LCP-2373 CONTROL	
P-07-651	00EX03	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: PULLBOX TO: PB-33 (EXISTING) 1 3/C-#12-VFD >> PMP-2366 POWER 1 3/C-#12-VFD >> PMP-2375 POWER	P-07-674 P-07-612 P-07-641
C-07-652	06E04	0.75"	6	#14	XHHW-2	1	#14	XHHW-2	FR: LCP-2373 TO: CONDUIT TEE 6 #14 >> LCP-2373 CONTROL	C-07-653
C-07-653	06E02 06E04	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: PULLBOX 6 #14 >> LCP-2371 CONTROL 6 #14 >> LCP-2372 CONTROL 6 #14 >> LCP-2373 CONTROL	C-07-663 C-07-650 C-07-650 C-07-652
L-07-655	06E03	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2371 (EXISTING) TO: JB-2371 2 #12 >> AIT-2371 (EXISTING) POWER	L-07-656

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-07-655	06E03	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-2371 (EXISTING)	S-07-656
									TO: JB-2371	
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	
L-07-656	06E03 06E04	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: JB-2371	
									TO: CONDUIT TEE	
									2 #12 >> AIT-2371 (EXISTING) POWER	L-07-655
									2 #12 >> AIT-2372 POWER	L-07-657
S-07-656	06E03 06E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: JB-2371	
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	S-07-655
									1 2/CS-#16 >> AIT-2372 SIGNAL	S-07-657
L-07-657	06E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2372	L-07-656
									TO: CONDUIT TEE	
									2 #12 >> AIT-2372 POWER	
P-07-657	00EX03 06E02	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PULLBOX	P-07-672
									TO: PB-33 (VIA EXISTING CONDUIT 07-E593)	
									3 #12 >> MIX-2371 POWER	P-07-647
									3 #12 >> MIX-2372 POWER	P-07-647
									3 #12 >> MIX-2373 POWER	P-07-647
S-07-657	06E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-2372	S-07-656
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2372 SIGNAL	
L-07-658	06E03 06E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: AIT-2373	L-07-661
									TO: CONDUIT TEE	
									2 #12 >> AIT-2373 POWER	
S-07-658	06E03 06E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: AIT-2373	S-07-661
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2373 SIGNAL	
L-07-659	06E04	0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	L-07-661
									TO: CONDUIT TEE	
									2 #12 >> AIT-2371 (EXISTING) POWER	L-07-655
S-07-659	06E04	0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-07-661
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	S-07-655
C-07-661	06E01	1.5"	24	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C-07-662
									TO: PULLBOX	
									6 #14 >> LCP-2365 CONTROL	C-07-614
									6 #14 >> LCP-2366 CONTROL	C-07-614
									6 #14 >> LCP-2375 CONTROL	C-07-644
									6 #14 >> LCP-2376 CONTROL	C-07-644
L-07-661	06E02 06E04	0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	L-07-662
									TO: CONDUIT TEE	
									2 #12 >> AIT-2373 POWER	L-07-658
									2 #12 >> AIT-2371 (EXISTING) POWER	L-07-659
S-07-661	06E02 06E04	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-07-662
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2373 SIGNAL	S-07-658
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	S-07-659
C-07-662	00EX03	2"	24	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX	C-07-671
									TO: PB-33 (EXISTING)	
									6 #14 >> LCP-2365 CONTROL	C-07-661
									6 #14 >> LCP-2366 CONTROL	C-07-661
									6 #14 >> LCP-2375 CONTROL	C-07-661
									6 #14 >> LCP-2376 CONTROL	C-07-661
L-07-662	06E02	0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	L-07-629
									TO: CONDUIT TEE	
									2 #12 >> AIT-2363 POWER	L-07-628
									2 #12 >> AIT-2373 POWER	L-07-661
									2 #12 >> AIT-2371 (EXISTING) POWER	L-07-661
S-07-662	06E02	1"	3	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S-07-629
									TO: CONDUIT TEE	
									1 2/CS-#16 >> AIT-2363 SIGNAL	S-07-628
									1 2/CS-#16 >> AIT-2373 SIGNAL	S-07-661
									1 2/CS-#16 >> AIT-2371 (EXISTING) SIGNAL	S-07-661

CONDUIT SCHEDULE AREA 07

TURLOCK SECONDARY CLARIFIER NO. 5 AND DENITRIFICATION

AERATION BASINS, RAS PUMP STATION NO. 2, CLARIFIER NO. 5

ENGINEER	**SKB**
REVISION	**0**
DATE	1/12/17

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-07-663	06E02 00EX03	2"	18	#14	XHHW-2	1	#14	XHHW-2	FR: PULLBOX	C-07-672
									TO: PB-33 (VIA EXISTING CONDUIT 07-E591)	
									6 #14 >> LCP-2371 CONTROL	C-07-653
									6 #14 >> LCP-2372 CONTROL	C-07-653
									6 #14 >> LCP-2373 CONTROL	C-07-653
C-07-671	00EX03 00EX04	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PB-33 (EXISTING)	
									TO: MCC-7A (VIA MCC-7 TRENCH & EXISTING 07-E691)	
									6 #14 >> LCP-2361 CONTROL	C-07-633
									6 #14 >> LCP-2362 CONTROL	C-07-633
									6 #14 >> LCP-2363 CONTROL	C-07-633
									6 #14 >> LCP-2365 CONTROL	C-07-662
									6 #14 >> LCP-2376 CONTROL	C-07-662
P-07-671	00EX03 00EX04	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-33 (EXISTING)	
									TO: MCC-7A (VIA MCC-7 TRENCH & EXISTING 07-E705)	
									3 #12 >> MIX-2361 POWER	P-07-627
									3 #12 >> MIX-2362 POWER	P-07-627
									3 #12 >> MIX-2363 POWER	P-07-627
C-07-672	00EX03 00EX04	2"	30	#14	XHHW-2	1	#14	XHHW-2	FR: PB-33 (EXISTING)	
									TO: MCC-7B (VIA MCC-7 TRENCH & EXISTING 07-E690)	
									6 #14 >> LCP-2366 CONTROL	C-07-662
									6 #14 >> LCP-2375 CONTROL	C-07-662
									6 #14 >> LCP-2371 CONTROL	C-07-663
									6 #14 >> LCP-2372 CONTROL	C-07-663
									6 #14 >> LCP-2373 CONTROL	C-07-663
P-07-672	00EX03 00EX04	2"	9	#12	XHHW-2	1	#12	XHHW-2	FR: PB-33 (EXISTING)	
									TO: MCC-7B (VIA MCC-7 TRENCH & EXISTING 07-E708)	
									3 #12 >> MIX-2371 POWER	P-07-657
									3 #12 >> MIX-2372 POWER	P-07-657
									3 #12 >> MIX-2373 POWER	P-07-657
P-07-673	00EX03 00EX04	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: PB-33 (EXISTING)	
									TO: MCC-7A (VIA MCC-7 TRENCH & EXISTING 07-E706)	
									1 3/C-#12-VFD >> PMP-2365 POWER	P-07-621
									1 3/C-#12-VFD >> PMP-2376 POWER	P-07-621
P-07-674	00EX03 00EX04	2"	2	3/C-#12-VFD	VFD			INTEGRAL	FR: PB-33 (EXISTING)	
									TO: MCC-7B (VIA MCC-7 TRENCH & EXISTING 07-E707)	
									1 3/C-#12-VFD >> PMP-2366 POWER	P-07-651
									1 3/C-#12-VFD >> PMP-2375 POWER	P-07-651

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 17050

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. General requirements applicable to all Process Control and Instrumentation Work.
   2. General requirements for process control and instrumentation submittals.

B. Related sections:
   1. Document 00700 - General Conditions.
   2. Document 00800 - Supplementary Conditions.
   3. Section 01110 - Summary of Work.
   4. Section 01140 - Work Restrictions.
   5. Section 01292 - Schedule of Values.
   6. Section 01312 - Project Meetings.
   7. Section 01324A - Progress Schedules and Reports.
   8. Section 01324B - Progress Schedules and Reports.
   9. Section 01329 - Safety Plan.
   10. Section 01330 - Submittal Procedures.
   11. Section 01410 - Regulatory Requirements.
   12. Section 01450 - Quality Control.
   13. Section 01600 – Product Requirements.
   14. Section 01610 - Project Design Criteria.
   15. Section 01612 - Seismic Design Criteria.
   16. Section 01614 - Wind Design Criteria.
   17. Section 01756 - Commissioning.
   18. Section 01770 - Closeout Procedures.
   19. Section 01782 - Operation and Maintenance Data.
   20. Section 16050 - Common Work Results for Electrical.
   21. Section 16075 - Identification for Electrical Systems.
   22. Section 16222 - Low Voltage Motors up to 500 Horsepower.
   23. Section 17100 - Control Strategies.
   24. Section 17101 - Specific Control Strategies.
   25. Section 17950 - Testing, Calibration, and Commissioning.

C. Interfaces to equipment, instruments, and other components:
   1. Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers, which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.

2. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional instruments, wiring, control system inputs/outputs, controls, interlocks, electrical hardware etc., which may be necessary to make a complete, functional installation based on the actual equipment furnished:
    a. Make all changes necessary to meet the manufacturer's wiring requirements.
3. Submit all such changes and additions to the Engineer for acceptance as specified in Document 00700.
4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the instrumentation and control systems are completely accounted for. Include any items indicated on the Drawings or in Specifications from another discipline in the scope of Work:
    a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
5. Loop drawings:
    a. Provide complete loop drawings for all systems, including packaged equipment furnished as part of a vendor furnished package, and for all pre-purchased equipment.
    b. The form, minimum level of detail, and format for the loop drawings must match that of the sample loop drawings included in the Contract Documents.
    c. The Owner and Engineer are not responsible for providing detailed loop diagrams for Contractor furnished equipment.

D. All instrumentation, and control equipment and systems for the entire project to comply with the requirements specified in the Instrumentation and Control Specifications, whether referenced in the individual Equipment Specifications or not:
1. The requirements of the Instrumentation and Control Specifications apply to all Instrumentation and Control Work specified in other Specifications, including HVAC controls, packaged mechanical systems, LCPs, VCPs, etc.
2. Inform all vendors supplying instrumentation, control systems, panels, and/or equipment of the requirements of the Instrumentation and Control Specifications.
3. The Owner is not responsible for any additional costs due to the failure of the Contractor to notify all subcontractors and suppliers of the Instrumentation and Control Specifications' requirements.

E. Special subcontractor requirements:
1. As specified elsewhere in this Section, provide indicated portions of the Work specified in the Instrumentation and Control Specifications by a pre-selected SCADA Subcontractor (SSC).

F. Contract Documents:
1. General:
    a. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work.
2. Specifications:
    a. Documents 00700 and 00800 of the Contract Documents govern the Work.
    b. These requirements are in addition to all General Requirements.

3. Contract Drawings:
    a. The Instrumentation and Control Drawings show in a diagrammatic manner, the desired locations, and arrangements of the components of the Instrumentation Work. Follow the Drawings as closely as possible, use professional judgment and coordinate with the other trades to secure the best possible installation, use the entire Drawing set for construction purposes.
    b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only, exercise professional judgment in executing the Work to ensure the best possible installation:
        1) The equipment locations and dimensions indicated on the Drawings and elevations are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all instrumentation and control equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
        2) The Contractor has the freedom to select any of the named manufacturers as identified in the individual Specifications; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.
    c. Installation details:
        1) The Contract Drawings include installation details showing means and methods for installing instrumentation and control equipment. For cases where typical details are not provided or compatible with an installed location, develop installation details that are necessary for completing the Work, and submit these details for review by the Engineer.
    d. Schematic diagrams:
        1) All controls are shown de-energized.
        2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
        3) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
        4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
        5) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences indicated on the Drawings or in the Specifications. Combine all information and furnish a coordinated and fully functional control system.

G. Alternates/Alternatives:
    1. Substitute item provisions as specified in Document 00700.

H. Changes and change orders:
    1. As specified in Document 00700.

1.02 REFERENCES

A. Code compliance:
    1. As specified in Section 01410:
        a. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.
    2. The following codes and standards are hereby incorporated into this Section:
        a. American National Standards Institute (ANSI).
        b. American Petroleum Institute (API):
            1) RP 550 - Manual on Installation of Refinery Instruments and Control Systems; Part II-Process Stream Analyzers; Section 5-Oxygen Analyzers.
            2) RP 551 - Process Measurement Instrumentation.
        c. International Organization for Standardization (ISO):
            1) 9001 - Quality Management Systems - Requirements.
        d. International Society of Automation (ISA):
            1) 5.1 - Instrumentation Symbols and Identification.
            2) 5.4 - Instrument Loop Diagrams.
            3) 20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
        e. National Electrical Manufacturers Association (NEMA):
            1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
        f. National Fire Protection Association (NFPA).
        g. National Institute of Standards and Technology (NIST).
        h. Underwriters Laboratories, Inc. (UL):
            1) 508 - Standard of Safety for Industrial Control Equipment.
            2) 508A - Standard of Safety for Industrial Control Panels.

B. Compliance with Laws and Regulations:
    1. As specified in Document 00700.

1.03 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations in accordance with:
    1. Factory Mutual (FM).
    2. International Electrotechnical Commission (IEC).
    3. Institute of Electrical and Electronics Engineers (IEEE).
    4. International Society of Automation (ISA).
    5. International Organization for Standardization (ISO).
    6. National Electrical Code (NEC).
    7. National Electrical Manufacturers Association (NEMA).
    8. InterNational Electrical Testing Association (NETA).
    9. National Fire Protection Association (NFPA).
    10. National Institute of Standards and Technology (NIST).
    11. Underwriters Laboratories (UL).

B. Specific definitions:
   1. Control circuit: Any circuit operating at 120 volts alternating current (VAC) or direct current (VDC) or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
   2. Panel: An instrument support system that may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems.
   3. Power circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
   4. Signal circuit: Any circuit operating at less than 50 VAC or VDC, which conveys analog information or digital communications information.
   5. Digital bus: A communication network, such as PROFIBUS, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions and diagnostic information.
   6. 2-Wire transmitter (loop powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Section, 2-wire transmitter refers to a transmitter that provides a signal such as 4 to 20 mA 24VDC regulation of a signal in a series circuit with an external 24 VDC driving potential:
      a. Fieldbus communications signal or both.
   7. Powered transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Section, the produced signal may be a 4 to 20 mA 24VDC signal, a digital bus communications signal or both.
   8. System supplier - As specified in ICSC Qualifications in the Quality Assurance article of this Section.
   9. Modifications: Changing, extending, interfacing to, removing or altering an existing circuit.

C. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 2 enclosure in accordance with NEMA 250.
   3. Type 3 enclosure in accordance with NEMA 250.
   4. Type 3R enclosure in accordance with NEMA 250.
   5. Type 3S enclosure in accordance with NEMA 250.
   6. Type 3X enclosure in accordance with NEMA 250.
   7. Type 3RX enclosure in accordance with NEMA 250.
   8. Type 3SX enclosure in accordance with NEMA 250.
   9. Type 4 enclosure in accordance with NEMA 250.
   10. Type 4X enclosure in accordance with NEMA 250.
   11. Type 5 enclosure in accordance with NEMA 250.
   12. Type 6 enclosure in accordance with NEMA 250.
   13. Type 6P enclosure in accordance with NEMA 250.
   14. Type 12 enclosure in accordance with NEMA 250.
   15. Type 12K enclosure in accordance with NEMA 250.
   16. Type 13 enclosure in accordance with NEMA 250.

D. Acronym definitions:
   1. CCS: The PCS central computer system (CCS) consisting of computers and software. The personal computer-based hardware and software system that

includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software and functions.

2. DPDT: Double-pole, double-throw.
3. ES: Enterprise system: Computer based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
4. FAT: Factory acceptance test also known as Source Test.
5. HART: Highway addressable remote transducer.
6. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode, equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode, equipment is started or stopped and valves are opened or closed through a control algorithm within the PLC software. In the Off mode, the equipment is prohibited from responding from the PLC control.
7. HMI: Human machine interface is a software application that presents information to an operator or user about the state of a process, and to accept and implement the operators control instructions. Typically information is displayed in a graphical format.
8. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems. The ICSC performs all portions of the instrumentation and controls work that is not specifically designated to be the responsibility of the designated SCADA Subcontractor (SSC).
9. IJB: Instrument junction boxes: A panel designed with cord sets to easily remove, replace or relocate instrument signals.
10. I/O: Input/Output.
11. IP: Internet protocol or ingress protection.
12. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc. and does not contain a PLC or RIO.
13. LAN: Local area network: A control or communications network that is limited to the physical boundaries of the facility.
14. LOI: Local Operator Interface is an operator interface device consisting of an alphanumeric or graphic display with operator input functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface.
15. LOR: Local-Off-Remote control function. In the Remote mode, equipment is started or stopped, and valves are opened or closed through the PLC based upon the selection of the HOA. In the Local mode, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
16. NJB: Network junction box. An enclosure that contains multiple access points to various networks within the facility. Networks could be Ethernet, Ethernet/IP, Fieldbus, RIO etc.
17. P&ID: Process and instrumentation diagram.
18. PC: Personal computer.

19. PCIS: Process control and instrumentation system: Includes the entire instrumentation system, the entire control system, and all of the Work specified in the Instrumentation and Control Specifications and depicted on the Instrumentation Drawings. This includes all the PCS and instruments and networking components as well as the various servers, workstations, thin clients etc.
20. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
21. PCS: Process Control System: A general name for the computerized system that gathers and processes data from equipment and sensors and applies operational controls to the process equipment. It includes the PLCs and/or RIOs, LOIs, HMIs, both LCPs, VCPs and all data management systems accessible to staff.
22. PJB: Power junction box: An enclosure with terminal blocks that distribute power to multiple instruments.
23. PLC: Programmable logic controller.
24. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.
25. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
26. SCADA: Supervisory control and data acquisition system: A general name for the computerized system that gathers and processes data from sensors and equipment located outside of the facility, such as wells, lift stations, metering stations etc.
27. SCADA Subcontractor (SSC): Designated by OWNER but responsible contractually to CONTRACTOR. HSQ Technology, 26227 Research Road, Hayward, CA., 94545-3725. Lead contacts: Scott Cramer, Peter Waenink, HSQ Technology, 26227 Research Road, Hayward, CA 94545, Phone 510 259-3713, Fax 510 259-1392, cramer@hsq.com, waenink@hsq.com http://www.hsq.com.
28. SPDT: Single-pole, double-throw.
29. SPST: Single-pole, single-throw.
30. UPS: Uninterruptible power supply.
31. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, LOI, HMI, etc.
32. WAN: Wide area network: A control or communications network that extends beyond the physical boundaries of the facility.

1.04 SYSTEM DESCRIPTION

A. General requirements:
   1. The Work includes everything necessary for and incidental to executing and completing the instrumentation and control system work indicated on the Drawings and specified in the Specifications and reasonably inferable there from including but not limited to:
      a. Preparing hardware submittals for field instrumentation.
      b. Design, develop, and draft loop drawings, control panel designs, and all other drawing submittals specified in the Instrumentation and Control Specifications.

c. Prepare the test plan, the training plan, and the spare parts submittals.
d. Procure all hardware.
e. Fabricate panels.
f. Perform factory tests on panels.
g. Perform bench calibration and verify calibration after installation.
h. Oversee and certify installation of the PCS system.
i. Oversee, document, and certify loop testing.
j. Oversee, document, and certify system.
k. Installation Testing.
l. Oversee and document Functional Testing.
m. Conduct the Process Operational Period and the Instrumentation and Controls Process Performance Testing.
n. Prepare operation and maintenance manuals.
o. Conduct training classes.
p. Integrate the PCS with instrumentation and control devices provided under other sections.
q. Provide Record Drawings and Loop Drawings associated with Instruments and equipment:
    1) As specified in the Contract Documents.
    2) For Owner furnished items.
    3) For interfaces with existing equipment.
r. Resolve signal, power, or functional incompatibilities between the PCS and interfacing devices.
s. Perform all required corrective and preventative maintenance.

2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of all equipment furnished by others, as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
3. Coordinate all aspects of the Work between Contractor and all subcontractors before bidding to ensure that all costs associated with a complete installation are included. The Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the SCADA Subcontractor, the ICSC, the other subcontractors, or suppliers.
4. Furnish detailed, complete, and thorough operations and maintenance documentation, including but not limited to operations manuals, maintenance manuals, as-built wiring drawings, training manuals, as-built software documentation, and all other documentation required to operate, modify, and maintain all parts of the PCS.
5. The SCADA Subcontractor will provide as-built software documentation for the PLCs and computers programmed by the SCADA Subcontractor. The SCADA Subcontractor will provide training on hardware and software items provided by the SCADA Subcontractor. All other documentation and training shall be by the Contractor.
6. Where demolition is indicated on the Drawings, the electrical subcontractor is responsible for disconnecting equipment electrical connections and rendering the equipment safe. The ICSC, in coordination with the SCADA Subcontractor, is responsible for physically removing all instrumentation to be demolished and return it either to the Owner or dispose of it as directed by the Owner's representative.

7. The SCADA Subcontractor shall be responsible for any program modifications to systems provided by the SCADA Subcontractor needed based on the demolition of the equipment, both for the loops directly and indirectly affected. The Contractor shall be responsible for all other programming modifications necessary based on demolition of the equipment.
8. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
    a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before performing any Work.
    b. Provide and document interface with, modifications to, upgrade, or replacement of existing circuits, power systems, controls, and equipment.
9. Revise in a manner as directed by the Engineer all I/O and addressing that the Engineer determines to be unacceptable as a result of a lack of Contractor coordination between Contract Documents and all suppliers.
10. Defective Work:
    a. As specified in Document 00700.

B. New system:
1. Furnish, install, and place into service the operating PCIS for the new Secondary Clarifier No. 5, RAS Pump Station, Mixed Liquor Flumes 5 & 6, as well as modifications to Mixed Liquor Flume 4 and Aeration Basins 1-7, and provide coordination with the City of Turlock's software driven, computer based SCADA system to perform the specified monitoring, communications, alarm, control, display and reporting functions for the Owner's facilities all in accordance with the requirements of the Contract Documents. Provide the entire PCIS complete and operable, in accordance with the Contract Documents. Furnish new system and equipment that matches existing equipment, including but not limited to, colors, manufacturers, I/O voltage, panel layouts, SCADA screens, etc.

C. Operating facility:
1. As specified in Section 01140.
2. Portions of this existing facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
    a. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction to meet the requirements of the Owner.
    b. As weather and facility demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.
    c. Where portions of the Work are in existing facilities and require interface to existing circuits, power systems, controls and equipment, perform comprehensive and detailed field investigations of existing conditions. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
3. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.

4. The Contractor is responsible for the integrity and measurement accuracy of all loops. However, any defect found in existing equipment is the responsibility of the Owner.
5. The standards of documentation, instrument tagging, cable and conductor termination, terminal identification and labeling that apply to the new installation apply equally to the existing installation.

D. New and Modified Facilities Control System Overview: Provide all RTU, PLC, SCADA and networking hardware and software needed for a complete distributed control system for the new system facilities. Equipment and installation include PCMs, MCP, RTUs, fiber optic cables, fiber patch panels, Ethernet switches, fiber optic transceivers, Ethernet cables and patch cables, uninterruptible power supplies, and other system components:
   1. RTU-208 (New):
      a. This shall be a new RTU panel in a new prefabricated building with the following points:

DI	DO	AI	AO
81	15	12	6

      b. Allow 25 percent of wired spare I/O for each type.
      c. In addition to 25 percent spare above, provide 30 percent spare panel space.
      d. To be connected to RTU-207 via fiber optic cable.
   2. RTU-207A (New):
      a. This shall be a new RTU panel in Electrical Building No. 7 with the following points:

DI	DO	AI	AO
75	13	16	7

      b. Allow 25 percent of wired spare I/O for each type.
      c. In addition to 25 percent spare above, provide 30 percent spare panel space.
      d. To be connected to RTU-207 via Ethernet cable.
   3. RTU-207 (Existing):
      a. Modify panel and furnish PLC equipment as necessary to include capacity for additional I/O points as follows:

DI	DO	AI	AO
64	13	10	4

      b. To be connected to RTU-207A via Ethernet cable.
      c. To be connected to RTU-208 via fiber optic cable.
   4. RTU-30 (Existing):
      a. Modify panel and furnish PLC equipment as necessary to include capacity for additional I/O points as follows:

DI	DO	AI	AO
8	2	3	2

   5. The above I/O counts are for estimation only. Provide signals as necessary to produce a fully functioning system as designed in Contract Documents.
   6. Provide local control panels for new electrical loads, including pumps, mixers, valves, and gates.
   7. Provide common junction box (IJB) for dissolved oxygen transmitters at all aeration basins. Panel to provide ability to change signal used by Blower VCP to control aeration air.

E. Division of Work:

1. The Owner's designated SCADA Subcontractor assigned to perform process control configuration tasks, will perform programming and configuration of SCADA software. See the attachment to 17050 for SCADA Subcontractor's prenegotiated scope.
2. The SCADA Subcontractor will not program any PLCs, HMIs or OITs provided by equipment manufacturers as part of packaged systems.
3. The Contractor shall provide information on packaged and pre-purchased systems, as required, coordinating between control equipment provided under this Contract and equipment and services provided by the ICSC and SCADA Subcontractor.
4. Outline of Responsibilities:
   a. The following table is a general outline of responsibilities for part of the work described in Division 17. It is provided for the convenience of the Contractor to assist understanding of the Contract scope as it relates to the SCADA and Network systems hardware and software. It is not intended to be comprehensive or complete. Most of the work specified in Division 17 is not listed in the table below.
   b. The table below is an overview of responsibilities. Refer to specific requirements in individual paragraphs in this Section and other Sections for the requirements. In case of a conflict between the table below and wording in the specifications, the specification wording shall govern. Any work described in Division 17 that is not explicitly specified to be provided by the Owner, Engineer, or SCADA Subcontractor shall be provided by the Contractor.
   c. Table 1: Process Control and Instrumentation System (PCIS) Responsibilities:

Table 1
Turlock: Secondary Clarifier No. 5 and Denitrification Project

Control System Component	Furnish	Install	Program/ Configure	Test and Startup	Remarks
All RTUs (New and Modified)					
Hardware					
PCM RTU Enclosure	S	C	S	S	
RTU	S	S	S	S	Includes processor, IO modules, and necessary communication modules
HMI	S	S	S	S	
Ethernet Switch	S	S	S	S	
Fiber Patch Panel	S	S	NA	S	
Media Converter	S	S	S	S	
Fiber Patch Cables	S	S	NA	S	
Copper Patch Cables	S	S	NA	S	
Wiring Inside PCM RTU Panel	S	S	NA	S	Includes landing field wires to field terminals and all internal panel wiring
Battery Backup or UPS	S	S	S	S	

Table 1
Turlock: Secondary Clarifier No. 5 and Denitrification Project

Control System Component	Furnish	Install	Program/ Configure	Test and Startup	Remarks
Fiber optic cable and fiber terminations to other RTU panels	C	C	NA	C	
Software					
Program RTU	S	S	S	S	
Program Ethernet Switches	S	S	S	S	
Program PCIS & HMIs	S	S	S	S	
Design					
Existing RTU Modifications	S	S	S	S	Prior to procurement or construction, SCADA Subcontractor to perform field visit to confirm existing panels are capable of modifications shown in Design Documents
Miscellaneous					
Hardware					
Other Equipment or Devices Not Noted above	C	C	C	C	

Legend:
C = CONTRACTOR responsibility
S = SCADA SUBCONTRACTOR (HSQ Technology)
NA = Not applicable

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 01330 and this Section.

B. General:
1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
2. Furnish the submittals required by each section in the Instrumentation Specifications.
3. Adhere to the wiring numbering scheme specified in Section 16075 throughout the Project:
   a. Uniquely number each wire.
   b. Wire numbers must appear on all Equipment Drawings.
4. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.

C. Submittal preparation:
   1. During the period of preparation of submittals, the Contractor shall authorize direct, informal liaison between the ICSC and the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions may be authorized informally by the Engineer, which do not alter the scope of Work or cause increase or decrease in the Contract price or times. During this informal exchange, no oral statement by the Engineer shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant exception to, or variation from, these Contract Documents.
   2. In these Contract Documents, some items of Work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ISA-5.1:
      a. Employ the nomenclature and numbers designated in this Section and indicated on the Drawings exclusively throughout shop drawings, data sheets, and similar submittals.
      b. Replace any other symbols, designations, and nomenclature unique to a manufacturer's, suppliers, or subcontractor's standard methods with those identified in this Section and indicated on the Drawings.

D. Specific submittal requirements:
   1. Shop drawings:
      a. Required for materials and equipment listed in this and other sections.
      b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
      c. Shop drawings requirements:
         1) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
         2) Locations of conduit entrances and access plates.
         3) Component layout and identification.
         4) Schematic and wiring diagrams with wire numbers and terminal identification.
         5) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
         6) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
         7) Weight.
         8) Finish.
         9) Nameplates:
            a) As specified in Section 16075 or as indicated in the Drawings.
         10) Temperature limitations, as applicable.
      d. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
      e. Adhere to wiring numbering scheme outlined in Section 16075 throughout the Project:
         1) Uniquely number each wire per the Specifications.
      f. Wire numbers must appear on all equipment drawings.

g. Organize the shop drawing submittals for inclusion in the Operation and Maintenance Manuals:
    1) Furnish the initial shop drawing submittal bound in one or more standard size, 3-ring, D-ring, loose leaf, vinyl plastic, hard cover binders suitable for bookshelf storage.
    2) Binder ring size: 2 inches.
h. Include the letterhead and/or title block of the firm responsible for the preparation of all shop drawings. Include the following information in the title block, as a minimum:
    1) The firm's registered business name.
    2) Firm's physical address, email address, and phone number.
    3) Owner’s name.
    4) Project name and location.
    5) Drawing name.
    6) Revision level.
    7) Personnel responsible for the content of the drawing.
    8) Date.
i. The work includes modifications to existing circuits:
    1) Clearly show all modifications to existing circuits.
    2) In addition, show all existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.

2. Product data:
    a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
    b. Include:
        1) Catalog cuts.
        2) Bulletins.
        3) Brochures.
        4) Quality photocopies of applicable pages from these documents.
        5) Identify on the data sheets the Project name, applicable specification section, and paragraph.
        6) Identify model number and options for the actual equipment being furnished.
        7) Neatly cross out options that do not apply or equipment not intended to be supplied.
    c. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
    d. Adhere to wiring numbering scheme outlined in Section 16075 throughout the Project:
        1) Uniquely number each wire per the Specifications.
    e. Wire numbers must appear on all equipment drawings.
3. Detailed sequence of operation for all equipment or systems.
4. Operation and maintenance manuals:
    a. As specified in Section 01782.
    b. Operational Manual:
        1) Prepare and provide a simplified version of the standard manufacturer’s HMI software and system operations manual that includes basic instructions in the application of the system as required for operators in day-to-day operations.

c. Control System Software Record Documents:
    1) Include complete documentation of all the software programs provided for the entire control and PCS system, including:
        a) Listings of all application software on both hard copy and DVD-ROM.
        b) Database, both hard copy and DVD-ROM.
        c) Communication protocols.
        d) All documentation necessary to maintain, troubleshoot, modify, or update the software system.
d. Organize the operation and maintenance manuals for each process in the following manner:
    1) Section A - Process and Instrumentation Diagrams.
    2) Section B - Control Descriptions.
    3) Section C - Loop Drawings.
    4) Section D - Instrument Summary.
    5) Section E - Instrument Data Sheets and Brochures.
    6) Section F - Sizing Calculations.
    7) Section G - Instrumentation Installation Details.
    8) Section H - Test Results.
    9) Section I - Operational Manual.
    10) Section J - Spare Parts List.
    11) Section K - Control System Software.

5. Material and equipment schedules:
    a. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
        1) Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
6. Itemized instrument summary:
    a. Submit a hard copy of the instrument summary.
    b. List all of the key attributes of each instrument including:
        1) Tag number.
        2) Manufacturer.
        3) Model number.
        4) Service.
        5) Area location.
        6) Calibrated range.
        7) Loop drawing number.
    c. Associated LCP, VCP, PCM, or PLC.
7. Instrument data sheets and cut sheets:
    a. Furnish fully completed data sheets, both electronically in Microsoft Word or Excel and in hardcopy, for each instrument and component according to ISA-20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. The data sheets provided with the instrument specifications are preliminary and are not complete. They are provided to assist with the completion of final instrument data sheets. Additional data sheets may be required. Include the following information on the data sheet:
        1) Component functional description specified in this Section and indicated on the Drawings.
        2) Manufacturers model number or other product designation.
        3) Tag number specified in this Section and indicated on the Drawings.
        4) System or loop of which the component is a part.

5) Location or assembly at which the component is to be installed.
6) Input and output characteristics.
7) Scale range with units and multiplier.
8) Requirements for electric supply.
9) Requirements for air supply.
10) Power consumption.
11) Response timing.
12) Materials of construction and of component parts that are in contact with, or otherwise exposed to, process media, and or corrosive ambient air.
13) Special requirements or features, such as specifications for ambient operating conditions.
14) Features and options that are furnished.

b. Provide a technical brochure or bulletin (“cut sheet”) for each instrument on the project. Submit with the corresponding data sheets:
1) Where the same make and model of instrument is used in 2 or more applications on the project, and the process applications are nearly identical, and the materials, features and options are identical submit one brochure or bulletin for the set of identical instruments.
2) Include a list of tag numbers for which it applies with each brochure or bulletin.
3) Furnish technical product brochures that are complete enough to verify conformance with all Contract Document requirements, and to reflect only those features supplied with the device.
4) Cross out models, features, options, or accessories that are not being provided.
5) Clearly mark and identify special options and features.

c. Organization: Index the data sheets and brochures in the submittal by systems or loops.

8. Control panel hardware submittal:
a. Submit the following in 1 submittal package.
b. Complete and detailed bills of materials:
1) Including quantity, description, manufacturer, and part number for each assembly or component for each control panel.
2) Include all items within an enclosure.

c. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and Control System equipment.
d. Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium voltage power cables.
e. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.
f. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
1) The manufacturer's model number or other identifying product designation.
2) Tag and loop number.
3) System to which it belongs.
4) Site to which it applies.
5) Input and output characteristics.
6) Requirements for electric power.

7) Device ambient operating requirements.
8) Materials of construction.

9. Schedule of values:
   a. In addition to completing all items referred to in the schedule of values, Section 01292, submit per unit instrument and labor costs used in developing the final bid for the PCS system, for the express purpose of pricing and cost justification for any proposed change orders. It is the responsibility of the ICSC subcontractor to prove to the Engineer's satisfaction that said per unit costs were used in the development of the final Bid amount.
10. Installation recommendations:
    a. Submit the manufacturer's printed recommendations for installation of instrumentation equipment.
11. Training submittals:
    a. Develop and submit for review a general training plan for approval by Owner within 14 calendar days from Notice to Proceed. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
    b. The Engineer will review the general training plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the Engineer, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system, provide more qualified instructors.
    c. The general training plan and schedule shall be updated by the Contractor at the beginning of each Phase and approved by the Owner a minimum of 30 days prior to commencement of training.
    d. Training course plan submittals:
       1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson as specified in Section 01756.
       2) Describe any student pre-requisites for the course or training activity.
       3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.
       4) Submit training materials.
    e. Incorporate all submittal review comments into the course.
    f. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.
12. Project Record documents:
    a. Furnish as specified in Section 01770.
13. Loop Drawings:
    a. Submit loop drawings for every analog, discrete, and fieldbus signal and control circuit:
       1) Provide a loop drawing submittal that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop on this Project.

2) This requirement applies to all signal and control circuits associated with equipment on this Project including vendor supplied equipment packages and control panels.
3) Provide loop drawings in the format indicated in the contract drawings. Provide all tagging in accordance with the Owner's standard.

b. Show every instrument and I/O point on at least one loop diagram.
c. Provide a complete index in the front of each bound volume:
1) Index the loop drawings by systems or process areas.
d. Provide drawings showing definitive diagrams for every instrumentation loop system:
1) Show and identify each component of each loop or system using requirements and symbols from ISA-5.4.
2) Furnish a separate drawing sheet for each system or loop diagram.
e. In addition to the ISA-5.4 requirements, show the following details:
1) Functional name of each loop.
2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
3) Show all terminal numbers, regardless of the entity providing the equipment.
4) MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.
5) Designation of and, if appropriate, terminal assignments associated with, every manhole, pull-box, junction box, conduit, and panel through which the loop circuits pass.
6) Show vendor control panel, instrument panel, conduit, junction box, equipment and PCS terminations, termination identification, wire numbers and colors, power circuits, and ground identifications.
7) If a circuit is continued on another drawing, show the name and number of the continuation drawing on the loop drawing. Provide complete references to all continuation drawings whether vendor control panels, other loop drawings, existing drawings provided by the Owner, or other drawings.
f. In addition to the above requirements, provide loop diagrams in accordance with the example loop diagram as indicated on the Drawings.

14. Instrument Installation Drawings:
a. Submit, instrument installation, mounting, and anchoring details for all components and assemblies, including access requirements and conduit connection or entry details.
b. Furnish for each instrument a dedicated 8 1/2-inch by 11-inch installation detail that pertains to the specific instrument by tag number.
c. For each detail, provide certification and the hard copies, by the instrument manufacturer, that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable.
d. For each detail, provide, as a minimum, the following contents:
1) Necessary sections and elevation views required to define instrument location by referencing tank, building or equipment names and numbers, and geographical qualities such as north, south, east, west, basement, first floor, etc.
2) Ambient temperature and humidity where the instrument is to be installed.

3) Corrosive qualities of the environment where the instrument is to be installed.
4) Hazardous rating of the environment where the instrument is to be installed.
5) Process line pipe or tank size, service and material.
6) Process tap elevation and location.
7) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
8) Routing of tubing and identification of supports.
9) Mounting brackets, stands, anchoring devices, and sun shades.
10) Conduit entry size, number, location, and delineation between power and signal.
11) NEMA ratings of enclosures and all components.
12) Clearances required for instrument servicing.
13) List itemizing all manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.

15. Control Panel Drawings:
    a. Layout Drawings:
        1) Submit panel, enclosure, console, furniture, and cabinet layout drawings for all items provided.
        2) As a minimum, include the following information:
            a) To scale front, side, and plan views.
            b) Dimensions.
            c) Interior and exterior arrangements.
            d) Mounting information, including conduit entrance location.
            e) Finish data.
            f) Tag number and functional name of items mounted in and on each panel, console, and cabinet.
            g) Nameplate legend including text, letter size, materials and colors.
    b. Wiring and Piping Diagrams:
        1) Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
        2) Include the following information:
            a) Name of panel.
            b) Wiring and piping sizes and types.
            c) Terminal strip numbers.
            d) Wire tags and labels.
            e) Functional name and manufacturer's designation for items to which wiring and piping are connected.
            f) Electrical control schematics in accordance with ANSI standards.
    c. Installation drawings:
        1) Provide site-specific installation drawings for all control equipment panels, including dimensions.
        2) Provide scaled drawings and show the position of the equipment at its intended installation location.
        3) Show the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.

4) Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.

16. Schematic Diagrams:
    a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
    b. Include device and field connection terminal numbers on all schematic diagrams.
    c. Incorporate equipment manufacturer’s shop drawing information into the schematic diagrams in order to document the entire control system.
17. Control System Diagram:
    a. Submit a complete set of control system diagrams including the following information:
        1) All PLCs, workstations, printers, communication devices, and communication links:
            a) Show all PLCs with their current I/O allocation, and future I/O allocation, current plus spares provided, and maximum potential I/O based on available slots.
        2) All cables required for communication requirements.
        3) Show each component fully annotated with conduit size and number associated with the power source.
18. Process Control Software Submittal:
    a. In accordance with Product Data and Shop Drawing general requirements.
    b. Submit a complete description of the standard application software programs, operating system and utility programs, including modifications and explanation of how the specific functional requirements are met:
        1) Provide a cross-reference between the Specification requirements and the software submittal, in order to provide the Engineer the ability to identify how each specified requirement or function is met.
    c. A complete listing of the PCS system point I/O database:
        1) Include for each data point, relevant parameters such as range, contact orientation, limits, incremental limits, I/O card byte, I/O hardware address, and PLC assignment.
        2) Organize on a site-by-site basis, separate by point type.
        3) In addition to the active I/O points, list the implemented spare I/O points and the available I/O points remaining on each card, as well as other defined future points specified or shown.
    d. Detailed descriptions of procedures used to implement and modify control strategies and database construction.
    e. Preliminary overview, screens, station graphic displays, and preliminary reports.
19. Instrumentation and Control System Contractor Statement of Qualifications:
    a. Submit statement of qualifications of the proposed ICSC in accordance with subsequent requirements of this Section.
20. Control Descriptions:
    a. For each control loop, provide a detailed functional description of the operation of the equipment, signals, and controls as shown on the P&IDs:
        1) Include all functions depicted or described in the Contract Documents.

2) Include within the Control Description content:
a) All specific requirements.
b) All common requirements that pertain in general to all loops.
c) Listing all ranges, setpoints, timers, values, counter values, etc.

21. Commissioning and Process Start-up Submittals:
a. General testing submittal requirements are specified in this Section:
1) Additional requirements are specified in Sections 01756, 17950 and other technical sections.
b. Test Procedure Submittals:
1) Submit the proposed procedures to be followed during tests of the PCS and its components in 2 parts:
a) Preliminary Submittal: Outline of the specific proposed tests and examples of proposed forms and checklists.
b) Detailed Submittal: After successful review of the Preliminary Submittal, submit the proposed detailed test procedures, forms, and checklists. Include a statement of test objectives with the test procedures.
c. Provide certified and witnessed test and calibration checklists for each of the following tests:
1) Source Testing:
a) Also called Factory Acceptance Tests (FAT).
b) Submit completed Manufacturer's Certificate of Source Testing as specified in Section 01756.
2) Functional Testing:
a) Loop Validation Tests:
(1) Loop Validation Certifications:
(a) Complete field device loop tests have been successfully completed for all individual instruments, all separate analog control networks, all valves, all VCPs, all motors, all local operator interface panels, all motor control centers, etc.
b) Calibration, adjustment, and test details for all components and systems.
c) Programming.
d) Submit completed Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756.
3) Process Operational Period.

22. Test reports:
a. As specified in Section 01330.
b. Additional requirements for commissioning and process start-up reports are specified in Section 17950.

23. Calculations:
a. Where required by specific Instrumentation Specifications:
1) Because these calculations are being provided by a registered professional engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculation means.

1.06 QUALITY ASSURANCE

A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.

B. ICSC qualifications:
   1. General information on the proposing company:
      a. Document that the ICSC company has been actively involved in the instrumentation, PLC based control systems, business for a minimum of five years and has adequate facilities, organization structure, manpower and technical and managerial expertise to properly perform the Work as specified in these Specifications.
      b. Submit a financial prospectus indicative of the corporation's financial state. This prospectus shall also include:
         1) A letter from a financial institution indicating a current line of credit and bonding limit which can be applied to this Project.
         2) Latest annual report or reviewed financial statement.
   2. Document that the ICSC has a qualified permanent service facility:
      a. Said facility shall be staffed with permanent employees and equipped with the tools and test equipment necessary to calibrate, test, and process start-up all of the instrumentation, control, telemetry, SCADA and control systems hardware and software furnished under this Contract, including remote diagnostic capability.
      b. Document in-house resource of permanent personnel experienced in the design and programming of equipment and systems as specified in these Specifications.
      c. Document the existence of a training program staffed by qualified instructors, to provide proper training in the operation and maintenance of equipment as specified in these Specifications.
      d. Document that the firm is a recognized or certified “system integrator partner” or similar designation for the control software and PLC system being supplied for this Project.
   3. Similar project experience of the company:
      a. Provide a list of at least 3 successfully completed projects for a water and/or wastewater system of similar scope and complexity in which the proposing firm used components the same as those intended for use on this Project. The proposing firm must have performed, for each listed project, system engineering, system fabrication and installation, documentation (including schematic, wiring and panel assembly drawings), software configuration and documentation, field testing, calibration and process start-up, operator instruction and maintenance training. In addition, provide the following information for each project:
         1) Name of plant or system owner, contact name, and current telephone number. Design engineer’s name, address, and telephone number. Failure to provide current contact information may result in the listed project being disqualified for use in meeting the minimum requirements for prequalification.
         2) Manufacturer and model number(s) of the PLC based control system and the computer-based SCADA system used for both hardware and software.
         3) Brief description of the system.
         4) Approximate number of input and output signals: analog, digital, and fieldbus.

5) Brief application software description.
6) Contracted cost of the system, separate by base amount and any change orders for the completed projects.
7) Duration of the project and date of completion.

4. Information on the proposed Project team members:
   a. Provide the name and resume of the individual persons who will be responsible for each of the following:
      1) Office engineering and management of this Project.
      2) Lead for software configuration/programming.
      3) Individual who will be responsible for the hardware and hardware interface design.
      4) Individual who will be responsible for field testing, calibration, process start-up.
      5) Individual who will be responsible for operator training.
   b. All of these individuals must be permanent employees of the proposing firm.
5. Determination of the proposed ICSC qualifications is at the sole discretion of the Engineer.

C. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

D. The ICSC must have their own operating UL listed panel fabrication facility. All panels must be fabricated at this facility and meet all UL 508/508A requirements.

E. ICSC:
1. The Contractor, through the use of a qualified ICSC, is responsible for the remaining implementation of the PCIS and the integration of the system with other required instrumentation, control devices, and software. See the division of responsibility table in section 1.04.E. The ICSC's complete responsibilities are different than those of the SCADA Subcontractor. It is the Contractor's responsibility to coordinate all work.
2. The ICSC assumes full responsibility, through the Contractor, to perform all work to select, furnish, install, test, calibrate, and place into operation all instrumentation, controls, telemetry equipment, control panels, and control system including application software, for a complete, integrated and functional PCIS system.
3. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these Specifications that the ICSC be responsible for the integration of the PCIS with existing devices and devices provided under the Contract Documents with the objective of providing a completely integrated control system.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600.

B. Shipping precautions:
1. After completion of shop assembly, successful Source Test, pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy-duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.

2. Place dehumidifiers when required, inside the polyethylene coverings.
3. Skid-mount the equipment for final transport.
4. Provide lifting rings for moving without removing protective covering.
5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

C. Special instructions:
1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

D. Tagging:
1. Tag each component and/or instrument to identify its location, instrument tag number, and function in the system.
2. Firmly attach a permanent tag indelibly machine marked with the instrument tag number, as given in the tabulation, on each piece of equipment constituting the PCS.
3. Tag instruments immediately upon receipt in the field.
4. Prominently display identification on the outside of the package.
5. Utilize the Tag and Loop Number identifications shown on the P&IDs.

E. Delivery and inspection:
1. Deliver products in undamaged condition, in manufacturer's original container or packaging with identifying labels intact and legible. Include date of manufacture on label.

1.08 PROJECT OR SITE CONDITIONS

A. Site conditions:
1. Provide a PCS, including all equipment, raceways and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
2. Seismic classification:
a. Provide all equipment and construction techniques suitable for the seismic requirements for the site, as specified in Section 01612.
3. Wind:
a. Provide all equipment and construction techniques suitable for the site wind loading criteria, as specified in Section 01614.
4. Altitude, temperature and humidity:
a. As specified in Section 01610.
b. Provide all equipment and instrumentation fully rated for continuous operation at this altitude, temperature and humidity conditions with no additional derating factors applied.
c. Provide additional temperature conditioning equipment to maintain all equipment and instrumentation in non-conditioned spaces or outdoors subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature as determined by the equipment manufacturer's guidelines:
1) Provide all power wiring for these devices (e.g., heaters, fans, etc.), whether or not indicated on the Drawings.

5. Area classifications:
    a. Furnish enclosures that match the area classifications as specified in Section 16050.
6. Site security:
    a. Abide by all security and safety rules concerning the Work on the Site, as specified in Section 01329.

1.09 SEQUENCING

A. General:
1. As specified in Sections 01312 and 01756.
2. Testing requirements are specified in Sections 01756, 17950 and other sections.
3. General scheduling requirements are specified in Section 01324A.
4. Work restrictions and other scheduling requirements are specified in Section 01140.
5. Commissioning and Process Start-up requirements as specified in Section 01756.

B. Submit proposed ICSC statement of qualifications:
1. The ICSC must be accepted by the Engineer before any other Work commences.

C. Pre-submittal conferences:
1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.
2. The Contractor, SCADA Subcontractor, ICSC, electrical subcontractor, and all manufacturers furnishing major pieces of equipment must attend, including but not limited to:
    a. Vendor control panels.
    b. Chemical feed systems.
    c. Motor control centers.
    d. Switchgear.
    e. Variable frequency drives.
    f. Lighting.
    g. Engine generators.

D. System configuration meetings:
1. The Contractor, ICSC, electrical subcontractor, SCADA Subcontractor, and all manufacturers furnishing major pieces requiring coordination of equipment with control system must attend system configuration meetings. With permission from the Owner and Engineer, remote attendees may teleconference in. Manufacturer attendees include:
    a. Suppliers of vendor control panels.
    b. Suppliers of equipment interfacing with PCIS system.
2. SCADA Subcontractor shall review the system configuration, the system database, control schemes, displays, report formats, etc. with the Engineer and Owner on at least 2 occasions during development. The Contractor is required to attend all configuration meetings and coordinate all work with SCADA subcontractor and Owner.

3. First Review Meeting: Before configuration work is begun. The SCADA Subcontractor must bring to this meeting example of displays, display symbols, reports, etc. to show the capabilities, performance, and operation of the system software.
4. Final Review meeting: Held after initial completion of all configuration work. This final meeting may not be held in conjunction with the Source Test. Make final format revisions after this review.
5. Additional requirements as specified in Sections 17100 and 17101.

E. General Field Start-up and testing procedures:
   1. As specified in Section 01756.

F. Installation testing:
   1. As specified in Section 01756.
   2. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.
   3. Acceptance of the PCIS Installation testing must be provided in writing by the Owner before the performance testing may begin.

G. Training:
   1. As specified in Section 01756.

H. Functional testing:
   1. Representatives from each of the following groups shall be in attendance during the functional Testing: SCADA Subcontractor, ICSC, System Supplier. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.

I. Loop validation test:
   1. As specified in Section 17950:
      a. Notify the Owner of scheduled tests a minimum of 21 days before the estimated completion date of installation and wiring of the PCIS.
      b. Complete loop validation testing a minimum of 5 days before the pre-commissioning phase of the project.
      c. Loop validation certifications:
         1) After the field device loop tests have been successfully completed as specified in Section 17950 for all individual instruments, all separate analog control networks, all valves, all VCPs, all motors, all local operator interface panels, all motor control centers, etc., submit a certified copy of all test forms signed by the Contractor, Vendor, and the Owner's representative with test data entered, together with a clear and unequivocal statement that all instrumentation, including all control and signal wiring, has been successfully calibrated, inspected, and tested:
            a) Acceptance of the PCIS Installation Testing must be provided in writing by the Engineer before the Process Operational Period may begin.

J. Provide all special tools and spare parts, as specified in the Maintenance paragraph of this Section, before Process Operational Period commences, suitably wrapped and identified.

K. Process Operational Period:
   1. Upon completion of the Process Operational Period, conduct an Instrumentation and Controls Process Performance Test as a condition for Project final completion.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. Provide additional warranty as specified in the individual Instrumentation and Control Specifications that extends beyond the Correction Period, as specified in Document 00700 and 00800.

1.12 SYSTEM PROCESS START-UP

A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
   1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by the Contract Documents including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

B. Furnish all spare parts as required by the Contract Documents.

C. Spare parts:
   1. Furnish the spare parts selected by the Engineer from the priced list of spare parts in the hardware submittal.
   2. Furnish a price list of all special tools required to calibrate and maintain all of the instrumentation provided under the Contract Documents. Furnish the special tools selected by the Engineer from the priced list.

D. Provide portable Instrument calibrator with the following:
   1. One portable instrument calibrator current simulator with charger, pressure modules to accommodate all pressure measuring instruments furnished, and carrying case:
      a. Rochester Instrument Systems (RIS) CL-9002.
      b. Fluke 754 DPC.

E. Provide additional spare parts specified in other sections of the Instrumentation and Control Specifications.

F. Submit all special tools and spare parts, suitably wrapped and identified, before Process Operational Period commences.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide similar items from a single manufacturer throughout the PCIS portion of the Project.

B. Allowable manufacturers are specified in individual instrument and equipment specifications.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these devices and that bear all approvals and labels as required by the Specifications.

B. Provide materials complying with the applicable industrial standard as specified in the Contract Documents.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Furnish all meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise specified to match existing equipment.

B. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of within 0.5 percent of full scale and a minimum repeatability of within 0.25 percent of full scale.

C. Signal transmission:
   1. Analog signals:
      a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable, unless otherwise indicated.
      b. Furnish electrical analog signals outside control panels that are 4 to 20 mA 24 VDC, except as indicated.
      c. Analog signals within enclosures may be 1 to 5 VDC.
      d. Electrically or optically isolate all analog signals from other signals.

e. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
f. Maintain the total 4 to 20 milliamperes loop impedance to 10 percent below the published value at the loop operating voltage.
g. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.

2. Pneumatic Signals:
   a. All pneumatic signals: 3 to 15 pounds per square inch gauge.
3. Discrete input Signals:
   a. As indicated in the controller hardware specification.
4. Discrete output signals:
   a. Dry contacts or TRIAC outputs (with express written approval by the Engineer) as needed to coordinate with the field device.
   b. Provide external terminal block mounted fuse with blown fuse indication for all discrete outputs.
   c. Provide interposing relays for all discrete outputs for voltage and/or current compatibilities.
   d. Provide interposing relays as required for functionality of the control circuit.
5. Signal Performance and Design Criteria:
   a. Stability:
      1) After Control has taken corrective action, oscillation of the final control element shall not exceed 2 cycles per minute or a magnitude of motion of 0.5 percent of full travel.
   b. Response:
      1) Any change in setpoint or controlled variable shall produce a corrective change in position of the final control element and stabilized within 30 seconds.
   c. Agreement:
      1) Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
   d. Repeatability:
      1) For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position the final element.
   e. Sensitivity:
      1) Controls shall respond to a setpoint deviations and measured variable deviations within 1.0 percent of full scale.
   f. Performance:
      1) All instruments and control devices shall perform in accordance with the manufacturers' specifications.

D. Discrete circuit configuration:
   1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
   2. Alarm contacts: Fail to the alarm condition.
   3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.

E. Grounding:
   1. Provide control panels with a signal ground bus, isolated from the power ground bus:
      a. Provide multiple panels in one location with a common point for signal ground bus connection to ground.
   2. Ground single point ground shields and measurement loops at the source panel external terminals, unless otherwise noted, by bonding to the control panel signal ground bus.
   3. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

F. Instrument air:
   1. Where indicated on the Drawings, provide dry, filtered control air at 30 pounds per square inch gauge nominal pressure piped to all field instruments and instrument panels requiring air:
      a. Provide each field instrument with an integral, non-adjustable filter/regulator assembly to provide regulated air.
      b. Provide each instrument panel requiring air with an adjustable filter/regulator assembly with gauge and an air manifold to provide air to pneumatic instruments.
      c. Filter all air to 5 micron maximum particle size.
      d. Provide low pressure switch to alarm on insufficient air supply.

2.07 ACCESSORIES

A. Provide flow conditioning devices or other required accessories if necessary to meet the accuracy requirements in the Contract Documents.

B. Nameplates:
   1. Provide a nameplate for each controller, instrument transducer, instrument power supply, solenoid, or any other control device located either in the field or within panels.
   2. All nameplates shall be of identical style, color, and material throughout the facility.
   3. Device nameplates shall include:
      a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings:
         1) Device tag and loop number ID (e.g., FIT-2651).
         2) PLC ID (e.g., RTU-207).
         3) Power information (e.g., RTU-207, 120VAC).
      b. White lettering on a black background, laminated plastic.
   4. All instruments shall be equipped with Type 316 stainless steel nameplate with the instrument tag stamped in 3/8-inch letters and connected to the instrument using Type 316 stainless steel wire.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the Specifications.

B. Arrange with all manufacturers of the equipment and fabricators of panels and cabinets, to allow the Owner and Engineer to inspect and witness the testing of the equipment at the site of fabrication:
   1. Equipment includes the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices.

C. Source Test is specified in Section 17950.

PART 3 EXECUTION

3.01 EXAMINATION

A. The SCADA Subcontractor and ICSC are required to attend a pre-bid conference and examine the premises completely before bidding. It is the SCADA Subcontractor and ICSC's responsibility to be fully familiar with the existing conditions and local requirements and regulations.

B. Review the existing Site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

C. Provide a complete instrumentation and control system:
   1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, and process control and instrumentation system.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Equipment locations indicated on the Drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions as indicated on the Drawings:
      a. Actual field conditions govern all final installed locations, distances, and levels.
   2. Review all information indicated on the Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical, instrumentation, and mechanical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.

3. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.

B. Perform all related Electrical Work in accordance with the applicable sections of the Electrical Specifications.

C. The PCIS configurations are diagrammatic:
   1. The locations of equipment are approximate unless dimensioned.
   2. Where Project conditions require, make reasonable changes in locations and arrangements.

D. Field instruments installation:
   1. Install field instruments as specified in the Contract Documents, API RP 550 and RP 551, and the manufacturer's instructions.
   2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
      a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.
      b. Provide sun shields for all field electronic instruments exposed to direct sunlight.
   3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
      a. Type of flexible conduit required for the area classification:
         1) Area classification as specified in Section 16050.
      b. Maximum length of 18 inches.
   4. Connect field instruments with cable as specified in the Electrical Specifications, except when the manufacturer requires the use of special cable, or otherwise specified in this Section:
      a. Special cable applications shall be in accordance with the NEC.
   5. Verify the correctness of each installation:
      a. Polarity of electric power and signal connections.
      b. Ensure all process connections are free of leaks.

E. Process sensing lines and air tubing:
   1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
   2. Provide supports for rigid tubing at intervals of not more than 3 feet.
   3. Slope horizontal runs of instrument tubing at a minimum of 1/16th inch per foot to allow for draining of any condensate.
   4. Bends:
      a. Use proper tool.
      b. Make bends for parallel lines symmetrical.
      c. Make bends without deforming or thinning the walls of the tubing.
   5. Square-cut and clean all ends of tubing before being inserted in the fittings.
   6. Provide bulkhead fittings at all panels requiring pipe and/or tubing entries.
   7. Use stainless steel tubing for all piping hard piped from the air header, unless otherwise indicated on the Drawings or not compatible with the fluids or atmosphere in the area:
      a. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times maximum travel of the equipment.

F. Conduit, cables, and field wiring:
   1. Provide all PCS equipment cables, and process LAN communication networks under the Instrumentation and Control Specifications.
   2. Provide terminations and wire identification as specified in the Electrical Specifications.
   3. Protect all wiring from sharp edges and corners.
   4. Provide all conduits, fittings, boxes, etc. in accordance with all the requirements of the Electrical Specifications.

G. Equipment tie-downs:
   1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the Site.
   2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., shall be permanently mounted and tied down to structures.

H. Instrument tagging:
   1. As specified in Section 16075.
   2. Provide all field-mounted instruments with nameplates:
      a. Nameplates engraved with the instrument's full tag number as indicated on the Drawings:
         1) Affix tags with stainless steel wire fasteners.
   3. Provide all back of panel instruments with nameplates:
      a. Engraved with the instrument's full tag number as indicated on the Drawings:
   4. Provide all front of panel instruments with a nameplate.
   5. Provide all front of panel instruments with a nameplate:
      a. Engraving to include the following:
         1) Instrument's full tag number.
         2) Service description.
      b. Nameplates:
         1) Secure nameplates to the panel with stainless steel screws.
         2) Use an accepted adhesive if screws would violate the NEMA or other ratings of the enclosure.

I. Cable and conductor termination:
   1. Terminate all cables and conductors on terminal blocks.
   2. Terminal block enclosures:
      a. Suitable for the area classification as specified in Section 16050.

J. Surge protection:
   1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments.
   2. Individually fuse each 4 to 20 milliamperes direct current loop with a 1/16 ampere fuse between power supplies and receiver surge protectors.
   3. Provide voltage surge protection for 4 wire transmitters and analyzers:
      a. Protect both power source and signal loop.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756.

B. Owner Training:
   1. Demonstration requirements are specified in Section 17950.
   2. General:
      a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.
      b. Conduct all training at the Project Site unless another location is approved by the ENGINEER and OWNER:
         1) Include instruction on the use of all maintenance equipment and special tools provided under the Contract.
      c. Tailor training classes to the specific needs of the class participants:
         1) Develop separate courses for operators, maintenance staff, and supervisors:
            a) The specific categories and number of personnel in each category are identified below.
         2) Furnish training courses that are a combination of classroom and hands-on training:
            a) To the greatest extent possible, utilize components from the Owner's PCS system.
            b) Limit classes that include extensive hands-on activities to a maximum of 5 students per class.
         3) Present the minimum number of sessions, specified in Table 17050-3.10-T1, for each course in order to satisfy class size restrictions and limitations scheduling Owner staff.
         4) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.
      d. Schedule individual training classes:
         1) Complete training for maintenance personnel 90 days before Process Operational Period.
         2) Complete operator training classes before process start-up of the control system software, or any part of it:
            a) As specified in the Sequencing article of this Section.
         3) Schedule follow-up training classes after the PCS start-up on a schedule determined by the Owner.
      e. Instructor qualifications:
         1) Highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:
            a) Instructor qualifications are subject to the approval of the Engineer.
         2) Furnish training instructors thoroughly familiar with the PCIS system, who are members of the implementation team.

3) One of the individuals conducting the PCIS training course must be the same individual responsible for the majority of the programming that was performed for the instrumentation and control system.

3. Training manuals and materials:
   a. Furnish training manuals and other materials for training courses.
   b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.
   c. The manuals are to serve as teaching aids during presentation of the training classes.
   d. Manuals are to serve as reference material after the training has been completed.

Table 17050.3.10-T1				
Course Title	**Minimum Course Length (days per session)**	**Personnel (Estimated Number of Students)**	**Minimum Number of Sessions**	**Responsible Party**
Operator Training – Basic (PLC, SCADA, & Control System)	1	12	1	SCADA Subcontractor
Operator Training – Advanced (PLC, SCADA, & Control System)	1	12	1	SCADA Subcontractor
PLC/SCADA Software and Networking Training	1	8	1	SCADA Subcontractor
Vendor Packages (includes panel hardware, software, and equipment)	1	8	1	Vendor/Suppliers (Per Vendor)
Follow-up Training (mutually developed class)	1	5	5	Contractor and SCADA Subcontractor
Instrument Training	2	5	1	ICSC

4. Training course requirements:
   a. System overview training:
      1) Furnish training courses that give the Owner's supervisory level personnel an overview of all elements of the PCIS system that focus on the overall functional aspect of elements of the control system and provide an understanding of the interaction of the various components.
   b. Operator training:
      1) Furnish training courses that instruct system operators in the efficient operation of Contractor-provided aspects of the PCIS that include not only the general operation of each control system but also the operation of specific system features.
      2) Operator's training shall include the following:
         a) Control system overview: Architecture, equipment functions, software components, etc.
         b) Display navigation, overview, and types of displays.
         c) Process and equipment monitoring and control: Basic principles and operation.

d) Logging ON and OFF the system and description of the security and access system.
e) Alarm subsystem.
f) Trending: Provide a thorough session on how to use all trending functions.
g) Reports: How to access, print, and review content.
h) Control strategies: Present an average 15-minute review of each control strategy, including a hands-on demonstration of screens and operator functions for each.

c. PLC hardware training:
1) Furnish training on PLC hardware and on related components, including battery backup equipment, UPSs, LOI hardware, control circuits, and analog circuits.
2) Furnish training on PLC hardware principles, product features, proper installation, operation, troubleshooting, and maintenance.
3) PLC training may be provided by manufacturer's certified trainers.

d. PLC software training:
1) Furnish training on PLC software.
2) Two types of training are required, basic and project-specific:
a) Basic PLC software training covers the principles of PLC programming and the specific features and function of the PLC products used on this Project, provided by one of the PLC manufacturer's certified trainers.
b) Project-specific PLC software training covers the programming conventions, new standardized software modules, specific control strategy programs, and documentation created for the Work performed under this Contract. This training includes the specific knowledge needed to modify, expand, duplicate, troubleshoot, and repair the PLC programs provided under this Contract, provided by an individual who is thoroughly familiar with the delivered system, and is one of the senior programmers who programmed the PLCs for this Project.

e. Network equipment training:
1) Furnish basic training on all network hardware, switch and router configuration and software, and network monitoring software.
2) Include a detailed description and explanation of the installed network architecture, media, and functions.
3) Furnish an overview of the function and operation of each piece of network equipment.
4) Furnish training on network maintenance troubleshooting and repair.
5) Furnish training on how to install spare or off-line backup equipment.

f. Follow-up training:
1) Provide a series of on-site follow-up training classes beginning after process start-up of the SCADA/PCIS system. The intent for these classes is to provide the Owner's personnel the opportunity for a review and "refresher" of the training topics and material after they have had some experience using the system.
2) Mutually schedule and develop the content of these classes with the Owner no later than 1 month before the beginning of the first session:
a) Schedule at the Owner's discretion on non-consecutive days spaced out over the process start-up and warranty period.

g. Instrumentation training:
    1) Furnish training covering all instruments and control panels.
    2) Furnish the specified quantity of training, allocated to cover new instruments and hardwired controls as specified in this Section and specifically determined in the accepted training plan.
    3) Train maintenance staff in the use, cleaning, calibration, maintenance, and troubleshooting of all the instruments furnished within this Project.
    4) Furnish training on the operation of new hardwired controls.
h. Analytical instrument training:
    1) Furnish training covering all analytical instruments.
    2) Furnish the specified quantity of training, allocated to cover new analytical instruments as specified in this Section and specifically determined in the accepted training plan.
    3) Train maintenance staff in the use, cleaning, calibration, maintenance, and troubleshooting of all the analytical instruments furnished within this Project.
    4) Provide training by manufacturer.

5. Recording training sessions:
    a. Record all training.
    b. Produce audio-visual presentations by recording the actual training sessions of the Owner's personnel.
    c. Furnish digital video disk (DVD) format.
    d. These disks become the property of the Owner and cover, in detail, the training for the specific hardware and software of all the systems provided for the Project.
    e. Provide all the necessary cameras and recording equipment.

3.08 FIELD QUALITY CONTROL

A. Inspection:
1. Allow for inspection of PCIS installation as specified in Section 01450.
2. Provide any assistance necessary to support inspection activities.
3. Engineer inspections may include, but are not limited to, the following:
    a. Inspect equipment and materials for physical damage.
    b. Inspect installation for compliance with Drawings and Specifications.
    c. Inspect installation for obstructions and adequate clearances around equipment.
    d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
    e. Inspect equipment nameplate data to verify compliance with design requirements.
    f. Inspect cable terminations.
    g. Inspect/witness instrument calibrations/verifications.
4. Inspection activities conducted during construction do not satisfy inspection requirements specified in Section 17950.

B. Instrument Installation Inspection:
1. Provide any assistance necessary to support inspection activities.
2. Inspections may include, but are not limited to, the following:
    a. Inspect equipment and materials for physical damage.

b. Inspect the installed arrangement, lay lengths, orientation, piping obstructions etc. that could affect the instruments accuracy or repeatability.
c. Inspect installation for compliance with Drawings and Specifications.
d. Inspect installation for obstructions and adequate clearances around equipment.
e. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
f. Inspect equipment nameplate data to verify compliance with design requirements.
g. Inspect cable terminations.
h. Inspect/witness instrument calibrations/verifications.

3. Inspection activities conducted during construction do not satisfy inspection requirements specified in Section 17950.
4. Field acceptance testing: (Functional Testing) is specified in Section 17950. Additional general requirements are specified in Section 01756.

C. Installation supervision:
1. Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum, the ICSC shall provide the following services:
a. Installation resources:
1) Coordinate with the Contractor regarding installation requirements of the Contract Documents.
b. Provide technical assistance to installation personnel by telephone:
1) Furnish installation personnel with at least one copy of the accepted submittals, including all installation details.
c. Periodic inspections during the construction period.
d. A complete check of the completed installation to ensure that it is in conformance with the requirements of the equipment manufacturer and the Contract Documents.
e. Field verify accuracy and calibration of all instruments.

3.09 ADJUSTING

A. Control valves:
1. Stroke all control valves, cylinders, drives and connecting linkages from the control system as well as local control devices and adjust to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position.
2. Check control valve actions and positioner settings with the valves in place to ensure that no changes have occurred since the bench calibration.

B. Make all revisions necessary to the control system software, as directed by the Engineer:
1. It is understood that the Contractor knows and agrees that changes will be required in the control system software during the Source Testing, Functional Testing, Process Operational Period, Process Start-up and during the Project Correction Period.

3.10 CLEANING

A. As specified in Section 01770.

B. Vacuum clean all control panels and enclosures before process start-up and again after final completion of the project.

C. Clean all panel surfaces.

D. Return to new condition any scratches and/or defects.

E. Wipe all instrument faces and enclosures clean.

F. Leave wiring in panels, manholes, boxes, and other locations in a neat, clean, and organized manner:
   1. Neatly coil and label all spare wiring lengths.
   2. Shorten, re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.

G. As specified in other sections of the Contract Documents.

3.11 PROTECTION

A. Protect all Work from damage or degradation until date of Substantial Completion.

3.12 SCHEDULES (NOT USED)

END OF SECTION

PRE-NEGOTIATED PROPOSAL FROM HSQ TECHNOLOGY

SECTION 17050:

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

HSQ TECHNOLOGY

26227 Research Road
Hayward, California 94545-3725
http://www.hsq.com
Telephone: (510) 259-1334 ◆ *Facsimile: (510) 259-1392*

By Email: mhollerbach@carollo.com
jwickstrom@carollo.com

April 18, 2017

Carollo Engineers, Inc.
10822 W. Toller Drive, Suite 200
Littleton, CO 80127

Attention: Matthew Hollerbach, EI
James Wickstrom

Reference: **Secondary Clarifier No. 5 and Denitrification Project**
City of Turlock, CA
HSQ Quote No. 1610-0019-SC-B

Matthew & James:

HSQ Technology is pleased to offer you a revised quote for the RTU modifications of the existing RTU-30 (Filter Pump Station) and RTU-207 (Electrical Building No. 7). Additionally, HSQ will provide new RTU-207A (West Aeration Basins) and RTU-208 (North Aeration Basins).

HSQ will provide the engineering, database and graphics, programming, and field startup required to add 326 new I/O points into the current Turlock SCADA system.

Below is a listing of all included items in this scope of work:

Included: Existing RTU-30 Additions

- One (1) HSQ 1332, 8-Ch Relay Output Board
- One (1) HSQ 6224, 4-Ch Analog Output/4-Ch Digital Input Module
- One (1) HSQ 3010, 8-Ch Analog Input/8-Ch Digital Input/4-Ch Digital Output Module
- Twelve (12) 24V Relays
- Eight (8) Loop-Powered Isolators
- Terminal blocks, etc. as needed.

Included: Existing RTU-207 Additions

- One (1) HSQ 2509, 32-Ch Digital Input Board
- One (1) HSQ 2548, 16-Ch Relay Digital Output Board
- Three (3) 6224, 4-Ch Analog Output/4-Ch Digital Input Module
- Twelve (12) Eight (8) Loop-Powered Isolators
- Terminal blocks, etc. as needed

Included: New RTU-207A

- One (1) 72"H x 60"W x 24"D NEMA 12 Enclosure with Door-Operated Light Kit, Folding Shelf, Fan Package and Thermostat
- One (1) HSQ 25x86 Processor
- One (1) HSQ 2585 Power Control Board
- Two (2) 12VDC 75aH Back-Up Batteries
- One (1) HSQ 2509, 32-Ch Digital Input Board
- One (1) HSQ 1332, 8-Ch Relay Output Board
- One (1) HSQ 2548, 16-Ch Relay Digital Output Board
- Three (3) HSQ 2508, 32-Ch Analog Input Board
- Five (5) 6224, 4-Ch Analog Output/4-Ch Digital Input Module
- Ninety-Six (96) Loop-Powered Isolators
- One (1) HSQ 2511, Power Box Assembly
- One (1) HSQ 2592, Communication Board
- One (1) 8-Port Managed EtherNet Switch
- One (1) Surface-Mount Multimedia Outlet System with 3 Duplex SC Fiber Adapters
- One (1) 27V, 11A Power Supply
- Terminal blocks, etc. as needed

Included: New RTU-208

- One (1) 72"H x 60"W x 24"D NEMA 12 Enclosure with Door-Operated Light Kit, Folding Shelf, Fan Package and Thermostat
- One (1) HSQ 25x86 Processor
- One (1) HSQ 2585 Power Control Board
- Two (2) 12VDC 75aH Back-Up Batteries
- Four (4) HSQ 2509, 32-Ch Digital Input Board
- One (1) HSQ 1332, 8-Ch Relay Output Board
- One (1) HSQ 2548, 16-Ch Relay Digital Output Board
- One (1) HSQ 2508, 32-Ch Analog Input Board
- Two (2) 6224, 4-Ch Analog Output/4-Ch Digital Input Module
- Thirty-Two (32) Loop-Powered Isolators
- One (1) HSQ 2511, Power Box Assembly
- One (1) HSQ 2592, Communication Board
- One (1) 8-Port Managed EtherNet Switch
- One (1) Surface-Mount Multimedia Outlet System with 3 Duplex SC Fiber Adapters
- One (1) 27V, 11A Power Supply
- Terminal blocks, etc. as needed

Included: Systems

- New/additional Database and Graphics
- Programming of New RTUs and modified programming of existing RTUs
- Two (2) Field Meetings
- Engineering
- Four (4) Weeks Onsite Startup
- Submittals
- Drawings – New RTUs
- Updated Drawings – Modified RTUs

Excluded:

- Blower Master Control Panel modifications to the PLC code to include the new Dissolved Oxygen instruments in Aeration Basins 1-7.
- Software modifications to any Non-HSQ products
- Installation and terminations of the RTUs
- UPS System
- Taxes (see Notes below)
- Bonds

Note:

- Sales tax is not included. Please let us know if you need this to be included and what taxes are required.

HSQ Technology offers the above listed scope of work for the **Lump Sum Price** of **$360,170.00**. This proposal will remain valid through September 30, 2017.

The warranty period commencing on the date of Final Acceptance (of HSQ's portion of work) is twelve (12) months.

If you have any questions or need additional information, please contact the undersigned at (800) 486-6684 or by email at est@hsq.com.

Sincerely yours,

HSQ TECHNOLOGY

Scott D. Cramer
Senior Estimator

SDC/ks

SECTION 17100

CONTROL STRATEGIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contractor-developed loop description submittal requirements.
   2. General programming requirements.
   3. Common control functions:
      a. General control and monitoring functions to be provided throughout the PCIS system:
         1) These requirements apply to all systems, and supplement the specific loop descriptions in Section 17101 and information indicated on the Drawings.

A. Related sections:
   1. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   2. Section 17101 - Specific Control Strategies.

1.02 REFERENCES

A. As specified in Section 17050.

1.03 DEFINITIONS

A. As specified in Section 17050.

B. Hardwired control: Control circuitry that does not utilize software to initiate functionality.

C. Hardwired interlocks: A safety or protective feature that will interrupt operation of the equipment in all operating modes with no required operator intervention.

D. Software interlocks: A safety or protective feature that will interrupt operation of the equipment when the RTU has control.

E. Slew rate: Rate of change in respect to time.

F. Clamp: Imposed upper and lower limits on setpoints to eliminate entries outside the allowable control parameters.

G. Watchdog timer: Timers imposed to test components such as discrete I/O to verify the health of the card.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. As specified in Section 17050.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 17050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

A. As specified in Section 17050.

B. General programming requirements:
   1. Use variable names or aliases derived from tag and loop identification on the P&IDs for all process values:
      a. Unless otherwise noted, utilize floating-point format for all RTU algorithms and calculations.
      b. Provide RTU logic to convert raw input values into engineering units in a floating-point format.
   2. Store all adjustable parameters in the RTU, and configure so that an operator with sufficient security access can change the parameters from the LOI or HMI. Update and display the current value at all locations, regardless of where the last change was made.
   3. Program slew rates for all setpoints to limit the effect of updated setpoints on the process:
      a. Provide for control setpoints and manual speed and position selections.
      b. Store new setpoints in one register, and gradually ramp the actual setpoint register at the slew rate until it reaches the new value.
      c. Provide operator access to change slew rates from the HMI.
   4. Saved setpoints:
      a. Provide an operator selection to save all setpoint values.
      b. Furnish 1 or more screens at the HMI that display the initial values for all setpoints defined during start-up and the value for each setpoint the last time they were saved.
      c. Provide an operator selection to restore all setpoints to the initial start-up value.
      d. Provide an operator selection to restore all setpoints to the last saved value.
   5. Store a copy of all adjustable parameters and accumulated and integrated totals in PCS:
      a. Upon re-loading of the RTU program, re-load these values to the RTU from PCS.
   6. Calculated values:
      a. Program calculations such that division by zero errors cannot occur.
      b. Prevent calculations from generating values that exceed the limits of the equipment or data type structures (integers) internal to the RTU.
      c. Configure counting functions (start counts and operation counts) to allow a minimum of 10,000 counts, and to roll-over to zero at an even decimal interval (1 followed by 4 or more zeros).
      d. Configure integrating functions to accurately accumulate the maximum rate from the instrument/equipment (totalizers, run time meters) for 30 years.

7. Timers:
    a. Provide programmable settling and proving timers in all control sequences for starting and stopping of equipment to allow the process to settle down before proceeding with any additional control functions:
        1) The settling timers may be overridden by setting the timer to 0 seconds.
    b. Embed the timers in the RTU logic, tune in the field, and list separately as part of the software submittal and O&M manual.
8. Control Panel status:
    a. Design the RTU system to function as a stand-alone unit that performs all of the control functions described herein completely independent from the functions of the PCS system PC-based operator interfaces:
        1) Failure of the PCS system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the RTU.
    b. Furnish a minimum of 1 screen that depicts the status of all enclosures containing RTUs or I/O in the control system, including but not limited to the following:
        1) Intrusion status on all enclosures equipped with intrusion switches.
        2) AC power failure:
            a) Monitor ahead of UPS.
        3) DC power supply failure:
            a) For redundant power supplies, alarm when either power supply fails.
        4) UPS failure signal.
9. RTU system communication status:
    a. Furnish a minimum of 1 screen to display all communication errors and status within the PCIS:
        1) Communication between PCS and RTUs, RTU to RTU, RTU to RIO, and RIO and/or PCS to VCP.
        2) Display status of each node, and summary of failures over the past 60 minutes.
    b. Generate a communications alarm if any communication fault is detected or there is no response from a node for more than a user specified time.
    c. In the event of communications loss:
        1) Continue normal operation at each RTU.
        2) Where control parameters are received over a communications link:
            a) If a link fails where process elements use the remote value for closed-loop control, hold operating status, speed and position, of the process elements at their last state before the communication alarm, unless other I/O local to that RTU indicates shutdown or over-ride conditions:
                (1) Ensure that the operator can control the process using PCIS HAND mode at the local LOI.
            b) If a link fails where process elements use the remote value to determine setpoints, settings or control levels, continue to operate using the last value received:
                (1) Provide a manual over-ride entry at the local LOI to allow an operator to enter a different value for any such remote signal.
                (2) Generate an alarm whenever an over-ride value is in use.

C. Common control functions:
   1. Incorporate common control functions into all control loops and devices and into the control programming, whether or not specifically shown in the specific control descriptions or elsewhere in the Contract Documents.
   2. Alarms:
      a. Generate alarms within the RTU logic.
      b. Indicate alarms at the LOI and HMI. Enable acknowledgement from either the HMI or the LOI.
      c. Generate high, high-high, low, and low-low level alarms where indicated:
         1) Provide an alarm reset deadband for each analog value to prevent excessive repeated alarms.
         2) Provide logic and timers to inhibit analog alarms based on process events. For example, inhibit low flow alarms when a pump is stopped, or has not been running long enough to establish flow.
      d. Flash all alarm and fail conditions and their respective indicators on the PCIS graphic screens and local indicating lights until the condition is acknowledged by the operator, even if the alarm condition is no longer present.
      e. Once the alarm is acknowledged by an operator, display alarm conditions in a steady state (not flashing) while the alarm condition is still present:
         1) Flash with a cycle rate of 1/2 second on and 1/2 second off.
      f. Once the alarm has been cleared and the operator has acknowledged the alarm or fail condition, turn the graphic alarm indicator off.
      g. For all alarms that do not have inherent timers, provide an operator-adjustable proving timer to limit nuisance alarms, continuously adjustable from zero seconds to 100 minutes. The initial setting of proving timers shall be zero seconds:
         1) The RTU shall start the timer when it first detects an alarm condition, and shall only activate the alarm after the timer has expired.
         2) If the alarm condition clears while the timer is running, the timer shall reset, and the alarm shall not be activated.
      h. Use interlocks and proving timers to prevent alarms from operating due to power loss, except for loss of power alarms.
      i. Furnish an alarm silence pushbutton at each PCM, LOI, or LCP with an audible alarm to signal the RTU to turn off the audible alarm until the next alarm occurs.
      j. Any alarm that is not acknowledged after a setpoint period of time shall activate the auto dialer.
      k. Lamp test: Furnish lamp test pushbuttons at each control panel with more than 10 pilot lights, that illuminates all pilot lights on the panel:
         1) The lamp test may sequence through blocks of lights.
         2) Minimum on time for each lamp during lamp test 15 seconds.
      l. Horns and Beacons:
         1) Activate PCM horn and beacon on all critical alarms and on other alarms as defined by the Facility Alarm Philosophy.
         2) Deactivate PCM horn and beacon when PCM reset pushbutton is activated.
         3) Silence PCM horn when PCM silence pushbutton is activated.
   3. Where a reset is shown for counts, totals and times maintained in the RTU:
      a. Provide a reset selection on the HMI screen that displays the value.
      b. Provide a preset function on the HMI to allow an operator-entered value to become the current accumulated total.

c. Limit access to the reset and preset functions to operators with suitable security level.
d. Log the value before reset, operator, time, and date of reset in the PCS archive.
e. Log the value before preset, preset value, operator, time, and date of preset in the PCS archive.

4. Where start counts are indicated on the Drawings, or required in this Section, count starts for each piece of equipment (off to on transitions of running status) in the RTU:
   a. Display total starts on PCIS screens, and provide a reset function.
   b. Where indicated, calculate number of starts for each day:
      1) Display current day and previous day starts on PCIS displays.
      2) Do not reset daily start count when overall count is reset.
      3) Archive starts for each day through PCS.
5. Where run time accumulation is indicated on the Drawings, or required in this Section, integrate accumulated run time to the nearest 0.1 hour whenever the running status input indicates that the equipment is running:
   a. Display total run time in hours on PCIS screens.
   b. Where indicated, calculate total run time for each day:
      1) Display current day and previous day run time on the HMI to the nearest 0.1 hour.
      2) Do not reset daily run time when overall time is reset.
      3) Archive run time for each day through PCS.
6. For all monitored analog values:
   a. Convert all values to engineering units in floating-point format within the RTU.
   b. Maintain trends in PCS.
   c. Totalize flows in the RTU logic:
      1) Where totalized flows are input to a discrete input, count input pulses and multiply by the volume per pulse.
      2) Where no totalizer input is shown, integrate the analog input over time.
      3) Display totals on the HMI and LOI.
      4) Archive totals to the historical database through PCS.
   d. Calculate hourly, daily, and monthly averages:
      1) Calculations may be performed by the RTU or PCS.
      2) Display averages on the HMI, and archive through PCS.
   e. Calculate minimum and maximum values for each hour, day, and month:
      1) Calculations may be performed by the RTU or PCS.
      2) Display minima and maxima on the HMI, and archive through PCS.
   f. Generate an alarm whenever an over-ride value is in use.
7. Analog data processing:
   a. Engineering units conversion:
      1) Use engineering units for all analog point values. Convert analog inputs to engineering units.
   b. Analog magnitude checking:
      1) Provide upper and lower limits to prevent operator-entered values (setpoints, etc.) from falling outside acceptable limits.

c. Analog value quality:
    1) Monitor analog values received at each RTU from analog inputs or communications from another RTU or RIO, and generate alarms for the following conditions:
        a) Rate of change in excess of acceptable limit:
            (1) Provide a separate rate limit for each value.
        b) Stale value:
            (1) For analog signals that come from analog inputs or calculations using analog inputs, which are expected to have some variation each time the input is read, alarm when there is no change in the value for 10 times the normal expected scan or communication update.

8. Analog device override (LOI and HMI):
    a. Provide the following functions from the HMI and the local LOI for each and every analog input:
        1) An over-ride value to be used in place of the analog input:
            a) Enter in engineering units:
                (1) Display the calibrated range in engineering units.
                (2) Only allow entries within the calibrated range of the instrument.
            b) When the analog input is enabled, track the analog input so that the over-ride matches the analog input value when the input is initially disabled.
            c) Maintain over-ride status and value in the RTU.
            d) Only allow access to over-ride selections and settings to operators with sufficient security.
        2) An enable/disable selection:
            a) When enabled, the value used by the PCIS system is equal to the analog input value.
            b) When disabled, the analog input is ignored, and the over-ride value is used for all control and display functions.
            c) Generate an alarm whenever an analog input is disabled.
            d) Enter a value for the analog input from the PCIS system to the RTU.
        3) Use the over-ride value for all display and control functions instead of the actual analog input value.
    b. Provide the following functions in the RTU, with selections and value entry from the HMI and/or LOI:
        1) An over-ride value to be used in place of the normal output value:
            a) Enter in percent of output span.
            b) When the analog output is enabled, track the analog input so that the over-ride matches the analog output value when the output is initially disabled.
        2) An enable/disable selection:
            a) When enabled, the value sent to the output is the value determined by the RTU based on the control logic or operator-entered value in PCIS HAND.
            b) When disabled, the calculated PCIS HAND values are ignored, and the over-ride value is sent to the output.
            c) Generate an alarm whenever an analog output is disabled.

9. Tank and vessel levels:
    a. Display all tank and vessel levels as both a level (typically in feet) and a volume (typically in gallons):
        1) Some individual displays may be only level or volume, when agreed to by the Owner and Engineer during screen meetings.
    b. Monitor rate of change of volume on all tanks and vessels:
        1) Establish the maximum withdraw rate at which the volume should decrease (all pumps or feeders operating at maximum output). Generate an alarm whenever the volume decreases faster than this rate.
        2) Establish the minimum fill rate at which the volume should increase when filling. Generate an alarm whenever the volume increases faster than this rate. Verify tank and vessel level is fluctuating to verify the validity of the IO register. If it is determined the register is not active or failed in a manner that leaves a stagnant value generate an alarm.
10. I/O filtering and processing:
    a. Analog input filtering:
        1) For each analog input provide an adjustable first order filter, for the purpose of smoothing out spikes and other noise for analog transmitter input signals. By default, configure analog inputs with no filtering affect.
        2) Monitor analog input signal quality:
            a) Over range: The input value is above the normal range (typically over 21 mA).
            b) Under range: The input value is below the normal range (typically under 3 mA, indicating a probable broken connection).
            c) Generate alarms for over or under range inputs.
            d) Do not use over or under range values for control or calculation purposes:
                (1) Where a second instrument is provided to monitor the same condition (a redundant instrument, or additional instruments furnished for averaging or different operating modes), and has a valid signal, use that input for control.
                (2) Otherwise, hold all outputs affected by the signal at their last values before the signal went out of range.
        3) Digital input filtering (proving timer):
            a) Provide an adjustable time delay function (0-10 seconds) on discrete input for the purpose of de-bouncing.
            b) By default, discrete inputs shall be configured with de-bounce timers set to zero seconds.
11. Instrument scaling (HMI/LOI):
    a. Provide 1 or more maintenance screens to display ranges and trigger points for all field instruments:
        1) For analog instruments, use input scaling values in the RTU to determine minimum and maximum calibration points.
        2) For discrete instruments, display calibrated pick-up and drop-out values.

12. PCIS HAND-OFF-AUTO:
    a. Where indicated, provide HAND-OFF-AUTO and START-STOP selections in the PCIS, accessed from an LOI or HMI for operators with sufficient security, to provide the following operating modes:
        1) PCIS AUTO: The normal, automatic control mode of the strategy which allows full RTU control in response to process conditions and programmed sequences.
        2) PCIS HAND: Enables PCIS Manual control where control decisions are made by an operator through the PCIS START-STOP, OPEN/CLOSE, or other selections as indicated.
        3) PCIS OFF: Automated PCIS control is disabled and RTU calls for all associated equipment to stop and valves to close or go to their identified safe state.
        4) Program the RTU so that switching a strategy between AUTO and HAND (either direction) occurs with a smooth transition. Keep running or position status unchanged when control is switched to HAND until a change is requested using the operator selections (START, STOP, OPEN, CLOSE). Keep running and position status unchanged when control is switched to AUTO until the control logic determines a change is required.
13. Display the current status of all operator selections (PCIS HAND/AUTO, PCIS START/STOP, etc.) on LOI and HMI.
14. Permissives:
    a. Implement software permissives where indicated to place equipment in a safe condition in response to impending hazardous process conditions. Apply software permissives when equipment is operating in PCIS AUTO or PCIS HAND.
    b. Use hard-wired permissives for equipment protection where indicated.
15. Process control algorithms:
    a. Jog and hold: Unless otherwise indicated, use jog and hold control algorithms where possible:
        1) When the error between process variable and setpoint is beyond a setpoint deadband:
            a) Jog valve or ramp speed in the required direction for a preset “Jog Time” or until the process variable reaches or passes the setpoint.
            b) Then hold speed or position through a setpoint “Hold Time.”
            c) Continue alternating jog and hold until the error is less than the deadband.
        2) Provide operator access to Jog Time and Hold Time setpoints from the HMI.
    b. PID algorithms: Use where indicated, or where necessary to provide fast response:
        1) Provide a PID faceplate with the following displays and functions for each PID control algorithm:
            a) Display Output, CV.
            b) Display Setpoint, SP.
            c) Display Process Variable, PV.
            d) Allow for operator selection of Automatic or Manual control of the output.

e) Under Manual control of output allow the operator to enter the desired output value.
f) Allow for input of the 3 Proportional, Integral and Derivative tuning parameters.
g) Configure PID loops to prevent reset windup when controlled equipment is operating in Manual (local or PCIS), or when the equipment has reached a physical limit.
h) When controlled equipment is being operated in remote PCIS HAND, configure the PID function to track the process variable to provide a smooth transfer between Manual and Automatic modes.
i) Provide selectable slew rates with adjustable setpoints to allow the PID algorithm to slowly ramp to its final value to minimize system disturbance.

16. Equipment alternating and sequencing:
    a. Distribute number of starts and run time equally between identical equipment.
17. Motor control:
    a. Monitor the device's LOCAL-OFF-REMOTE (LOR) switch (the hard-wired switch at the MCC, drive or equipment) to determine when the RTU has control of the associated equipment:
        1) Display current REMOTE status on the PCIS screens.
    b. Monitor the device's running status from the starter auxiliary or run status input:
        1) Display the current status (running or stopped) on the PCIS screens.
        2) Use status to calculate total run time and daily run time, and to count total starts and daily starts.
        3) Provide time stamp for each start.
        4) For motors 200 HP and greater, provide software to prevent exceeding the manufacturer's recommended maximum starts per hour.
    c. When equipment control has been given to the RTU as reported by the LOCAL-OFF-REMOTE switch, allow selection of PCIS AUTO or PCIS HAND control modes based upon operator selection using the PCIS screens.
    d. Starting, stopping and running when the device LOR is in LOCAL:
        1) With the LOR switch in the LOCAL position, the motor is controlled by the START and STOP pushbuttons.
        2) With the LOR switch in the OFF position, the motor is prohibited from running.
        3) With the LOR switch in the REMOTE position, the motor is controlled remotely.
    e. Starting, stopping and running when the device LOR is in REMOTE:
        1) When the motor is expected to be running (RTU has issued a START or RUN due to process conditions or operator selection), LOR is in

REMOTE, and the device is not reported to be running, start an operator adjustable “Control Activation” timer:

a) Provide “Control Activation” timers for each piece of controlled equipment:
   (1) If the LOR and required running status do not change, and the RTU does not receive running status within the “Control Activation” time period:
      (a) De-activate the output.
      (b) Place the device in a “Failed” state.
      (c) Generate a “Failed to Respond” alarm.

2) When the motor is not expected to be running (RTU has issued a STOP or removed the RUN output), LOR is in REMOTE, and the device is reported to be running, start the “Control Activation” timer:
   a) If the LOR and required stopped status do not change, and the RTU does not lose the running status within the “Control Activation” time period:
      (1) Keep the RUN output off or the STOP output on.
      (2) Place the device in a “Failed” state.
      (3) Generate a “Failed to Respond” alarm.

3) Re-establish RTU control of a device in a “Failed” state only after the following:
   a) An operator turns the device’s LOR switch out of REMOTE, and back to REMOTE (i.e., REMOTE input to the RTU cycles off and back on).

f. Where motor winding high temperature switches or RTD temperature elements are shown, generate an alarm when high temperature is sensed (contact opens or temperature above the high alarm setpoint), but do not stop the motor unless otherwise indicated.

g. Control two-speed motors similar to other motors, except as listed below:
   1) Motor states are RUN-FAST, RUN-SLOW, and STOP.
   2) Start all two-speed motors in the RUN-SLOW state. If or when the high speed is required (RUN-FAST operator selection or process conditions), transition to RUN-FAST after a designated time.
   3) When transitioning from RUN-FAST to RUN-SLOW, remove the RUN-FAST output or issue a STOP, then wait for a “Fast to Slow” time delay before energizing the RUN-SLOW or START-SLOW output.

h. Simultaneous starts:
   1) Prevent more than one motor-driven load 25 HP or larger in the same facility from starting concurrently:
      a) When starting one load, inhibit start logic for all other such equipment until the load being started is up to speed (RVSS or VFD), or after a setpoint time delay (full-voltage starters and miscellaneous equipment).
   2) Use the same logic to prevent multiple large devices from starting concurrently on restoration of power after a power outage, whether operating on generator or utility power.

i. Speed control:
   1) Modulate speed on VFD-driven motors using jog and hold, or PID control algorithms to maintain process conditions as described in the specific loop descriptions.

2) Operate speed control within a pre-defined range:
    a) Minimum speed as determined by equipment manufacturer. The higher of:
        (1) Minimum motor speed to maintain adequate cooling for the type of load driven (constant or variable torque).
        (2) Minimum equipment speed, such as minimum speed to deliver flow or to deliver minimum flow for equipment cooling or lubrication.
    b) Maximum speed 100 percent (60 hertz) or as identified by equipment manufacturer.
3) Where multiple equipment may operate together to maintain the same process condition:
    a) Provide an operator selection for starting sequence.
    b) Start the first equipment at a preset starting speed.
    c) When one or more equipment is running and the speed control algorithm reaches a preset “Start Next” speed value (initially 95 percent of speed range) through a preset time delay:
        (1) Start the next available equipment at the preset starting speed.
        (2) Ramp up the started equipment and ramp down the previously running equipment to the mid operating speed (adjustable in the RTU). Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with the new load running at the mid speed (for example if one pump is running and the second pump will be added, then the total flow of both pumps running at mid operating speed should be approximately the same as flow of one pump at Start Next speed).
        (3) Once both equipment reach the mid operating speed, resume the speed control algorithm for those equipment.
        (4) Operate all equipment at the same speed following the output of the speed control algorithm.
    d) When two or more pieces of equipment are running, monitor for a “Stop Next” condition:
        (1) Where flow rate is monitored, use a preset “Stop Next” flow rate for each possible number and combination of equipment:
            (a) Determine initial “Stop Next” speed based on the flow that can be provided with one fewer piece of equipment running at a speed slightly below the “Start Next” speed.
        (2) When the “Stop Next” condition exists through a preset time delay:
            (a) Ramp speed of running equipment except for the equipment to be stopped up to a preset value based on the number of items running. Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with one fewer load running (typically slightly below the preset “Start

Next" speed) while ramping speed of equipment to be stopped down to the preset minimum speed.
(b) Stop the load once it reaches minimum speed.
(c) Operate all remaining equipment at the same speed following the output of the speed control algorithm.

18. Gate and valve control:
    a. Monitor the device's LOCAL-STOP-REMOTE (LSR) switch(es) (the integral switch in the actuator or hard-wired switch at the local control station):
        1) Display current REMOTE status on PCIS screens.
    b. Start an "Open Activation" timer whenever the device is expected to be open (RTU has issued an OPEN command in PCIS AUTO, or OPEN was selected in PCIS HAND):
        1) Initially set "Open Activation" time to twice the normal opening time.
        2) If the LSR position and open command do not change, and the RTU does not receive fully open status feedback within the "Open Activation" time period:
            a) De-activate the open output.
            b) Place the device in a "Failed" state.
            c) Generate a "Failed to Open" alarm.
    c. Start a "Close Activation" timer whenever the device is expected to be closed (RTU has issued a CLOSE command in PCIS AUTO, or CLOSE was selected in PCIS HAND):
        1) Initially set "Close Activation" time to twice the normal closing time.
        2) If the LSR position and close command do not change, and the RTU does not receive fully closed status feedback within the "Close Activation" time period:
            a) De-activate the close output.
            b) Place the device in a "Failed" state.
            c) Generate a "Failed to Close" alarm.
    d. For modulating valves (valves controlled from either a 4-20 mA signal or digital communications command) with position feedback, start a "Position Error" timer whenever the position feedback differs from the required position command by more than a setpoint error when the LSR is in REMOTE:
        1) For analog modulating devices, error is determined by position feedback differing from position command by more than the setpoint error.
        2) For discrete modulating devices, error is determined by feedback not changing in the correct direction, or changing at less than a setpoint rate, when the OPEN or CLOSE RTU output is active.
        3) Initially set the "Position Error" time to 60 seconds.
        4) If the LSR position does not change, and position error stays outside of the setpoint error through the "Position Error" time period:
            a) Hold position output.
            b) Place the device in a "Failed" state.
            c) Generate a "Position Fail" alarm.
    e. Provide separate time delay settings for each function and for each device.
    f. If the valve position inputs indicate an impossible state (i.e., valve open and closed at the same time), place the device in a "Failed" state and generate an "Illegal State" alarm.

Re-establish RTU control of a device in a “Failed” state only after an operator turns the device’s LSR switch out of REMOTE and back to REMOTE (i.e., REMOTE input to the RTU cycles off and back on):

g. For all alarm conditions, control other devices (as stopping pumps, etc.) as stated in the individual loop descriptions to make the system safe.
h. For discrete modulating valves (valves positioned to intermediate positions to control process values through discrete OPEN and CLOSE outputs), count the number of actuations (OPEN or CLOSE commands) in the RTU:
    1) Display count on the HMI.
    2) Provide a reset function for the count.

19. Chemical systems (LOI/HMI):
    a. Provide the following chemical system screens:
        1) Where one LOI manages more than one chemical system, a main menu screen that will allow the operator to access the individual chemical system screens using software keys.
        2) One or more screens for each individual chemical system controlled at that location, containing:
            a) All status displays (running, failed, etc.).
            b) Selections (lead/lag, which process flow to pace to, etc.).
            c) Setpoint entry and display.
            d) Calculated feed requirement (result of flow pacing calculation) in engineering units (typically milligrams of chemical per minute).
            e) Output signal to feeder in percent of full span.
            f) Actual chemical flow rate from flowmeter (where shown).
            g) Process flow rate(s) used to pace each chemical on the individual chemical screens (PROC FLOW):
                (1) Where different process flows can be selected for flow pacing, display and identify the selected source.
        3) Chemical system calculations: Perform calculations as indicated on the Drawings and in the individual loop descriptions. Use the following assumptions, unless otherwise noted.
        4) Where chemical flow feedback is not used, assume feeder output is linear in response to control signal.
        5) Zero signal (typically 4 milliamperes) produces zero flow.
        6) Perform flow-pacing calculations using as indicated on the Drawings or described in the individual loop descriptions.
    b. Provide the setpoints and selections indicated on the Drawings and in the individual loop descriptions. Typical setpoints include:
        1) QMAX: Maximum calibration value:
            a) Chemical flow rate measured from calibration column at maximum feeder output (typically in gallons of solution per hour or milliliters of solution per minute).
        2) CONC: Chemical concentration:
            a) The concentration of the chemical in the solution to be fed, in engineering units (typically milligrams of chemical per liter of chemical solution).
        3) DENSITY:
            a) Density of the chemical solution to be fed in engineering units or as a specific gravity.
            b) Used to calculate the concentration of the chemical in the solution.

4) DOSE: Desired dosage:
a) Desired chemical concentration in the process stream in engineering units (typically milligrams of chemical per liter of process fluid).
5) FLOW SEL: Selection of process stream(s) for flow pacing.
6) OPEN/CLOSED LOOP:
a) Selection of method of controlling chemical flow-paced feed rate.
b) OPEN LOOP: Signal to feeder is based on feeder calibration (QMAX) to deliver calculated chemical solution feed rate. Chemical solution flowmeter is not used for control.
c) CLOSED LOOP: Chemical feed rate is directly controlled using the calculated chemical solution feed rate as the setpoint, and the flow rate from the chemical solution flowmeter as the process variable.

20. Breaker status:
a. Display the following data to the extent it is available from the specified device:
1) Open.
2) Closed.
3) Tripped.
4) Ground fault.
21. Power and starter information:
a. Retrieve data via power quality meters, motor protection relays, digital bus networks, or metering instruments, as indicated.
b. Display the following data to the extent it is available from the specified device:
1) Current:
a) A-Phase.
b) B-Phase.
c) C-Phase.
2) Volts:
a) A-Phase.
b) B-Phase.
c) C-Phase.
3) Reactive power.
4) Real power.
5) Apparent power.
6) Power factor.
c. For engine/generator system monitoring, also display percent of rated output.
22. Plant shutdown:
a. See Section 17101.
23. Power failure:
a. Retain all operating setpoints during power failure.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17101

SPECIFIC CONTROL STRATEGIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loop descriptions:
      a. Specific control requirements and functional descriptions for individual control loops.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.
      b. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.02 REFERENCES

A. As specified in Section 17050.

1.03 DEFINITIONS

A. As specified in Section 17050.

1.04 SUBMITTALS

A. Develop detailed loop descriptions based on the information in the Contract Documents, and submit as specified in Sections 01330 and 17050:
   1. For each control loop, provide a detailed functional description of the operation of the equipment, signals, and controls shown on the P&IDs:
      a. Include all functions depicted or described in the Contract Documents.
      b. Include the following within each loop description:
         1) All requirements specific to that loop.
         2) Common control requirements applicable to that loop.
         3) List of all ranges, setpoints, timers, values, counters, etc.
   2. Where there are similar loops with identical control, such as multiple loops for individual raw water pumps, only 1 loop description need be developed and the remaining loops may reference that loop description.

B. Loop description format:
   1. Loop number and title.
   2. References:
      a. List P&IDs that are specifically referenced.
   3. Abstract:
      a. General description of how the loop works, what devices are involved, and how the process will be controlled.
      b. Process values, setpoints, and limits, including units and ranges:
         1) Show span and range values for analog inputs and outputs, and operating point and deadband for discrete inputs.
   4. Hardwired control:
      a. Detailed description of the control functions at the local level.
      b. Function of local operator interfaces.
      c. Operation of hardwired field pilot controls:
         1) Pushbuttons.
         2) Selector switches.
         3) Potentiometers.
         4) Pilot lights, indicators, and other displays.
   5. Hardwired interlocks:
      a. Explanation of the operation of system interlocks and hardwired permissive conditions.
   6. PLC control:
      a. Detailed description of the control functions that are under control of the PLC.
      b. Operator controls and automatic controls.
      c. Setpoints, alarms, etc.:
         1) Include units and ranges for analog values.
         2) Include span and range for analog inputs and outputs.
         3) Include operating point and deadband for discrete inputs, and identify conditions where contacts are open, and when they close.
      d. Control sequences.
   7. Software interlocks:
      a. Operation of system software interlocks.
   8. LOI control:
      a. Detailed description of the operator controls.
   9. PCS control:
      a. Detailed description of the operator controls.
      b. Setpoints, alarms, etc.
   10. Indicators and alarms:
      a. List any indicators and alarms specific to the loop that are not covered in the common control strategies.
   11. Failure modes:
      a. List any failure modes specific to the loop that are not covered in the common control strategies.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 PROCESS AREA NO. 01

A. ML (Mixed Liquor) Flume Flow Control Gates:
   1. References:
      a. Process Area: 01.
      b. P&ID Drawing: 01N01.
      c. Mechanical Drawings: 01YS04.
      d. Specification Sections: 11294B, 13447.
   2. Mechanical Equipment:

Tag Number	Equipment Name
GAT-0441	Mixed Liquor Flume No. 4 Inlet Gate
GAT-0451	Mixed Liquor Flume No. 5 Inlet Gate
GAT-0461	Mixed Liquor Flume No. 6 Inlet Gate (Future)

   3. Abstract:
      a. The ML Flume downward opening weir gates control flow into the individual Parshall flumes.
   4. Local Controls and Instrumentation:
      a. Instruments and Protective Devices:
         1) Devices integral to gate actuators.
      b. Control Devices:
         1) Gate LOCAL/OFF/REMOTE selector switch (each gate).
         2) Gate OPEN/STOP/CLOSE selector switch (each gate).
      c. Indicators and Alarms:
         1) Parshall flume FLOW RATE indication (each Parshall flume).
         2) Parshall flume LEVEL indication (each Parshall flume).
         3) Gate PERCENT OPEN indication (each gate).
         4) Gate CLOSED indication (each gate).
         5) Gate actuator HIGH TORQUE alarm (each gate).
   5. MCC Controls and Instrumentation: None.
   6. SCADA Functions:
      a. Remote Controls:
         1) Remote Manual Mode:
            a) Set PERCENT OPEN for each gate.
            b) CLOSE for each gate.
      b. Screen Indicators and Alarms:
         1) Parshall flume FLOW RATE indication (each Parshall flume).
         2) Gate REMOTE indication (each gate).
         3) Gate PERCENT OPEN indication (each gate).
         4) Gate CLOSED indication (each gate).
         5) Gate actuator HIGH TORQUE alarm (each gate).

3.02 PROCESS AREA NO. 02

A. Secondary Clarifier No. 5 Sludge Collector Mechanism:
   1. References:
      a. Process Area: 02.
      b. P&ID Drawing: 02N01.
      c. Mechanical Drawings: 02M01, 02M02.
      d. Specification Section: 11353B.

2. Mechanical Equipment:

Tag Number	Equipment Name
SC-2651	Secondary Clarifier No. 5 Sludge Collector

3. Abstract:
   a. The secondary clarifier sludge collector mechanism collects settled sludge from Secondary Clarifier No. 5.
   b. The collector mechanism operates continuously while the clarifier is in use.
   c. LCP-2652 has HOA selector switches for the skimmer arm spray valve and weir washer valve. For both selectors, when the switch is HAND the valve will open. With the switch in OFF, the valves will not be permitted to run. With the switch in AUTO, the SCADA system will control the valve.
4. Local Controls and Instrumentation:
   a. Instruments and Protection Devices:
      1) Spray water electric ball valve.
      2) Weir washer electric ball valve.
      3) Skimming arm position switch.
      4) High torque switch.
      5) High-high torque switch.
      6) Shear pin limit switch.
      7) Motor winding temperature switch.
      8) Sludge blanket monitor.
   b. Local Control Devices:
      1) Clarifier:
         a) LOCAL-OFF-REMOTE selector
         b) START pushbutton.
         c) LOCKOUT-STOP pushbutton.
         d) Alarm SILENCE pushbutton.
         e) Alarm RESET pushbutton.
      2) Scum Spray:
         a) HAND-OFF-AUTO selector
      3) Weir Wash:
         a) HAND-OFF-AUTO selector
   c. Indicators and Alarms:
      1) Alarm horn.
      2) Alarm beacon.
5. MCC Controls and Instrumentation:
   a. Control Devices:
      1) Motor overload RESET.
   b. Indicators and Alarms:
      1) RUN indication.
      2) Common FAIL indication.
   c. Hardwired Interlocks:
      1) High-High Torque: Shut down and latch out the sludge collector mechanism and generate HIGH-HIGH TORQUE alarm.
      2) Shear Pin Failure: Shut down and latch out the mechanism and generate SHEAR PIN FAILURE alarm.
      3) Motor High Temperature: Shut down the mechanism and generate MOTOR HIGH TEMPERATURE alarm.
      4) Motor Overload: Shut down and latch out the mechanism and generate MOTOR OVERLOAD alarm. The mechanism latch out shall be maintained until the RESET pushbutton at the MCC is depressed.

5) When the equipment is latched out, it shall not start until the RESET pushbutton is pressed.

6. SCADA Functions:
   a. Remote Controls:
      1) Remote-Manual Mode:
         a) START-STOP control.
         b) Equipment runs continuously when started.
      2) Remote-Automatic Mode:
         a) None.
   b. Screen Indicators and Alarms:
      1) Clarifier:
         a) REMOTE indication.
         b) RUN indication.
         c) RUN time indication.
         d) Sludge blanket depth indication.
         e) HIGH Sludge blanket depth alarm.
         f) LOW Sludge blanket depth alarm.
         g) HIGH TORQUE alarm.
         h) HIGH-HIGH TORQUE alarm.
         i) SHEAR PIN FAIL alarm.
         j) MOTOR HIGH TEMPERATURE alarm.
         k) MOTOR OVERLOAD alarm.
      2) Scum Spray:
         a) AUTO indication.
         b) DURATION indication
      3) Weir Wash:
         a) AUTO indication.
   c. DURATION indication. Software Interlocks:
      1) Each time the skimming arm trips the skimmer arm position switch, the electric ball valve opens for the duration of the timer (operator adjustable setpoint: 0 to 120 seconds; default = 30 seconds).
      2) The weir wash valve shall open based on a daily repeat cycle timer for an operator adjustable duration setpoint: (0 to 12 hours; default = 4 hours).

B. Secondary Scum Pumps:
   1. References:
      a. Process Area: 02.
      b. P&ID Drawing: 02N01.
      c. Mechanical Drawings: 02M01, 02M02.
      d. Specification Section: 11312K.
   2. Mechanical Equipment:

Tag Number	Equipment Name
PMP-2655	Secondary Scum No. 5 Pump No. 1.
PMP-2656	Secondary Scum No. 5 Pump No. 2.

   3. Abstract:
      a. Scum collected by the Secondary Clarifier No. 5 mechanism is discharged into a scum collection box containing two submersible pumps.
      b. The secondary scum pumps discharge to the Primary Influent Flume to Flotators No. 1 and No. 2 through the secondary scum pipeline that also collects flow from Secondary Clarifier No. 4.

c. The pumps can be started and stopped locally by the operator using the HAND/OFF/AUTO (HOA) switch.
d. In HAND position, the pumps will run continuously.
e. In OFF position, the pumps will stop.
f. In AUTO position, the pumps are controlled automatically by the vendor control panel (VCP). The pumps will start and stop based on level setpoints as determined by an indicating analog controller connected to a submersible pressure transducer in the wet well. The pumps will alternate lead and lag positions automatically.

4. Local Controls and Instrumentation:
   a. Instruments and Protective Devices:
      1) Each Pump:
         a) Motor winding high temperature switches.
         b) Motor moisture detection sensors.
         c) Pump protection module (in panel above wet well).
      2) Wet Well:
         a) Submersible pressure transducer.
   b. Indicators and Alarms:
      1) None.
5. Vendor Control Panel (VCP):
   a. The scum pumps are controlled by a VCP with an integrated controller and hardwired controls. See Section 11312K for additional information.
   b. VCP Control Devices:
      1) Each pump:
         a) HAND-OFF-AUTO selector.
         b) LOCKOUT-STOP pushbutton.
         c) RESET pushbutton.
         d) LEAD/LAG selector switch.
      2) Wet well:
         a) Level indicating controller.
   c. VCP Indicators and Alarms:
      1) RUNNING pilot light for each pump.
      2) FAULT pilot light for each fault condition for each pump:
         a) Pump fault is defined as motor overload, high temperature, or excessive moisture.
      3) Sump level indication.
      4) HIGH LEVEL ALARM pilot light.
      5) LOW-LOW LEVEL ALARM pilot light.
      6) Run time indication.
   d. VCP Interlocks:
      1) Low-Low Level: Shutdown the pump in all modes of operation and generate LOW-LOW LEVEL alarm. Do not latch out.
      2) Motor High Temperature: Shutdown and latch out the pump in all modes of operation and generate MOTOR HIGH TEMPERATURE alarm.
      3) Moisture Detection: Shutdown and latch out the pump in all modes of operation and generate MOTOR HIGH TEMPERATURE alarm.
      4) Motor Overload: Shut down and latch out the mechanism and generate MOTOR OVERLOAD alarm.
      5) When the pump is latched out, it shall not start until the RESET pushbutton is pressed.

e. Control Functions: The VCP provided with the pumps shall contain the following control functions:
   1) Off: With the HAND/OFF/AUTO selector switch in the OFF position, the pump is prevented from running.
   2) Hand Control: With the HAND/OFF/AUTO selector switch in the HAND position, the pump will run.
   3) Automatic Control: With the HAND/OFF/AUTO selector switch in the AUTO position, the pump will run based on sump level as specified below:
      a) Operation of the pumps is based on signals received from the level indicating controller connected to the submersible pressure transducer:
         (1) High Level (Elev. 95): Start the lead pump.
         (2) High-High Level (Elev. 96): Start the lag pump and generate High-High alarm.
         (3) Low Level (Elev. 75): Stop the lead and lag pumps.
         (4) Low-Low Level (Elev. 74): Generate Low-Low alarm.
      b) Provide an alternator to switch lead-lag operation of the pumps after every pump down.

6. MCC Controls and Instrumentation: None.
7. SCADA Functions:
   a. Remote Controls: None.
   b. Screen Indicators and Alarms:
      1) Each Pump:
         a) PUMP IN AUTOMATIC.
         b) PUMP IN RUNNING.
         c) PUMP FAULT.
      2) Wet Well:
         a) HIGH-HIGH LEVEL alarm.
         b) LOW-LOW LEVEL alarm.
         c) Level indication.

3.03 PROCESS AREA NO. 03

A. Return Activated Sludge (RAS) Flow Control:
   1. References:
      a. Process Area: 03.
      b. P&IDs: 03N01.
      c. Mechanical Drawings: 03M01, 03M02.
      d. Specification Sections: 13443, 13447, 15116.

      Mechanical Equipment:

Tag Number	Equipment Name
VAL-2651	Secondary Clarifier No. 5 RAS Flow Control Valve.
VAL-2661	Secondary Clarifier No. 6 RAS Flow Control Valve (Future).

   2. Abstract:
      a. The return activated sludge (RAS) flow rate from the Secondary Clarifier No. 5 to the RAS Pump Station wet well will be controlled with a modulating plug control valve.
      b. During normal operation, the valve will modulate to meet a target flow setpoint. The setpoint can be a discrete value input by the operations staff or a varying setpoint defined as a percentage of the process influent flow (Q).

3. Local Controls and Instrumentation:
    a. Instruments and Protective Devices:
        1) Magnetic flow meter.
        2) Devices integral to valve actuator.
    b. Control Devices:
        1) LOCAL-OFF-REMOTE selector switch.
        2) OPEN-STOP-CLOSE push buttons.
    c. Indicators and Alarms:
        1) Valve OPEN indication.
        2) Valve CLOSED indication.
        3) Valve operator TROUBLE alarm.
        4) Flow indication.
4. MCC Controls and Instrumentation: None.
5. SCADA Functions:
    a. Remote Controls:
        1) Selection of REMOTE MANUAL or REMOTE AUTO modes can be made through SCADA.
        2) Remote-Manual Mode:
            a) Valve position control.
        3) Remote-Automatic Mode:
            a) Provide a selector switch so the operator can choose one of two operational modes: CONSTANT RAS FLOW SETPOINT mode or PROPORTIONAL RAS FLOW SETPOINT mode.
            b) CONSTANT RAS FLOW SETPOINT:
                (1) Provide operator-adjustable RAS flow setpoint for Secondary Clarifier No. 5. Allowable setpoint range shall be as follows: 0.5 mgd to 6.0 mgd; default 5.0 mgd.
                (2) Modulate the RAS flow control valve to maintain the RAS Flow Setpoint measured by the corresponding RAS flow meter.
            c) PROPORTIONAL RAS FLOW SETPOINT:
                (1) Provided operator-adjustable setpoint for desired percentage of influent flow to Secondary Clarifier No. 5 measured by Mixed Liquor Flume No. 5 (20 percent to 50 percent; default of 33 percent).
                (2) Modulate the RAS flow control valve to maintain the RAS Flow Setpoint measured by the corresponding RAS flow meter.
                (3) The RAS Flow Setpoint that is calculated by multiplying the operator input percentage of influent flow by the flow measured at Mixed Liquor Flume No. 5.
            d) The RAS control valve will fail in last position on loss of flow signal from the associated RAS flow meter, associated mixed liquor flume, or any other failure that could impact valve operation.
    b. Screen Indicators and Alarms:
        1) REMOTE indication.
        2) Valve position.
        3) Valve CLOSED indication.
        4) Valve operator TROUBLE alarm.
        5) RAS flow rate indication.

c. Software Interlocks:
   1) Maintain Secondary Clarifier No. 5 RAS Flow Control Valve fully open when RAS Pump No. 1 is operating in Setpoint Flow Control Mode or Proportional Setpoint Flow Control Mode.

B. Return Activated Sludge (RAS) Pumps:
   1. References:
      a. Process Area: 03.
      b. P&IDs: 03N01, 03N02.
      c. Mechanical Drawings: 03M01, 03M02.
      d. Specification Sections: 11312G.
   2. Mechanical Equipment:

Tag Number	Equipment Name
PMP-2711	RAS Pump No. 1.
PMP-2721	RAS Pump No. 2.
PMP-2731	RAS Pump No. 3 (Future).

   3. Abstract:
      a. The RAS pumps withdraw RAS from the Secondary Clarifier No. 5 RAS Pump Station No. 2 wet well and pump it into the RAS discharge pipeline. Pumped RAS flow is combined with RAS pumped by the Secondary Clarifier No. 4 RAS Pump Station before it is discharged to the Biotower Effluent Boxes where it is mixed with Biotower effluent and distributed to the aeration basins.
      b. The pumping system includes 2 submersible pumps. Space in the pump station is provided for a future pump that will serve future Secondary Clarifier No. 6.
      c. A pipeline connects the Secondary Clarifier No. 5 RAS Pump Station to a RAS low pressure RAS piping system connected to Secondary Clarifier Nos. 1-4 RAS piping and the Biotower Pump Station. This piping system can be used in two ways:
         1) To return RAS flow from the Secondary Clarifier No. 5 RAS Pump Station to the Biotower Pump Station.
         2) To fill the Secondary Clarifier No. 5 RAS Pump Station wet well with RAS withdrawn from other secondary clarifiers.
      d. Under normal operation, the two pumps will operate in a level setpoint control mode where the flow pumped out of the RAS wet well equals the flow entering the pump station:
         1) If flows entering the RAS pump station wet well are less than the minimum flow rate of one pump, the lead pump will cycle on and off according to operator adjustable setpoints.
         2) Level control mode is the default mode of operation.
      e. The pump station can also be operated in two different flow setpoint control modes:
         1) In Setpoint Flow Control Mode, the pump station pumps a constant flow rate input by the operator.
         2) In Proportional Flow Control Mode, the pump station pumps a variable flow rate that is a constant fraction of the influent flow to Secondary Clarifier No. 5.
      f. A low-low level interlock for each pump is activated by a level indicating controller connected to a submersible pressure transducer in each well.

4. Local Controls and Instrumentation:
    a. Instruments and Protective Devices:
        1) Each pump:
            a) Submersible pressure transducer.
            b) Motor winding temperature switch.
            c) Motor moisture detection sensors.
        2) Each pump discharge:
            a) Magnetic flow meter.
    b. Control Devices:
        1) Each pump:
            a) LOCK-OUT/STOP pushbutton.
    c. Indicators and Alarms:
        1) Each pump:
            a) Level indicating controller.
        2) Each pump discharge:
            a) Flow rate indication.
5. VFD Panel Controls and Instrumentation:
    a. Control Devices:
        1) LOCAL/OFF/REMOTE selector switch.
        2) START push button.
        3) LOCK-OUT/STOP push button.
        4) Manual speed potentiometer.
        5) Alarm RESET button.
    b. Indicators and Alarms:
        1) RUN indication.
        2) SPEED indication.
        3) Common FAIL alarm.
    c. Interlocks:
        1) Motor High Temperature: Shut down and latch out pump and generate MOTOR HIGH TEMPERATURE alarm.
        2) Moisture Detection: Shut down and latch out pump and generate MOISTURE DETECTION alarm.
        3) VFD Failure: Shut down and latch out pump and generate VFD FAIL alarm.
        4) Low-Low Wet Well Level Alarm: Shut down pumps located in same wet well as low-low level switch and generate a LOW-LOW LEVEL ALARM. Do not latch out pump.
        5) When a pump is latched out, it shall not start until the RESET pushbutton is pressed.
6. PLC/SCADA Functions:
    a. Remote Controls:
        1) Selection of Remote Manual or Remote Automatic modes can be made through the plant SCADA system.
        2) Remote-Manual Mode:
            a) START/STOP control.
            b) Manual SPEED controls.
            c) Equipment runs continuously when started.

3) Remote-Automatic Mode:
   a) In REMOTE mode, the RAS Pump Station No. 2 shall operate in in LEVEL CONTROL MODE, SETPOINT FLOW CONTROL MODE, or PROPORTIONAL SETPOINT FLOW CONTROL MODE as selected by the operator:
      (1) The default mode is LEVEL CONTROL MODE.
   b) Provide a LEAD/LAG selector switch to select the order of pump operation:
      (1) If the lead pump fails, the lag pump will assume responsibility.
   c) LEVEL CONTROL MODE:
      (1) Provide the following operator adjustable setpoints:
         (a) Wet well level setpoint (elevation 98.00 to 85.50, default 95.00).
         (b) Lead pump start level (elevation 98.00 to 95.00, default 96.00).
         (c) Lead pump shut down level (elevation 93 to 85.50, default 85.50).
      (2) The PLC shall achieve the level setpoint by controlling the number of pumps on-line and modulating the speed of the VFD controlled pumps using a PID controller.
      (3) The process input to the PLC will be the level measured in the wet well containing the lead pump.
      (4) When the Lead Pump Start Level is reached, the lead pump will start at its minimum speed and the PLC will increase the speed of the pump to maintain the level setpoint.
      (5) If the lead pump reaches maximum speed and the wet well level continues to rise above the Wet Well Level Set Point:
         (a) Start the lag pump.
         (b) Lower the lead pump speed to a lower “Neutral point” speed.
         (c) Allow the lag pump to attain the “Neutral point” speed.
         (d) Modulate the speed of the lead and lag pumps together to obtain the level setpoint.
      (6) If the lead and lag pump speeds have decreased to their minimum speed and the wet well level continues to fall, then:
         (a) Place pumps off-line in a manner similar to that described above in the reverse order they were placed on-line.
      (7) If the Lead Pump Shut Down level is reached, then:
         (a) The lead pump shall shutdown without an alarm annunciation in this condition.
   d) SETPOINT FLOW CONTROL MODE:
      (1) Provide operator-adjustable flow setpoint for RAS Pump Station No. 2 (2.5 mgd to 5.0 mgd; default 5.0 mgd).
      (2) The PLC shall achieve the flow setpoint by controlling the number of pumps on-line and modulating the speed of the VFD controlled pumps using a PID controller.
      (3) The process input to the PLC will be the flow measured by the discharge flow meter designated by the operator based on the manual valve configuration.

(4) When the pumps are called to start, the lead pump will start at its minimum speed and the PLC will increase the speed of the pump to maintain the flow setpoint.
(5) If the lead pump reaches maximum allowable full speed and the process flow rate remains less than the setpoint flow rate, the PLC will:
(a) Start the lag pump.
(b) Lower the lead pump speed to a lower “Neutral point” speed.
(c) Allow the lag pump to attain the “Neutral point” speed.
(d) Modulate the speed of the lead and lag pumps together to obtain the flow setpoint.
(6) If the pumps speed decreases to the a minimum speed set point due to a decrease in the flow set point, the PLC shall shut down the lag pump and continue to modulate the lead pump to maintain the flow set point.

e) PROPORTIONAL SETPOINT FLOW CONTROL MODE:
(1) Provide the following operator adjustable setpoints:
(a) Setpoint percentage of influent flow to Secondary Clarifier No. 5 measured by Mixed Liquor Flume No. 5 (20 percent to 50 percent; default of 33 percent).
(b) Minimum RAS flow setpoint (2.5 mgd to 5 mgd; default 2.5 mgd).
(2) The PLC calculates a RAS Flow Setpoint by multiplying the operator input percentage of influent flow by the flow measured at Mixed Liquor Flume No. 5.
(3) Modulate the RAS pumps as described under SETPOINT FLOW CONTROL MODE, above, to maintain the calculated, variable RAS Flow Setpoint.
(4) Do not allow the pump station to pump less than the Minimum RAS Flow Setpoint value.

4) Minimum Speed: The VFD controlled pumps’ minimum speed shall not be less than the pump manufacturer’s minimum recommended speed.

b. Screen Indicators and Alarms:
1) Each pump:
a) REMOTE indication.
b) RUN indication.
c) SPEED indication.
d) LEAD/STANDBY indication.
e) Run time indication and totalizer.
f) VFD FAIL alarm.
g) MOTOR HIGH TEMPERATURE alarm.
h) MOISTURE DETECTION alarm.
2) Each duty pump discharge:
a) Flow indication.
b) Flow totalization.
c) Flow meter failure.

3) Each wet well:
a) Level indication.
b) Low-low level alarm.
c) High level alarm.

c. Software Interlocks: None.

3.04 PROCESS AREA NO. 04 - NO. 06

A. Anoxic Zone and Swing Zone Mixers:

1. References:
   a. Process Area: 04, 05, 06.
   b. P&IDs: 04N01, 04N02, 04N03, 05N01, 05N02, 06N01, 06N02.
   c. Mechanical Drawings: 04M01, 04M03, 04M04, 05M01, 05M03, 05M04, 06M01, 06M03, 06M04.
   d. Specification Sections: 11317.
2. Mechanical Equipment:

Tag Number	Equipment Name
MIX-2311	Mixer No. 1, Aeration Basin No. 1.
MIX-2312	Mixer No. 2, Aeration Basin No. 1.
MIX-2313	Mixer No. 3, Aeration Basin No. 1.
MIX-2321	Mixer No. 1, Aeration Basin No. 2.
MIX-2322	Mixer No. 2, Aeration Basin No. 2.
MIX-2323	Mixer No. 3, Aeration Basin No. 2.
MIX-2331	Mixer No. 1, Aeration Basin No. 3.
MIX-2332	Mixer No. 2, Aeration Basin No. 3.
MIX-2333	Mixer No. 3, Aeration Basin No. 3.
MIX-2341	Mixer No. 1, Aeration Basin No. 4.
MIX-2342	Mixer No. 2, Aeration Basin No. 4.
MIX-2343	Mixer No. 3, Aeration Basin No. 4.
MIX-2351	Mixer No. 1, Aeration Basin No. 5.
MIX-2352	Mixer No. 2, Aeration Basin No. 5.
MIX-2353	Mixer No. 3, Aeration Basin No. 5.
MIX-2361	Mixer No. 1, Aeration Basin No. 6.
MIX-2362	Mixer No. 2, Aeration Basin No. 6.
MIX-2363	Mixer No. 3, Aeration Basin No. 6.
MIX-2371	Mixer No. 1, Aeration Basin No. 7.
MIX-2372	Mixer No. 2, Aeration Basin No. 7.
MIX-2373	Mixer No. 3, Aeration Basin No. 7.

3. Abstract:
   a. Submersible mixers provide mixing energy in the swing and anoxic zones to prevent the settling of solids and improve denitrification process efficiency.
4. Local Controls and Instrumentation:
   a. Instruments and Protective Devices:
      1) Motor winding temperature switch.
      2) Motor moisture detection sensors.
      3) Pump protection module (in panel above equipment).
   b. Control Devices:
      1) LOCK-OUT/STOP pushbutton.
   c. Indicators and Alarms:
      1) None.

5. MCC Panel Controls and Instrumentation:
    a. Control Devices:
        1) LOCAL/OFF/REMOTE selector switch.
        2) START push button.
        3) LOCK-OUT/STOP push button.
        4) Alarm RESET button.
    b. Indicators and Alarms:
        1) RUN indication.
        2) Common FAIL alarm.
    c. Hardwired Interlocks:
        1) Motor High Temperature: Shut down and latch out pump and generate MOTOR HIGH TEMPERATURE alarm.
        2) Moisture Detection: Shut down and latch out pump and generate MOISTURE DETECTION alarm.
        3) Motor Overload: Shut down and latch out the equipment and generate MOTOR OVERLOAD alarm.
        4) When a mixer is latched out, it shall not start until the RESET pushbutton is pressed.
6. SCADA Functions:
    a. Remote Controls:
        1) Remote-Manual Mode:
            a) START-STOP control.
            b) Equipment runs continuously when started.
    b. Screen Indicators and Alarms at SCADA:
        1) REMOTE indication.
        2) RUN indication.
        3) Run time indication and totalizer.
        4) MOTOR HIGH TEMPERATURE alarm.
        5) MOISTURE DETECTION alarm.
        6) MOTOR OVERLOAD alarm.

B. MLR (Mixed Liquor Return) Pumps:
1. References:
    a. Process Area: 04, 05, 06.
    b. P&IDs: 04N01, 04N02, 04N03, 05N01, 05N02, 06N01, 06N02.
    c. Mechanical Drawings: 04M01, 04M05, 04M06, 05M01, 05M05, 05M06, 06M01, 06M05, 06M06.
    d. Specification Sections: 11312P, 11292A.

2. Mechanical Equipment:

Tag Number	Equipment Name
PMP-2315	MLR Pump No. 1, Aeration Basin No. 1.
PMP-2316	MLR Pump No. 2, Aeration Basin No. 1.
PMP-2325	MLR Pump No. 1, Aeration Basin No. 2.
PMP-2326	MLR Pump No. 2, Aeration Basin No. 2.
PMP-2335	MLR Pump No. 1, Aeration Basin No. 3.
PMP-2336	MLR Pump No. 2, Aeration Basin No. 3.
PMP-2345	MLR Pump No. 1, Aeration Basin No. 4.
PMP-2346	MLR Pump No. 2, Aeration Basin No. 4.
PMP-2355	MLR Pump No. 1, Aeration Basin No. 5.
PMP-2356	MLR Pump No. 2, Aeration Basin No. 5.
PMP-2365	MLR Pump No. 1, Aeration Basin No. 6.
PMP-2366	MLR Pump No. 2, Aeration Basin No. 6.
PMP-2375	MLR Pump No. 1, Aeration Basin No. 7.
PMP-2376	MLR Pump No. 2, Aeration Basin No. 7.

3. Abstract:
   a. The mixed liquor return (MLR) pumping system includes two variable speed submersible horizontal axial flow pumps in each aeration basin. The pumps are located in final aerobic zone located at the wall between the final aerobic zone and the first anoxic zone. The pumps pump return mixed liquor (ML) from the final aerobic zone, through a flap gate, and to the first anoxic zone, where it is mixed with effluent from the biotowers and RAS.
   b. The MLR pumps are intended to operate in a duty/standby configuration. Only one MLR pump can be operating at a time for each aeration basin.
   c. The pumps are intended to be operated continuously while an aeration basin is in service.
   d. The pump speed is normally controlled based on a flow setpoint input through the SCADA system. The setpoint pump speed is calculated from a pump curve programmed into the PLC.
4. Local Controls and Instrumentation:
   a. Instruments and Protective Devices:
      1) Motor winding temperature switch.
      2) Motor moisture detection sensors.
      3) Pump protection module (in panel above equipment).
   b. Control Devices:
      1) LOCK-OUT/STOP pushbutton.
   c. Indicators and Alarms:
      1) None.
5. MCC/VFD Panel Controls and Instrumentation:
   a. Control Devices:
      1) LOCAL/OFF/REMOTE selector switch.
      2) START push button.
      3) LOCK-OUT/STOP push button.
      4) Manual speed potentiometer.
      5) Alarm RESET button.
   b. Indicators and Alarms:
      1) RUN indication.
      2) SPEED indication.
      3) Common FAIL alarm.

c. Hardwired Interlocks:
    1) Motor High Temperature: Shut down and latch out pump and generate MOTOR HIGH TEMPERATURE alarm.
    2) Moisture Detection: Shut down and latch out pump and generate MOISTURE DETECTION alarm.
    3) VFD Failure: Shut down and latch out pump and generate VFD FAIL alarm.
    4) When a pump is latched out, it shall not start until the RESET pushbutton is pressed.

6. SCADA Functions:
    a. Remote Controls:
        1) Selection of Remote Manual or Remote Automatic modes can be made through the plant SCADA system.
        2) Remote-Manual Mode:
            a) START/STOP control.
            b) Manual SPEED controls.
            c) Equipment runs continuously when started.
        3) Remote-Automatic Mode:
            a) Provide a DUTY-STANDBY selector switch to select the order of pump operation. Automatically switch operation to the STANDBY pump when the DUTY pump fails.
            b) Provide a selector switch so operator can choose one of two operational modes: CONSTANT FLOW SETPOINT mode or MLR FLOW AS % OF PROCESS INFLUENT mode.
            c) CONSTANT FLOW SETPOINT mode:
                (1) Provide an operator-adjustable MLR Flow Rate Setpoint based on pump speed:
                    (a) For Aeration Basin No. 1 - 3, the pumping rate ranges from 3 to 9 mgd, with a default of 9 mgd.
                    (b) For Aeration Basin No. 4 - 7, the pumping rate ranges from 2 to 7 mgd, with a default of 7 mgd.
                (2) The PLC shall control the speed of the Duty pump to achieve the operator input MLR Flow Rate Setpoint by calculating the speed setpoint from an approved pump curve provided by the pump manufacturer.
            d) MLR FLOW AS % OF PROCESS INFLUENT:
                (1) For each aeration basin, provide an operator-adjustable setpoint for desired percentage of influent flow (100 percent to 300 percent; default of 300 percent).
                (2) Provide in table for operator input of aeration basins in operation.
                (3) The PLC shall control the speed of the Duty pump to achieve a calculated MLR Flow Rate Setpoint by calculating the speed setpoint from an approved pump curve provided by the pump manufacturer.
                (4) The MLR Flow Rate Setpoint for each aeration basin shall be a calculated by the following formula:

MLR Flow Rate Setpoint = (Basin Volume / Total Volume of Basins in Operation) * Primary Effluent Flow

Where:

(a) Primary Effluent Flow as measured by the Primary Influent Flumes Nos. 1 -3 plus the Ceres flow meter.

(b) Basin Volume is based on the basin associated with MLR pump. Aeration basins 1 - 3 each have a volume of 1.57 MG. Aeration basins 4 - 7 each have a volume of 1.20 MG.

(c) Total Volume of Basins in Operation is calculated from the input table for basins in operation and the volume associated with each basin.

b. Screen Indicators and Alarms at SCADA:
   1) REMOTE indication.
   2) RUN indication.
   3) SPEED indication.
   4) LEAD/STANDBY indication.
   5) Run time indication and totalizer.
   6) VFD FAIL alarm.
   7) MOTOR HIGH TEMPERATURE alarm.
   8) MOISTURE DETECTION alarm.

c. Software Interlocks:
   1) In REMOTE, allow only one pump at a time in each aeration basin.
   2) Minimum Speed: The VFD controlled pumps' minimum speed shall not be less than the pump manufacturer's minimum recommended speed.

3.05 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

END OF SECTION

SECTION 17201

LEVEL MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ball float level switch.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   3. Section 17950 - Testing, Calibration, and Commissioning.

C. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050.

1.03 DEFINITIONS

A. As specified in Section 17050.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 17050.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050:
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Ball float level switch:
      a. Siemens Water Technologies Corp 9G-EF.
      b. ITT Flygt Model ENM-10.
      c. Anchor Scientific Incorporated Ecofloat/Solofloat.

2.02 MANUFACTURED UNITS

A. Ball float level switch:
   1. General:
      a. Free hanging, encapsulated body with a switch to determine position of float.
   2. Element:
      a. Mechanical switch encapsulated in waterproof floating ball of nominal diameter, supported by flexible PVC cable and jacket or heavy neoprene.
      b. The length of the PVC cable shall be, at a minimum, equal to sump depth plus 5 feet.
      c. Float: Provide Type 316 stainless steel or polypropylene, minimum 3 inches in diameter.
      d. An operating temperature rating: -30 degrees Fahrenheit to +150 degrees Fahrenheit.
      e. Mercury switches are not acceptable.
      f. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.
      g. Rated for Class 1, Division 2 areas as required.

3. Switch:
    a. Single pole double throw contacts rated 5 amps resistive at 120 VAC.
    b. Provide the number of floats per level system as indicated on the Drawings.
    c. Suspend ball float and adjust for level setpoint as required.
4. Components:
    a. Floats shall include Type 316 stainless steel clamp and brackets and 1/4 inch cable to allow testing of the float without entering the basin or wet well.
    b. Provide strain relief at both ends of the float cable.

2.03 ACCESSORIES

A. Provide sunshades for outdoor installation.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
    1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050.

3.05 ADJUSTING

A. As specified in Section 17950.

3.06 CLEANING

A. As specified in Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

B. Demonstrate performance of all instruments to the ENGINEER before commissioning.

3.08 PROTECTION

A. As specified in Section 17050.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be as indicated on the Drawings, as specified in the Specifications or both.

END OF SECTION

SECTION 17206

LEVEL MEASUREMENT: ULTRASONIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ultrasonic level instruments.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

C. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050.

1.03 DEFINITIONS

A. As specified in Section 17050.

B. Specific definitions:
   1. FDT: Field Device Tool.
   2. DTM: Device Type Manager.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 17050.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050:
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Ultrasonic level sensor with 4-wire remote transmitter:
      a. Ametek Drexelbrook: USonic-R Series.
      b. Siemens: Echomax Series sensor with HydroRanger 200 Series Transmitter.

2.02 MANUFACTURED UNITS

A. Ultrasonic level measurement with 4-wire remote transmitter:
   1. General:
      a. Continuous non-contact level measurement device with remote transmitter using ultrasonic echo sensing. The transducer generates an ultrasonic pulse in the range of 12 to 50 kHz and measures the time required for the pulse to travel to the process surface and return. The distance is calculated from the send and receive times. Each 4-wire level transmitter system includes, but is not limited to:
         1) Ultrasonic transducer.
         2) Signal cable.
         3) Transmitter.

2. Performance requirements:
    a. Accuracy:
        1) 0.25 percent of range.
    b. Repeatability:
        1) 0.1 percent of range.
3. Ultrasonic transducer:
    a. Encapsulated in chemical- and corrosion-resistant material as indicated on the Instrument Data Sheet or Instrument Index.
    b. Class I Division 1 for transducer only.
    c. Operating temperature range: -5 to 122 degrees Fahrenheit (-20 to 50 degrees Celsius).
    d. Operating relative humidity range: 5 to 95 percent.
    e. Functions:
        1) Temperature compensation.
    f. Mounting: As indicated in the Contract Documents.
4. Transmitter:
    a. Level-indicating transmitter:
        1) Indicator: Liquid crystal display with approximately 0.50-inch display scaled to read in engineering units.
        2) Sensitivity: Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition on indicating transmitter unit.
        3) Ability to allow for signal profiles and echo mapping:
            a) Provide manufacturer's software for re-mapping the signal.
    b. Functions:
        1) Level measurement.
        2) Tank volume.
        3) Flow measurement.
    c. Power supply:
        1) 120 VAC.
        2) Power consumption: 36 VA maximum.
    d. Outputs:
        1) Isolated 4 to 20 milliamperes DC.
        2) Relay outputs:
            a) 2 Form C contacts.
            b) Rated 5 amps at 250 VAC.
            c) Programmable.
        3) Enclosure: NEMA Type 4X.
        4) Mounting: As indicated in the Contract Documents.
        5) Operating temperature range from -5 to 122 degrees Fahrenheit (-20 to 50 degrees Celsius); relative humidity of 10 to 100 percent.

2.03 ACCESSORIES

A. Mounting brackets: As indicated on the Drawings.

B. Provide sunshades for outdoor installations.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to manufacturer's standard at a facility that is traceable to NIST:
   1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050.

3.05 ADJUSTING

A. As specified in Section 17950.

B. Turn on turbulent surface software feature for all installations measuring surfaces lacking a placid surface. This would include but not be limited to level measurements in mixed media filters and potentially wet wells.

3.06 CLEANING

A. As specified in Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

3.08 PROTECTION

A. As specified in Section 17050.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be as indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:	Carollo Engineers	ULTRASONIC LEVEL INSTRUMENTS					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17206	
Project:	Secondary Clarifier No.5 Design					Contract	Date
Customer:	City of Turlock						
Plant:	Wastewater Treatment Plant					Req.	P.O.
Location:	Turlock California						
BOM No.:						By / Chk / App	
File:							

G	1	**Instrument Tag Number**	LE/FIT-0451		
E	2	**Service**	Secondary Clarifier No.5 Mixed Liquor Flume Flow		
N	3	**P&ID**	01N01		
	4	**Other**			
	5	**Type**	Ultrasonic		
P	6	**Housing Material**	Mfg. Std.		
R	7	**Measurement Range**	0-6500 GPM		
O	8	**Op. Temp. Range**			
B	9	**Manufacturer**			
E	10	**Model**			
	11	**Model Number**			
C	12	**Style**	Mfg. Std		
A	13	**Length**			
B	14	**Other**			
L	15	**Other**			
E	16	**Other**			
	17	**Type**	4-Wire		
T	18	**Operating Mode**	Continuous		
R	19	**Enclosure**	NEMA 4X		
A	20	**Mounting**	Remote		
N	21	**Temperature Range**			
S	22	**Voltage Requirements**	115 VAC, 60 Hz		
M	23	**Power**			
I	24	**Accuracy**	0.25% of Range		
T	25	**Display**	0.5" LCD Display		
T	26	**Output**	4-20 mA		
E	27	**Calibration**			
R	28	**Status Relay**			
	29	**Manufacturer**			
	30	**Model No.**			
	31	**Elect. Entry**			
	32	**Other**			
O	33				
P	34				
T	35				
S	36				

Notes:

SECTION 17302

FLOW MEASUREMENT: MAGNETIC FLOWMETERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Full-body magnetic flowmeters.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

C. Provide all instruments identified in the Contract Drawings.

1.02 REFERENCES

A. As specified in Section 17050.

B. NSF International (NSF).

1.03 DEFINITIONS

A. As specified in Section 17050.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 17050.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050.

1.08 WARRANTY

A. As specified in Section 17050.

1.09 MAINTENANCE

A. As specified in Section 17050.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Endress+Hauser: Promag L400.
   2. Rosemount: 8700E.
   3. Krohne: IFC.
   4. Yokogawa: AXF.
   5. ABB: Watermaster.

2.02 MANUFACTURED UNITS

A. Magnetic flowmeter:
   1. General:
      a. Magnetic flowmeters obtain the flow velocity by measuring the changes of induced voltage of the conductive fluid passing across a controlled magnetic field.
      b. Complete zero stability shall be an inherent characteristic of the flowmeter system.
      c. Include for each magnetic flow metering system:
         1) A metering tube with electrodes (sensor).
         2) Signal cable.
         3) Transmitter integral or remote as indicated on the Drawings.
         4) Flowmeter grounding rings.
   2. Performance requirements:
      a. Accuracy:
         1) 0.25 percent of flow rate from 10 to 100 percent of full scale for velocities ranging between 1.9 to 10 feet per second.
      b. Repeatability:
         1) 0.25 percent of rate.
   3. Element:
      a. Metering tube:
         1) Constructed of carbon steel or Type 304 stainless steel (unless specifically noted otherwise in the instrument data sheets) with flanged connections to match with piping material.
         2) Liner material in conformance with:
            a) Manufacturer’s recommendations for the intended service.
            b) NSF certified for all drinking water applications.

3) Electrodes type and material in conformance with:
   a) Manufacturer's recommendations for the intended service.
   b) Utilize a minimum of 2**,** self-cleaning electrodes.
4) Meter terminal housing NEMA Type 4X unless specifically noted otherwise in the instrument data sheets.
5) Meter coating consisting of epoxy painted finish.
6) Components:
   a) 2 grounding rings:
      (1) Which are in conformance with the manufacturer's bore and material recommendation for the meter's intended service.
      (2) Designed to protect and shield from abrasion of the liner's edge interface at the meter's end.

4. Transmitter:
   a. Power supply:
      1) 120 VAC.
      2) Power consumption: 60 VA maximum.
   b. Outputs:
      1) As noted in the instrument data sheets.
      2) For all instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.
   c. Microprocessor-based signal converter/transmitter.
   d. Utilize DC pulse technique to drive flux-producing coils.
   e. Contain a 6-digit display for flow rate, percent of span, and totalizer.
   f. Operator keypad interface.
   g. Integral zero return to provide consistent zero output signals in response to an external dry contact closure.
   h. Integral low flow cut-off zero return.
   i. Programmable parameters including:
      1) Meter size.
      2) Full-scale flow rate.
      3) Magnetic field frequency.
      4) Time constant.
   j. Data retention for a minimum of 5 years without auxiliary main or battery power.
   k. Self-diagnostics and automatic data checking.
   l. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
   m. Ambient operating temperature limits of -5 to 140 degrees Fahrenheit (-20 to 60 degrees Celsius).

2.03 ACCESSORIES

A. Stainless steel tag labeled as specified in the Contract Documents.

B. Provide sunshades for all transmitters located outdoors.

C. Provide galvanic isolation gaskets, nylon/Teflon flange bolt insulation bushings and nylon washers on all meters installed on pipes with cathodic protection.

D. Furnish 1 spool piece for every size of magnetic flow tube being provided.

E. Electronic tester for calibration verification and diagnostics:
   1. Transmitter shall have continuous internal meter verification method comparing current meter system values to base line value.
   2. Should variance in readings be determined exceeding a preset limit the transmitter will provide an alarm condition via a configurable discrete output.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

B. Factory calibrate each flow metering system at a facility that is traceable to the NIST.

C. A real-time computer generated printout of the actual calibration date indication actual velocities and as read values of the flow tube:
   1. Flow calibration report of the manufacturers flow lab calibration procedure shall be shipped with the meter system.
   2. Minimum calibration shall be a 3 point calibration including 1, 3, and 10 feet per second velocities for every meter and transmitter system.
   3. Manufacturer shall archive all calibration reports for future reference.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050.

B. Provide manufacturer’s services to perform installation inspection.

3.05 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer’s instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 CLEANING

A. As specified in Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

B. Demonstrate performance of all instruments to the Engineer before commissioning.

3.08 PROTECTION

A. As specified in Section 17050.

3.09 SCHEDULES

A. Instrument Data Sheets included in this Section.

B. The provided information does not necessarily include all required instruments.

C. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:	Carollo Engineers	MAGNETIC FLOWMETERS				INSTRUMENT DATA SHEETS		
						Spec. No.		Rev.
Contractor:		No	By	Date	Revision	17302		
Project:	Secondary Clarifier No.5 Design					Contract		Date
Customer:	City of Turlock							
Plant:	Wastewater Treatment Plant					Req.		P.O.
Location:	Turlock, California							
BOM No.:						By	Chk	App
File:								

	1		Instrument Tag No.			FE/FIT-2651		FE/FIT-2711		FE/FIT-2731	
	2		Service			Clarifier No.5 RAS Flow		RAS Pump No. 1 RAS Flow		RAS Pump No. 3 RAS Flow	
	3		P&ID			03N01		03N02		03N02	
	4	C	Line Size / Schedule			16"		16"		16"	
	5	O	Line Material			DIP		DIP		DIP	
	6	N	Connection Type/ Pressure Rating			150# ANSI Flange		150# ANSI Flange		150# ANSI Flange	
	7	N	Connection Materials								
	8		Tube Size			16"		16"		16"	
E	9		Tube Material			Mfg Standard		Mfg Standard		Mfg Standard	
L	10		Liner Material			Mfg Standard		Mfg Standard		Mfg Standard	
E	11	M	Electrode Type			Mfg Standard		Mfg Standard		Mfg Standard	
M	12	E	Electrode Material			316SS		316SS		316SS	
E	13	T	Meter Casing								
N	14	E	Power Supply	Phase		120 VAC	1P	120 VAC	1P	120 VAC	1P
T	15	R	Grounding Type & Matl.								
	16		Enclosure Class			NEMA 4X		NEMA 4X		NEMA 4X	
	17		Other								
	18		Fluid			RAS		RAS		RAS	
	19	F	Max Flow			6500 GPM		6500 GPM		6500 GPM	
	20	L	Min Velocity								
	21	U	Min Flow	Norm Flow		0 GPM	3250 GPM	0 GPM	3250 GPM	0 GPM	3250 GPM
	22	I	Min Temp	Max Temp							
	23	D	Min Press	Max Press							
	24		Vacuum Possibility								
	25		Conductivity								
T	26		Function			Control and Display Unit		Control and Display Unit		Control and Display Unit	
R	27		Mounting			Remote		Integral		Integral	
A	28		Enclosure Class			NEMA 4X		NEMA 4X		NEMA 4X	
N	29		Length Signal Cable								
S	30		Type Span Adjustment								
M	31		Power Supply			120VAC		120VAC		120VAC	
I	32		Transmitter Output			4-20 mA HART		4-20 mA HART		4-20 mA HART	
			Relay Outputs			Form C		Form C		Form C	
T	33		Accuracy			0.25%		0.25%		0.25%	
T	34		Calibrated Range								
E	35		Empty Pipe Detection								
R	36		Bi-Directional Flow								
	37		Display Scale Size	Range							
	38		Alarm Contact No.	Form							
	39		Manufacturer								
	40		Element (Meter) Model No.								
	41		Transmitter (Inst.) Model No.								

Notes:

SECTION 17402

PRESSURE/VACUUM MEASUREMENT: INSTRUMENT VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Valve manifolds and instrument valves.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

C. Provide all valves identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050.

1.03 DEFINITIONS

A. As specified in Section 17050.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 17050.

B. Additional requirements:
   1. Product data:
      a. Valve type.
      b. Body material.
      c. Size.
      d. Options.
   2. Shop drawings:
      a. Mounting details for all manifold valves.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Examine the complete set of Contract Documents and verify that the valves are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the valve manufacturer's recommendations or specifications.

D. Provide valves manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

B. Protect valve manifolds and protective coatings from damage during handling and installation. Repair coating where damaged.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050:
   1. Provide valves suitable for the installed site conditions including, but not limited to, material compatibility, process, and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050.

1.09 MAINTENANCE

A. As specified in Section 17050.

B. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Valve manifold manufacturers: One of the following or equal:
   1. Anderson Greenwood.
   2. Hex Valve.
   3. Noshok.
   4. Rosemount.

B. Block and bleed valve manufacturers: One of the following or equal:
   1. Anderson Greenwood.
   2. Hex Valve.

C. Gauge valve manufacturers: One of the following or equal:
   1. Anderson Greenwood.
   2. Hex Valve.

2.02 MANUFACTURED UNITS

A. Valve manifolds:
   1. General:
      a. Provide 2-valve, 3-valve, blowdown type 5-valve, or metering type 5-valve manifolds as indicated on the Drawings.
      b. Valve manifolds shall have one piece bonnet with a metal to metal seal to the valve body below the bonnet threads.
   2. Requirements:
      a. Bonnet lock pin to prevent accidental loosening.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Manifold valves shall have straight through portion for bi-directional flow and easy roddable cleaning.
      e. Manifold valves shall allow for direct or remote instrument mounting.
      f. Shall be able to withstand pressures up to 6,000 psi for soft seat valves and 10,000 psi for hard seat valves at maximum 200 degrees Fahrenheit.
      g. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) O-Ring: Teflon.
      h. 2-Valve manifolds:
         1) 1 isolation valve and 1 drain/vent and calibration valve.
      i. 3-Valve manifolds:
         1) 2 isolation valves and 1 equalizing valve for differential pressure applications.
         2) Plugged vent connections used for vent/drain or calibration.
      j. Blowdown 5-valve manifold:
         1) 2 isolation valves, 1 equalizing valve, 2 blowdown valves for differential pressure applications.
      k. Metering 5-valve manifold:
         1) 2 isolation valves, 2 equalizing valves, 1 vent/drain and calibration valve for differential pressure applications.

B. Block and bleed valves:
   1. General:
      a. Valve shall provide process isolation and venting/draining capabilities.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Valve shall not be used with fluids with high solids content, such as raw wastewater or sludge.
   2. Requirements:
      a. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) O-Ring: Teflon.

C. Gauge valves:
   1. General:
      a. Valve shall provide process isolation from pressure instrument.
      b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.

2. Requirements:
    a. Materials of construction:
        1) Body material: Type 316 stainless steel.
        2) O-Ring: Teflon.

2.03 ACCESSORIES

A. Provide tube fitting, female NPT, or pipe butt weld connections if necessary.

B. Provide stainless steel concentric or eccentric pipe nipples when necessary.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location and verify it will work properly when installed:
    1. Notify the Engineer promptly if any installation condition does not meet the manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of all valves.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050.

3.05 ADJUSTING

A. As specified in Section 17950.

3.06 CLEANING

A. As specified in Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

B. Demonstrate performance of all valves to the Engineer before commissioning.

3.08 PROTECTION

A. As specified in Section 17050.

3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17407

PRESSURE MEASUREMENT: SUBMERSIBLE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Submersible pressure transmitters.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   3. Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.
   4. Section 17950 - Testing, Calibration, and Commissioning.

C. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050.

1.03 DEFINITIONS

A. As specified in Section 17050.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330, and 17050.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050:
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Submersible level measurement with 2-wire integral transmitter:
   1. The following, no equal:
      a. Dwyer, PBLTX.

2.02 MANUFACTURED UNITS

A. Submersible level measurement with 2-wire integral transmitter:
   1. General:
      a. Pressure is measured through a diaphragm-type measuring cell and converted to linear pressure measurement.
      b. Each submersible pressure transmitter system shall include:
         1) Signal cable, including pressure compensation tube.
         2) Transducer probe with integral transmitter.
         3) Transmitter cable termination box.
   2. Performance requirements:
      a. Accuracy:
         1) 0.3 percent of range.
      b. Repeatability:
         1) 0.25 percent of full scale.
      c. Rangeability:
         1) 3:1.

d. Range:
    1) As indicated on the contract documents.

3. Element:
    a. Sensor housing shall be Type 316L stainless steel or titanium with ceramic, teflon-coated, or titanium diaphragm.
    b. Protective cap shall be manufacturer's recommended material, chemically resistant to process fluid.
    c. Slip resistant extension cable with pressure compensation tube with Teflon filter.
    d. Enclosure for probe and transmitter assembly shall be NEMA Type 4X.
4. Transmitter:
    a. Power supply:
        1) 24 VDC: 2 wire loop powered.
        2) Power consumption: 18 VA maximum.
    b. Outputs:
        1) Isolated 4-20mA DC.
    c. Without display.
    d. Ambient operating temperature limits of -10 to 70 degrees Celsius (-14 to 158 degrees Fahrenheit).
    e. Transmitter shall be integral to probe housing.
5. Transmitter cable termination box:
    a. NEMA Type 4X.
    b. Equipped with filter or desiccant chamber to eliminate moisture from the pressure compensation tube.
    c. Termination for signal wires and pressure compensation tube.

2.03 ACCESSORIES

A. Type 316L stainless steel mounting clamp with Type 304 stainless steel mounting screws.

B. Provide guide tube for stillwell mounting.

C. Provide additional Type 316L stainless steel weight to prevent movement.

D. Provide additional anchor to prevent movement.

E. Provide cable clamp and strain relief.

F. Provide indicating controller with features as indicated on the Drawings and as specified in Section 17710.

G. Provide sunshade for outdoor installations.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST:
    1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050.

3.05 ADJUSTING

A. As specified in Section 17950.

3.06 CLEANING

A. As specified in Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

3.08 PROTECTION

A. As specified in Section 17050.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:	**Carollo Engineers**		**SUBMERSIBLE PRESSURE INSTRUMENTS**								
							Spec. No.		**Rev.**		
Contractor:			**No**	**By**	**Date**	**Revision**	17407				
Project:	Secondary Clarifier No.5 Design						**Contract**		**Date**		
Customer:	City of Turlock										
Plant:	Wastewater Treatment Plant						**Req.**		**P.O.**		
Location:	Turlock, California										
BOM No.:							**By**		**Chk**		**App**
File:											
	1	**Instrument Tag Number**	LE/LT-2711		LE/LT-2721						
G	**2**	**Service**	RAS Pump Station No. 2 Wetwell No. 1 Level		RAS Pump Station No. 2 Wetwell No. 2 Level						
E	**3**	**P&ID**	03N01		03N01						
N	**4**	**Fluid Type**	RAS		RAS						
	5	**Fluid Specific Gravity**	1.0		1.0						
	6	**Type**	Submersible		Submersible						
P	**7**	**Measuring Cell Material**	Diaphragm		Diaphragm						
R	**8**	**Probe Body Material**	316SS		316SS						
O	**9**	**Op. Temp. Range**	40-80 deg F		40-80 deg F						
B	**10**	**Op. Pressure Range**									
E	**11**	**Other**									
	12	**Other**									
C	**13**	**Style**	Mfg. Std		Mfg. Std						
A	**14**	**Signal Cable Length**	As Required		As Required						
B	**15**	**Other**									
L	**16**	**Other**									
E	**17**	**Other**									
	18	**Type**	2-Wire		2-Wire						
T	**19**	**Operating Mode**	Continuous		Continuous						
R	**20**	**Enclosure**									
A	**21**	**Mounting**	Integral		Integral						
N	**22**	**Temperature Range**									
S	**23**	**Measurement Range**	0-20 FT		0-20 FT						
M	**24**	**Power Supply**	24 VDC		24 VDC						
I	**25**	**Accuracy**	0.3 % of range		0.3 % of range						
T	**26**	**Display**									
T	**27**	**Output**	4-20 mA		4-20 mA						
E	**28**	**Calibration**									
R	**29**	**Status Relay**									
	30	**Manufacturer**									
	31	**Model No.**									
	32	**Elect. Entry**									
	33	**Other**									
O	**33**										
P	**34**										
T	**35**										
S	**36**										

Notes:

SECTION 17502

ANALYZERS: ORP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. ORP instruments.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   3. Section 17950 - Testing, Calibration, and Commissioning.

C. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050.

B. CSA International (CSA).

1.03 DEFINITIONS

A. As specified in Section 17050.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 17050.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050:
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

B. Provide manufacturer's recommended calibration kit, including buffers and solutions, with enough quantity to last through warranty period.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Endress+Hauser:
      a. Sensor Model CPS12D.
      b. Transmitter Model Mycom S CPM253 or Liquiline CM44.
   2. Rosemount:
      a. Sensor Model 396P.
      b. Transmitter Model 1056.
   3. ABB:
      a. Sensor Model TB551.
      b. Transmitter model AX460.

B. All instruments of similar nature must be furnished by the same manufacturer.

2.02 MANUFACTURED UNITS

A. ORP analyzer:
   1. General:
      a. The oxidizing reducing potential (ORP) is a unit of measurement for the state of equilibrium between oxidizing and reducing components of a media. A platinum or gold electrode shall be used with integrated noble metal reference system. The measuring electrode shall generate a voltage output relative to the oxidizing or reducing reactions.
   2. Performance requirements:
      a. Accuracy: Within 1.0 millivolt.
      b. Stability: Within 1.0 millivolt per month.
      c. Repeatability: Within 1.0 millivolt.
   3. Element:
      a. Sensor material:
         1) Gold pin ORP electrode.
         2) Molded reinforced polypropylene body threaded for submersion.
         3) Steady reference signal from the reference electrode junction by resisting plugging in dirty applications.
         4) Integral temperature sensor.
      b. ORP measuring range: -1,500 to 1,500 millivolts.
      c. Temperature measuring range: 0 to 100 degrees Celsius.
      d. Operating temperature range: 0 to 100 degrees Celsius.
      e. Operating pressure range: 0 to 87 pounds per square inch.
      f. Process connection:
         1) Immersion style with ball float.
   4. Transmitter:
      a. Power supply:
         1) 120 VAC.
         2) Power consumption: 10 volt-amperes maximum.
      b. Outputs:
         1) Isolated 4 to 20 milliamperes DC.
         2) As indicated in the instrument datasheets.
      c. Display:
         1) Backlit LCD digital display.
      d. Measurement ranges: -1,400 to 1,400 millivolts.
      e. Temperature: 0 to 50 degrees Celsius.
      f. Displayed resolution: Within 1.0 millivolts.
      g. Ambient conditions:
         1) Operable from 0 to 50 degrees Celsius.
         2) Relative humidity 0 to 95 percent non-condensing.
      h. Mechanical:
         1) Enclosure rating: NEMA Type 4X (IP65).
         2) Mounting:
            a) Panel mount suitable for easy mounting in enclosures that include gasket to maintain weather rating of the panel.
            b) Surface mount enclosures, including self-tapping screws.
            c) Pipe mounting; accessories included for mounting enclosures to a 2-inch pipe.
         3) Provide all mounting hardware for proper installation and servicing of the sensor assembly.

i. Conduit connection:
1) 1/2 inch NPT.
j. Electrical certification: NRTL certified to UL and CSA standards, and CE approved.

5. Components:
a. Sensor cable:
1) Provided watertight sensor-to-cable connector that prevents cable twisting and eliminates rewiring when replacing the sensor.
2) Cable length: As required to connect sensor to transmitter plus 10 percent.

2.03 ACCESSORIES

A. Sensor:
1. Process assemblies:
a. As specified on Drawings and Instrument Data Sheets.

B. Transmitter:
1. Mounting kit:
a. Wall and 2 inch pipe mounting kit.
b. Cable glands kit.

C. Preamplifier: Use manufacturer recommended:
1. Preamplifier required on coaxial cable runs longer than 15 feet.

D. Provide sunshades for outdoor applications.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST:
1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050.

B. Provide manufacturer's services to perform installation inspection, start-up and calibration/verification.

3.05 ADJUSTING

A. As specified in Section 17950.

3.06 CLEANING

A. As specified in Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

3.08 PROTECTION

A. As specified in Section 17050.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:			**ORP ANALYZERS**							
							Spec. No.			**Rev.**
Contractor:			**No**	**By**	**Date**	**Revision**	17502			
Project:	Secondary Clarifier No.5 Design						**Contract**			**Date**
Customer:	City of Turlock									
Plant:	Wastewater Treatment Plant						**Req.**			**P.O.**
Location:	Turlock, California									
BOM No.:							**By**	**Chk**	**App**	
File:										

G	**1**	**Tag No. Element**	AE/AIT-2313	AE/AIT-2323
E	**2**	**Service**	Aeration Basin No. 1	Aeration Basin No. 2
N	**3**	**P&ID**	04N01	04N03
	4	**Type**	Differential Electrode	Differential Electrode
	5	**Body Style**	Immersion	Immersion
	6	**Enclosure**	NEMA 6P	NEMA 6P
E	**7**	**Electrodes**	Gold	Gold
L	**8**	**Ambient Conditions**		
E	**9**	**Connection**	Threaded	Threaded
M	**10**	**Sample Flow Required**	N/A	N/A
E	**11**	**ORP Measuring Range**	-1500-1500 mV	-1500-1500 mV
N	**12**	**Temperature Measuring Range**		
T	**13**	**Manufacturer**		
	14	**Model No.**		
	15	**Length**		
	16	**Other**	Built in Temperature Compensation	Built in Temperature Compensation
C	**17**	**Style**	Mfg. Standard	Mfg. Standard
A	**18**	**Length**		
B	**19**	**Model No.**		
L	**20**	**Pre-Amplifier**		
E	**21**	**Other**		
	22	**Type**	Control Unit and Display	Control Unit and Display
T	**23**	**Enclosure**	NEMA 4X	NEMA 4X
R	**24**	**Mounting**	Remote	Remote
A	**25**			
N	**26**	**Power Requirements**	115 VAC, 60 Hz	115 VAC, 60 Hz
S	**27**	**Resolution**	+/- 1.0 mV	+/- 1.0 mV
M	**28**	**Accuracy**		
I	**29**	**Calibrated Range**		
T	**30**			
T	**31**	**Outputs**	4-20 mA	4-20 mA
E	**32**	**Contacts**		
R	**33**	**Manufacturer**		
	34	**Model No.**		
	35	**Display**		
	36	**Other**		
	37	**Other**		
	38	**Other**		
O	**38**	**Cleaning**		
P	**39**	**Low Flow Cell**		
T	**38**	**Process Assembly**	Immersion with Ball Float	Immersion with Ball Float
S	**38**	**Other**		
	39			

Notes:

A/E:		ORP ANALYZERS					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17502	
Project:	Secondary Clarifier No.5 Design					Contract	Date
Customer:	City of Turlock						
Plant:	Wastewater Treatment Plant					Req.	P.O.
Location:	Turlock, California						
BOM No.:						By	Chk App
File:							

G	1	Tag No. / Element	AE/AIT-2333	AE/AIT-2343
E	2	Service	Aeration Basin No. 3	Aeration Basin No. 4
N	3	P&ID	04N05	05N01
	4	Type	Differential Electrode	Differential Electrode
	5	Body Style	Immersion	Immersion
	6	Enclosure	NEMA 6P	NEMA 6P
E	7	Electrodes	Gold	Gold
L	8	Ambient Conditions		
E	9	Connection	Threaded	Threaded
M	10	Sample Flow Required	N/A	N/A
E	11	ORP Measuring Range	-1500-1500 mV	-1500-1500 mV
N	12	Temperature Measuring Range		
T	13	Manufacturer		
	14	Model No.		
	15	Length		
	16	Other	Built in Temperature Sensor	Built in Temperature Sensor
C	17	Style	Mfg. Standard	Mfg. Standard
A	18	Length		
B	19	Model No.		
L	20	Pre-Amplifier		
E	21	Other		
	22	Type	Control Unit and Display	Control Unit and Display
T	23	Enclosure	NEMA 4X	NEMA 4X
R	24	Mounting	Remote	Remote
A	25			
N	26	Power Requirements	115 VAC, 60 Hz	115 VAC, 60 Hz
S	27	Resolution	+/- 1.0 mV	+/- 1.0 mV
M	28	Accuracy		
I	29	Calibrated Range		
T	30			
T	31	Outputs	4-20 mA	4-20 mA
E	32	Contacts		
R	33	Manufacturer		
	34	Model No.		
	35	Display		
	36	Other		
	37	Other		
	38	Other		
O	38	Cleaning		
P	39	Low Flow Cell		
T	38	Process Assembly	Immersion with Ball Float	Immersion with Ball Float
S	38	Other		
	39			

Notes:

A/E:			**ORP ANALYZERS**							
							Spec. No.			**Rev.**
Contractor:			**No**	**By**	**Date**	**Revision**	17502			
Project:	Secondary Clarifier No.5 Design						**Contract**			**Date**
Customer:	City of Turlock									
Plant:	Wastewater Treatment Plant						**Req.**			**P.O.**
Location:	Turlock, California									
BOM No.:							**By**	**Chk**	**App**	
File:										

G	**1**	**Tag No. Element**	AE/AIT-2353	AE/AIT-2363
E	**2**	**Service**	Aeration Basin No.5	Aeration Basin No.6
N	**3**	**P&ID**	05N03	06N01
	4	**Type**	Differential Electrode	Differential Electrode
	5	**Body Style**	Immersion	Immersion
	6	**Enclosure**	NEMA 6P	NEMA 6P
E	**7**	**Electrodes**	Gold	Gold
L	**8**	**Ambient Conditions**		
E	**9**	**Connection**	Threaded	Threaded
M	**10**	**Sample Flow Required**	N/A	N/A
E	**11**	**ORP Measuring Range**	-1500-1500 mV	-1500-1500 mV
N	**12**	**Temperature Measuring Range**		
T	**13**	**Manufacturer**		
	14	**Model No.**		
	15	**Length**		
	16	**Other**	Built in Temperature Sensor	Built in Temperature Sensor
C	**17**	**Style**	Mfg. Standard	Mfg. Standard
A	**18**	**Length**		
B	**19**	**Model No.**		
L	**20**	**Pre-Amplifier**		
E	**21**	**Other**		
	22	**Type**	Control Unit and Display	Control Unit and Display
T	**23**	**Enclosure**	NEMA 4X	NEMA 4X
R	**24**	**Mounting**	Remote	Remote
A	**25**			
N	**26**	**Power Requirements**	115 VAC, 60 Hz	115 VAC, 60 Hz
S	**27**	**Resolution**	+/- 1.0 mV	+/- 1.0 mV
M	**28**	**Accuracy**		
I	**29**	**Calibrated Range**		
T	**30**			
T	**31**	**Outputs**	4-20 mA	4-20 mA
E	**32**	**Contacts**		
R	**33**	**Manufacturer**		
	34	**Model No.**		
	35	**Display**		
	36	**Other**		
	37	**Other**		
	38	**Other**		
O	**38**	**Cleaning**		
P	**39**	**Low Flow Cell**		
T	**38**	**Process Assembly**	Immersion with Ball Float	Immersion with Ball Float
S	**38**	**Other**		
	39			

Notes:

A/E:		ORP ANALYZERS					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17502	
Project:	Secondary Clarifier No.5 Design					Contract	Date
Customer:	City of Turlock						
Plant:	Wastewater Treatment Plant					Req.	P.O.
Location:	Turlock, California						
BOM No.:						By / Chk / App	
File:							

G	1	Tag No. / Element	AE/AIT-2373	
E	2	Service	Aeration Basin No. 7	
N	3	P&ID	06N03	
	4	Type	Differential Electrode	
	5	Body Style	Immersion	
	6	Enclosure	NEMA 6P	
E	7	Electrodes	Gold	
L	8	Ambient Conditions		
E	9	Connection	Threaded	
M	10	Sample Flow Required	N/A	
E	11	ORP Measuring Range	-1500-1500 mV	
N	12	Temperature Measuring Range		
T	13	Manufacturer		
	14	Model No.		
	15	Length		
	16	Other	Built in Temperature Sensor	
C	17	Style	Mfg. Standard	
A	18	Length		
B	19	Model No.		
L	20	Pre-Amplifier		
E	21	Other		
	22	Type	Control Unit and Display	
T	23	Enclosure	NEMA 4X	
R	24	Mounting	Remote	
A	25			
N	26	Power Requirements	115 VAC, 60 Hz	
S	27	Resolution	+/- 1.0 mV	
M	28	Accuracy		
I	29	Calibrated Range		
T	30			
T	31	Outputs	4-20 mA	
E	32	Contacts		
R	33	Manufacturer		
	34	Model No.		
	35	Display		
	36	Other		
	37	Other		
	38	Other		
O	38	Cleaning		
P	39	Low Flow Cell		
T	38	Process Assembly	Immersion with Ball Float	
S	38	Other		
	39			

Notes:

SECTION 17506

ANALYZERS: DISSOLVED OXYGEN (DO)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Dissolved oxygen (DO) analyzer.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.
      b. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
      c. Section 17950 - Testing, Calibration, and Commissioning.

C. Provide all instruments identified in the Contract Drawings.

1.02 REFERENCES

A. As specified in Section 17050.

1.03 DEFINITIONS

A. As specified in Section 17050.

B. NEMA:
   1. Type 6P enclosure in accordance with NEMA 250.

C. Specific definitions:
   1. DO - Dissolved oxygen.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 17050.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050.

1.08 WARRANTY

A. As specified in Section 17050.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following to match existing, no equal:
   1. Hach LDO probe with Hach SC200 controller.

2.02 MANUFACTURED UNITS

A. Dissolved oxygen analyzer:
   1. General:
      a. Dissolved oxygen analyzer for continuous monitoring of dissolved oxygen in liquid.
   2. Performance requirements:
      a. Measuring range: 0 to 20 parts per million (ppm).

b. Sensor accuracy:
    1) Within 0.2 ppm for values above 1 ppm.
    2) Within 0.1 ppm for values below 1 ppm.
c. Repeatability: Within 0.5 percent of span.
d. Response time:
    1) 90 percent value: Less than 40 seconds.
    2) 95 percent value: Less than 60 seconds.

3. Element:
    a. Optical type that measures the fluorescence or luminescence of a ruthenium or platinum coated sensor.
    b. Using no membrane, electrodes, or electrolyte.
    c. Drift: less than 1 percent per year.
    d. Automatic self-diagnostics.
    e. Integral temperature sensor.
    f. Maximum pressure: 150 pounds per square inch.
    g. Power supply: From transmitter through the sensor cable.
    h. Enclosure: NEMA Type 6P.
4. Transmitter:
    a. Power supply:
        1) 120 VAC.
        2) Power consumption: 75 VA maximum.
    b. Outputs:
        1) Isolated 4 to 20 milliamperes DC with HART communication protocol.
    c. Microprocessor based with features resident in non-volatile memory.
    d. Display dissolved oxygen content with 0.01 ppm resolution over a range of 0.00 to 9.99 ppm and 0.1 ppm resolution over a range of 10.0 to 20.0 ppm.
    e. Display temperature with 0.2 degree Celsius accuracy.
    f. Enclosure rating: NEMA Type 4X.
    g. Automatic temperature compensation.
5. Components:
    a. Manufacturer’s cable for sensor to transmitter connection.

2.03 ACCESSORIES

A. Calibration equipment:
    1. Provide components recommended by the manufacturer to verify calibration.

B. Provide sunshade for outdoor installations.

C. Provide a ball float mount kit for mounting the sensor.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer’s standard at a facility that is traceable to the NIST:
    1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050.

B. Provide manufacturer's services to perform installation inspection, start-up and calibration/verification.

3.05 ADJUSTING

A. As specified in Section 17950.

3.06 CLEANING

A. As specified in Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

3.08 PROTECTION

A. As specified in Section 17050.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:	Carollo Engineers	ANALYZERS - DISSOLVED OXYGEN (DO)						
						Spec. No.	Rev.	
Contractor:		No	By	Date	Revision	17506 (40_75_43)		
Project:	Secondary Clarifier No.5 Design					Contract	Date	
Customer:	City of Turlock							
Plant:	Wastewater Treatment Plant					Req.	P.O.	
Location:	Turlock, California							
BOM No.:						By	Chk	App
File:								

G	1	Tag No.	AE/AIT-2312	AE/AIT-2322
E	2	Service	Aeration Basin No. 1	Aeration Basin No. 2
N	3	P&ID	04N02	04N04
S	4	Type	Luminescent, Immersion type	Luminescent, Immersion type
E	5	Operating Temperature Range	32 to 122 degrees Fahrenheit	32 to 122 degrees Fahrenheit
N	6	Resolution	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation
S	7	Sensitivity	±0.5% of span	±0.5% of span
O	8	Repeatability	±0.5% of span	±0.5% of span
R	9	Accuracy	± 0.1 ppm Below 1 ppm; ± 0.2 ppm Above 1 ppm; ± 0.2% of span	± 0.1 ppm Below 1 ppm; ± 0.2 ppm Above 1 ppm; ± 0.2% of span
	10	Manufacturer	Hach	Hach
	11	Model No.		
C	12	Style	Mfr Std.	Mfr Std.
A	13	Length		
B	14	Model No.		
L	15	Other		
E	16	Other		
	17	Type	Microprocessor-based	Microprocessor-based
T	18	Enclosure	NEMA 4X	NEMA 4X
R	19	Mounting	Remote	Remote
A	20	Range	0-20 mg/l	0-20 mg/l
N	21	Repeatability	±0.05% of range	±0.05% of range
S	22	Power Requirements	120VAC 60Hz	120VAC 60Hz
M	23	Display	Graphic dot matrix LCD with LED backlighting	Graphic dot matrix LCD with LED backlighting
I	24	Resolution	240 x 160 pixels	240 x 160 pixels
T	25	Number of sensor input channels	2	2
T	26	Outputs	4-20 mA w/ HART	4-20 mA w/ HART
E	27	Manufacturer	Hach	Hach
R	28	Model No.		
	29	Ambient Operating Temperature	-4 to 140 degrees Fahrenheit	-4 to 140 degrees Fahrenheit
	30	Relays	4 SPDT type	4 SPDT type
O	31	Mounting Kit		
P	32	Cleaning		
T	33	Power cord		

Notes:

A/E:	Carollo Engineers	ANALYZERS - DISSOLVED OXYGEN (DO)					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17506 (40_75_43)	
Project:	Secondary Clarifier No.5 Design					Contract	Date
Customer:	City of Turlock						
Plant:	Wastewater Treatment Plant					Req.	P.O.
Location:	Turlock, California						
BOM No.:						By	Chk / App
File:							

G	1	**Tag No.**	**AE/AIT-2332**	**AE/AIT-2342**
E	2	**Service**	Aeration Basin No. 3	Aeration Basin No. 4
N	3	**P&ID**	04N06	05N02
S	4	**Type**	Luminescent, Immersion type	Luminescent, Immersion type
E	5	**Operating Temperature Range**	32 to 122 degrees Fahrenheit	32 to 122 degrees Fahrenheit
N	6	**Resolution**	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation
S	7	**Sensitivity**	±0.5% of span	±0.5% of span
O	8	**Repeatability**	±0.5% of span	±0.5% of span
R	9	**Accuracy**	± 0.1 ppm Below 1 ppm; ± 0.2 ppm Above 1 ppm; ± 0.2% of span	± 0.1 ppm Below 1 ppm; ± 0.2 ppm Above 1 ppm; ± 0.2% of span
	10	**Manufacturer**	Hach	Hach
	11	**Model No.**		
C	12	**Style**	Mfr Std.	Mfr Std.
A	13	**Length**		
B	14	**Model No.**		
L	15	**Other**		
E	16	**Other**		
	17	**Type**	Microprocessor-based	Microprocessor-based
T	18	**Enclosure**	NEMA 4X	NEMA 4X
R	19	**Mounting**	Remote	Remote
A	20	**Range**	0-20 mg/l	0-20 mg/l
N	21	**Repeatability**	±0.05% of range	±0.05% of range
S	22	**Power Requirements**	120VAC 60Hz	120VAC 60Hz
M	23	**Display**	Graphic dot matrix LCD with LED backlighting	Graphic dot matrix LCD with LED backlighting
I	24	**Resolution**	240 x 160 pixels	240 x 160 pixels
T	25	**Number of sensor input channels**	2	2
T	26	**Outputs**	4-20 mA w/ HART	4-20 mA w/ HART
E	27	**Manufacturer**	Hach	Hach
R	28	**Model No.**		
	29	**Ambient Operating Temperature**	-4 to 140 degrees Fahrenheit	-4 to 140 degrees Fahrenheit
	30	**Relays**	4 SPDT type	4 SPDT type
O	31	**Mounting Kit**		
P	32	**Cleaning**		
T	33	**Power cord**		

Notes:

A/E:	Carollo Engineers	ANALYZERS - DISSOLVED OXYGEN (DO)				Spec. No.	Rev.	
Contractor:		No	By	Date	Revision	17506 (40_75_43)		
Project:	Secondary Clarifier No.5 Design					Contract	Date	
Customer:	City of Turlock							
Plant:	Wastewater Treatment Plant					Req.	P.O.	
Location:	Turlock, California							
BOM No.:						By	Chk	App
File:								

G	1	Tag No.	AE/AIT-2352	AE/AIT-2362
E	2	Service	Aeration Basin No. 5	Aeration Basin No. 6
N	3	P&ID	05N04	06N02
S	4	Type	Luminescent, Immersion type	Luminescent, Immersion type
E	5	Operating Temperature Range	32 to 122 degrees Fahrenheit	32 to 122 degrees Fahrenheit
N	6	Resolution	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation
S	7	Sensitivity	±0.5% of span	±0.5% of span
O	8	Repeatability	±0.5% of span	±0.5% of span
R	9	Accuracy	± 0.1 ppm Below 1 ppm; ± 0.2 ppm Above 1 ppm; ± 0.2% of span	± 0.1 ppm Below 1 ppm; ± 0.2 ppm Above 1 ppm; ± 0.2% of span
	10	Manufacturer	Hach	Hach
	11	Model No.		
C	12	Style	Mfr Std.	Mfr Std.
A	13	Length		
B	14	Model No.		
L	15	Other		
E	16	Other		
	17	Type	Microprocessor-based	Microprocessor-based
T	18	Enclosure	NEMA 4X	NEMA 4X
R	19	Mounting	Remote	Remote
A	20	Range	0-20 mg/l	0-20 mg/l
N	21	Repeatability	±0.05% of range	±0.05% of range
S	22	Power Requirements	120VAC 60Hz	120VAC 60Hz
M	23	Display	Graphic dot matrix LCD with LED backlighting	Graphic dot matrix LCD with LED backlighting
I	24	Resolution	240 x 160 pixels	240 x 160 pixels
T	25	Number of sensor input channels	2	2
T	26	Outputs	4-20 mA w/ HART	4-20 mA w/ HART
E	27	Manufacturer	Hach	Hach
R	28	Model No.		
	29	Ambient Operating Temperature	-4 to 140 degrees Fahrenheit	-4 to 140 degrees Fahrenheit
	30	Relays	4 SPDT type	4 SPDT type
O	31	Mounting Kit		
P	32	Cleaning		
T	33	Power cord		

Notes:

A/E:	Carollo Engineers	ANALYZERS - DISSOLVED OXYGEN (DO)					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	17506 (40_75_43)	
Project:	Secondary Clarifier No.5 Design					Contract	Date
Customer:	City of Turlock						
Plant:	Wastewater Treatment Plant					Req.	P.O.
Location:	Turlock, California						
BOM No.:						By	Chk / App
File:							

G	1	**Tag No.**	**AE/AIT-2372**
E	2	**Service**	Aeration Basin No. 7
N	3	**P&ID**	06N04
S	4	**Type**	Luminescent, Immersion type
E	5	**Operating Temperature Range**	32 to 122 degrees Fahrenheit
N	6	**Resolution**	Below 10 ppm: ±0.07 ppm or mg/L, ±0.1% saturation Above 10 ppm: ±0.01 ppm or mg/L, ±0.1% saturation
S	7	**Sensitivity**	±0.5% of span
O	8	**Repeatability**	±0.5% of span
R	9	**Accuracy**	± 0.1 ppm Below 1 ppm; ± 0.2 ppm Above 1 ppm; ± 0.2% of span
	10	**Manufacturer**	Hach
	11	**Model No.**	
C	12	**Style**	Mfr Std.
A	13	**Length**	
B	14	**Model No.**	
L	15	**Other**	
E	16	**Other**	
	17	**Type**	Microprocessor-based
T	18	**Enclosure**	NEMA 4X
R	19	**Mounting**	Remote
A	20	**Range**	0-20 mg/l
N	21	**Repeatability**	±0.05% of range
S	22	**Power Requirements**	120VAC 60Hz
M	23	**Display**	Graphic dot matrix LCD with LED backlighting
I	24	**Resolution**	240 x 160 pixels
T	25	**Number of sensor input channels**	2
T	26	**Outputs**	4-20 mA w/ HART
E	27	**Manufacturer**	Hach
R	28	**Model No.**	
	29	**Ambient Operating Temperature**	-4 to 140 degrees Fahrenheit
	30	**Relays**	4 SPDT type
O	31	**Mounting Kit**	
P	32	**Cleaning**	
T	33	**Power cord**	

Notes:

SECTION 17524

ANALYZERS: SLUDGE DEPTH

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ultrasonic interface level transmitters.
   2. Automatic sludge blanket tracker.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   3. Section 17950 - Testing, Calibration, and Commissioning.

C. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050.

1.03 DEFINITIONS

A. As specified in Section 17050.

B. Specific definitions:
   1. NIR - Near infrared.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 17050.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050:
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: one of the following or equal:
   1. Ultrasonic level measurement with 4 wire remote transmitter:
      a. EchoSmart Interface Level Analyzer.
      b. Endress+Hauser Liquiline CM, Turbimax CUS71D.
      c. HACH Sonatax SC with sc200 controller.

2.02 MANUFACTURED UNITS

A. Ultrasonic interface level measurement with 4 wire remote transmitter:
   1. General:
      a. Continuous non-contact level measurement device with remote transmitter using ultrasonic echo sensing. The transducer generates an ultrasonic pulse and measures the time required for the pulse to travel to the process surface and return. The distance is calculated from the send-and-receive duration. Each 4 wire level transmitter system includes, but not limited to:
         1) Ultrasonic transducer.
         2) Signal cable.
         3) Transmitter.

2. Performance requirements:
    a. Accuracy:
        1) 0.33 feet or within 1 percent of range, whichever is greater.
    b. Range:
        1) 1 to 29 feet minimum.
3. Ultrasonic transducer:
    a. Encapsulated in chemical and corrosion-resistant material as indicated on the Instrument Data Sheet or Instrument Index.
    b. Operating temperature range: -40 to 120 degrees Fahrenheit (-40 to 50 degrees Celsius).
    c. Operating relative humidity range: 5 to 95 percent.
    d. Functions:
        1) Single level measurement.
        2) Programmable for:
            a) Sludge blanket level.
4. Transmitter:
    a. Level indicating transmitter:
        1) Indicator: Liquid crystal display with approximately 0.50-inch display scaled to read in engineering units.
        2) Sensitivity: Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition on indicating transmitter unit.
        3) Ability to allow for signal profiles and echo mapping:
            a) Provide manufacturers software for re-mapping the signal.
        4) Transmitter signal output:
    b. Power supply:
        1) 120 VAC.
    c. Outputs:
        1) Isolated 4-20 mA DC with HART communication protocol.
        2) Relay outputs:
            a) 3 Form C contacts.
            b) Rated 5 amps at 250 VAC.
            c) Programmable.
        3) Enclosure: NEMA Type 4X, suitable for wall or pipe stand mounting.
        4) Operating temperature range from -28 to 140 degrees Fahrenheit (-33 to 60 degrees Celsius), relative humidity of 10 to 100 percent.

2.03 ACCESSORIES

A. Mounting brackets: As indicated on the Drawings.

B. Shield to protect transducer against surface skimmer.

C. Provide calibration kit.

D. Provide sunshades for outdoor installations.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer's standard at a facility that is traceable to the NIST:
   1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050.

B. Provide manufacturer's services to perform installation inspection, start-up and calibration/verification.

3.05 ADJUSTING

A. As specified in Section 17950.

3.06 CLEANING

A. As specified in Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

3.08 PROTECTION

A. As specified in Section 17050.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

A/E:	**Carollo Engineers**			**SLUDGE LEVEL INSTRUMENTS**				**Spec. No.**		**Rev.**	
Contractor:		**No**	**By**	**Date**	**Revision**	17524					
Project:	Secondary Clarifier No.5 Design					**Contract**		**Date**			
Customer:	City of Turlock										
Plant:	Wastewater Treatment Plant					**Req.**		**P.O.**			
Location:	Turlock, California										
BOM No.:						**By**		**Chk**		**App**	
File:											

GEN	**1**	**Instrument Tag Number**	AE/AIT-2651	
	2	**Service**	Secondary Clarifier No.5 Sludge Level	
	3	**P&ID**	02N01	
	4	**Other**		
PROBE	**5**	**Type**	Ultrasonic	
	6	**Housing Mat'l**	Mfr. Recommendation	
	7	**Measurement Range**		
	8	**Op. Temp. Range**		
	9	**Manufacturer**		
	10	**Model**		
	11	**Model Number**		
CABLE	**12**	**Between Power Supply and Sensor**	Manufacturer's Standard	
	13	**Other**		
	14	**Other**		
	15	**Other**		
	16	**Other**		
TRANSMITTER	**17**	**Type**	Control and Display Unit	
	18	**Operating Mode**	Continuous	
	19	**Enclosure**	NEMA 4X	
	20	**Mounting**	Remote	
	21	**Range**	0-4 FT	
	22	**Volt Requirements**	115 VAC, 60 Hz	
	23	**Power**	36 VA Maximum	
	24	**Accuracy**		
	25	**Display**	LCD	
	26	**Output**	4-20 mA w/ Hart	
	27	**Calibration**		
	28	**Status Relay**	3 Form C Contacts	
	29	**Manufacturer**		
	30	**Model No.**		
	31	**Elect. Entry**		
OTHER	**33**	**Power Supply Unit – Volt Requirements**		
	34	**Power Supply Unit – Rating**		
	35	**Power Supply Unit – Communication**		
	36			
	37			

Notes:

SECTION 17710

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design, fabrication and assembly of all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:
      a. Custom built instrumentation and control panels, including all enclosures for hand stations controllers, low voltage power distribution and marshalling panels.
      b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCPs) and chemical feed panels.
      c. Control components.
      d. Control panel installation.

B. Related sections:
   1. Section 01330 - Submittal Procedures.
   2. Section 01612 - Seismic Design Criteria.
   3. Section 16050 - Common Work Results for Electrical.
   4. Section 16075 - Identification for Electrical Systems.
   5. Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower.
   6. Section 16412 - Low Voltage Molded Case Circuit Breakers.
   7. Section 16422 - Motor Starters.
   8. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

C. Provide all control panels identified in Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.

C. Underwriters Laboratories Inc. (UL):
   1. 508 - Standard for Industrial Control Equipment.
   2. 508A - Standard for Industrial Control Panel.
   3. 913 - Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations.
   4. 1449 - Standard for Surge Protective Devices.

1.03 DEFINITIONS

A. As specified in Section 17050.

B. Specific definitions:
   1. The term “panel” in this Section is interchangeable with the term “enclosure.”

1.04 SYSTEM DESCRIPTION

A. Panel dimensions:
   1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer’s non-certified information. It is the responsibility of the Contractor or manufacturer to design and size all panels:
      a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.
      b. Panel sizes that substantially deviate (within 3 inches in any dimension) from the sizes indicated on the Drawings must be approved by the Engineer.
      c. Maximum panel depth: 30 inches, unless otherwise indicated.

B. Structural design:
   1. Completed and installed panel work shall safely withstand seismic requirements at the project site as specified in Section 16050. Enclosures and internal equipment shall be braced to prevent damage from specified forces.

1.05 SUBMITTALS

A. Provide submittals as specified in Sections 01330 and 17050.

B. Provide a control panel hardware submittal for each control panel and enclosure being provided on this project, including but not limited to:
   1. Product data:
      a. Enclosure construction details and NEMA type.
      b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.
   2. Shop drawings:
      a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
         1) Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.
      b. Complete nameplate engraving schedule.
      c. Structural details of fabricated panels.
   3. Calculations:
      a. Provide installation details based on calculated shear and tension forces:
         1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.
      b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:
         1) Weight including panel internal components.
         2) Seismic forces and overturning moments.
         3) Shear and tension forces in connections.

c. Cooling calculations, including but not limited to:
    1) Highest expected ambient temperature for the enclosure's location.
    2) Internal heat load.
    3) Exposure to direct sunlight.
    4) Dimensions of the enclosure in inches.
    5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

C. Seismic design:
    1. Seismic panel construction:
        a. Seismic anchorage: Provide seismic design calculations and installation details for anchorage of all panels, enclosures, consoles, etc. to meet seismic requirements in Section 01612:
            1) Stamped by a Professional Engineer registered in the state where the project is being constructed.
        b. For floor-mounted freestanding panels weighing 200 pounds or more (assembled, including contents), submit calculations, data sheets, and other information to substantiate that panel, base, and framing meet minimum design strength requirements and seismic requirements as specified in Section 01612. Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.

1.06 QUALITY ASSURANCE

A. As specified in Section 17050.

B. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
    1. Provide all components and equipment with UL 508 listing.
    2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL 508A labeling.
    3. Provide fuses for all equipment that is not UL or UR listed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Project environmental conditions as specified in Section 17050:
    1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 17050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As listed below in the individual component paragraphs.

B. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

2.02 EXISTING PRODUCTS

A. Provide labor and materials for complete modifications to existing panels as required.

B. Field cut and refinish existing panel faces to original condition to accommodate installation of new instruments, removal of existing instruments, and fitting of blanks to suit new layouts. New instrument supports shall be provided as required for complete installation.

2.03 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
   1. Enclosures shall have the following properties:
      a. NEMA Type 1: Steel.
      b. NEMA Type 4: Steel with gasketed door, rain-tight.
      c. NEMA Type 4X: Type 316 stainless steel (unless Type 304 is indicated on the Drawings).
      d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.
      e. NEMA Type 12: Steel with gasketed door, dust-tight.
      f. NEMA Type 7: Cast aluminum.

B. Bolting material:
   1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
   2. Carriage bolts for attaching end plates.
   3. All other bolted joints shall have S.A.E. standard lock washers.

2.04 MANUFACTURED UNITS

A. Panels/enclosures:
   1. Manufacturer: One of the following or equal:
      a. Rittal.
      b. Pentair (formerly Hoffman Engineering).
      c. Saginaw Control & Engineering.
   2. Panel assembly:
      a. General guidelines for panel fabrication include:
         1) Continuous welds ground smooth.
         2) Exposed surfaces free of burrs and sharp edges.
         3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.
      b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	14	14
Up to 57	12	12
57 - 69	12	10
69 - 82	12, except 10 on back	10
82 or more	10	10

         1) Use heavier sheet metal to meet seismic requirements at the project site or when required due to equipment requirements.
      c. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.
      d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.
      e. Door construction:
         1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
         2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
         3) Heavy-gauge piano-type continuous stainless steel hinges.
         4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
         5) Gasket installed to seal against roll lip on the enclosure opening.
      f. Latches:
         1) For panels, provide each door with a 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely,

and form a compressed seal between door and gasket, at the top, side, and bottom:
a) Provide padlock for each enclosure with padlock provisions.
2) Include an oil-tight key-locking, 3-point latching mechanism on each door:
a) Provide 2 keys per panel.
b) All locks keyed alike.
3) For large NEMA Type 4 and NEMA Type 4X cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.

g. Panel cut-outs:
1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
2) Allow a minimum of 3-inch envelope around all displays, controllers, and monitors.
3) Reinforce around cut-outs with steel angles or flat bars for the following:
a) Large panel cutouts; for example, openings for local operator interfaces.
b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.

3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
a. Minimum 14-gauge, Type 304 stainless steel.
b. Captive stainless steel cover screws threaded into sealed wells.
c. Inside finish: White polyester powder coating.
d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.

4. In addition to the requirements specified above, the following requirements apply for NEMA Type 4X non-metallic enclosures:
a. Fiberglass construction.
b. 10-gauge plate-steel reinforcing on the sides, top, and bottom.
c. All seams sealed.
d. Fiberglass hinges with no exposed metal parts.
e. Captivate stainless steel door screws.
f. Provisions for internal, sidewall mounting panels either by welded channels to the interior, or by welded collar studs.
g. Provide aluminum mounting panels.
h. Non-metallic enclosures are not an acceptable substitute for stainless steel unless indicated on the Drawings.

5. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
b. Door hardware: Stainless steel.
c. Provide factory installed rain canopy and sun shield for all enclosures with operator interface panels.
d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.

B. Arrangement of components:
   1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
   2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.
   3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
   4. All control-panel-mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

C. Overcurrent protection:
   1. Main overcurrent device:
      a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:
         1) Door-mounted disconnect handles are not acceptable.
         2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
         3) Provide means to defeat the interlock.
         4) Lockable in the off position.
      b. Control panels supplied with 120 VAC:
         1) Provide an internal breaker with the line side terminals covered by a barrier.
         2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
   2. Provide circuit breakers as specified in Section 16412.
   3. Selection and ratings of protective devices:
      a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
      b. Voltage rating: Not less than the voltage of the application.
      c. Select current rating and trip characteristics to be suitable for:
         1) Maximum normal operating current.
         2) Inrush characteristics.
         3) Coordination of the protective devices to each other and to the source breaker feeding the panel.
   4. Provide a separate protective device for each powered electrical device:
      a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
      b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
         1) Size external fuse to open before any I/O-card-mounted fuses.
         2) Individual discrete inputs shall use a 0.5-ampere fuse.
      c. Control loops can use individual 5-ampere fuse for the loop.
      d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.

5. Fuses for 4 to 20 milliamperes signals:
    a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
        1) Label shall not cover or interfere with equipment manufacturer's instructions.
    b. An individual 1/2-ampere fuse for each 4 to 20 milliamperes analog loop powered from the control panel.
    c. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
    d. Manufacturer: One of the following or equal:
        1) Ferraz Shawmut.
        2) Littelfuse.
        3) Bussmann.
6. Fuse holders:
    a. Modular type:
        1) DIN rail mounting on 35-millimeter rail.
        2) Touch-safe design: All connection terminals to be protected against accidental touch.
        3) Incorporates blown-fuse indicator.
    b. Provide nameplate identifying each fuse:
        1) As specified in Section 16075.
    c. Manufacturer: One of the following or equal:
        1) Phoenix Contact.
        2) Allen-Bradley 1492-FB Series B.
7. Control circuit breakers:
    a. DIN rail mounting on 35-millimeter rail.
    b. Manual OPEN-CLOSE toggle switch.
    c. Rated for 250 VAC.
    d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
    e. Current ratings: As indicated on the Drawings or as required for the application.
    f. Provide nameplate identifying each circuit breaker:
        1) As specified in Section 16075.
    g. Manufacturer: One of the following or equal:
        1) Phoenix Contact.
        2) ABB.
        3) Allen-Bradley.
        4) Square D.

D. Conductors and cables:
1. Power and control wiring:
    a. Materials: Stranded, soft annealed copper.
    b. Insulation: 600 volts type MTW.
    c. Minimum sizes:
        1) Primary power distribution: 12 AWG.
        2) Secondary power distribution: 14 AWG.
        3) Control: 16 AWG.
    d. Color:
        1) AC power (line and load): Black.
        2) AC power (neutral): White.
        3) AC control: Red.

4) AC control: Orange for foreign voltages.
5) DC power and control (ungrounded): Blue.
6) DC power and control (grounded): White with Blue stripe.
7) Ground: Green.

2. Signal cables:
   a. Materials: Stranded, soft annealed copper.
   b. Insulation: 600 volts, PVC outer jacket.
   c. Minimum size: 18 AWG paired triad.
   d. Overall aluminum shield (tape).
   e. Copper drain wire.
   f. Color:
      1) 2-Conductor:
         a) Positive (+): Black.
         b) Negative (-): White and red.
      2) 3-Conductor:
         a) Positive (+): Black.
         b) Negative (-): Red.
         c) Signal: White.
   g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:
   1. Identify each conductor and cable with unique wire numbers as specified in Section 16075.
   2. Readily identified without twisting the conductor.

F. General wiring requirements:
   1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
   2. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.
   3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
   4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
   5. Provide power surge protection for all control panels.
   6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
   7. Provide non-metallic ducts for routing and organization of conductors and cables:
      a. Provide wiring separation plan.
      b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
      c. Provide separate ducts for signal and low-voltage wiring from power and 120-VAC control wiring:
         1) 120 VAC: Grey colored ducts.
         2) 24 VDC: White colored ducts.

8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
    a. Screw-on cable tie mounts.
    b. Hammer-on cable-tie mounting clips.
    c. Fingers of the nonmetallic duct.
9. Wire Ties:
    a. No wire ties inside wire duct.
    b. Use Panduit Cable tie installation tool, with tension control/cutoff.
    c. Verify cut ends are cut flush filed smooth after installed.
10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
11. Support panel conductors where necessary to keep them in place.
12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
    a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.
14. The control panel shall be the source of power for all 120-VAC devices interconnected with the control panel including, but not limited to:
    a. Solenoid valves.
    b. Instruments both mounted in the control panel and remotely connected to the control panel.

G. Provide power circuits for all Contractor and Vendor-furnished PLC cabinets in accordance with typical detail NE303.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Thermal management:
    1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range as specified in Section 17050.
    2. Air conditioner:
        a. Provide solid-state cabinet coolers or air conditioning units on all outdoor panels containing electronic components such as local operator interface (LOI) units, panel instruments, programmable logic controllers, or remote I/O.
        b. Provide filters on intake and exhaust openings.
        c. Increase panel sizes as needed to accommodate cooling units.
        d. Enclosure rating: Rated to match panel requirements.
        e. Power supply: 120 VAC.
        f. Manufacturer: The following or equal:
            1) Kooltronic Integrity Series 21.
    3. Heating:
        a. Provide all panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:
            1) The panel is not supplied with 120 VAC power.

2) There are no electronics or moisture-sensitive devices in the enclosure.
3) The panel is smaller than 38 inches high.

4. Heat exchanger:
   a. Closed-loop design ensuring separation of ambient air and clean air inside the cabinet.
   b. Filterless design to facilitate easy cleaning of the core.
   c. Mounting: As indicated on the Drawings.
   d. Manufacturer: The following or equal:
      1) Noren CC Series.
5. Enclosure temperature sensor as indicated on the Drawings:
   a. Provide wall-mounted RTD transmitter (to measure internal cabinet temperature) in all enclosures containing electrical components such as PLCs, RTUs, RIO, and VFDs.
   b. Platinum RTD.
   c. 4-20 mA DC output.
   d. Sensor and electronic enclosure.
   e. Accuracy: Within 2 degrees Fahrenheit.
   f. Manufacturer: One of the following or equal:
      1) Omega EWS Series.
      2) TCS Basys Controls TS Series as indicated on the Drawings.
6. Enclosure temperature switch:
   a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
   b. Sensor and electronic enclosure.
   c. Accuracy: Within 2 degrees Fahrenheit.
   d. Manufacturer: The following or equal:
      1) Hoffman ATEMNO/C.
      2) Pfannenberg FLZ.
7. Fan ventilation:
   a. Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.
   b. Provide finger-guard kit.
   c. Filter kit with 2 spare filters for each intake fan.
   d. Provide bezel and gasket kit.
   e. Provide fan shroud.
   f. Automatically adjust fan speed depending on remote temperature sensor input.
   g. 120 VAC, 60 Hertz.

B. Panel meters:
   1. Pointer type:
      a. Suitable for panel mounting.
      b. Minimum scale length: 3 inches.
      c. Calibrated in engineering units.
      d. Accuracy: Within 2 percent of span.
      e. NEMA Type 4/IP65 sealed front metal bezel.
      f. Manufacturer: The following or equal:
         1) Yokogawa.
         2) Red Lion.

2. Digital process indicating controllers:
    a. General:
        1) Integral provisions for scaling.
        2) Scale to process engineering units.
        3) Switch-programmable decimal points.
        4) Rated to retain NEMA rating of enclosure.
    b. Current and voltage indicators:
        1) 5-digit minimum.
        2) Minimum character height: 0.5 inches.
        3) Accuracy:
            a) AC/DC volts: Within 0.1 percent of reading plus 2 digits.
            b) DC current: 4 to 20 milliamperes; within 0.1 percent of reading plus 1 digit.
            c) DC voltage: 0 to 10 volts; within 0.1 percent of reading plus 1 digit.
        4) Outputs:
            a) As shown on Drawings.
            b) Contacts rated for 3A at 120VAC or 30VDC.
    c. Operating voltage: 120 VAC.
    d. Operating temperature: 0 to 60 degrees Celsius:
        1) Manufacturer: One of the following or equal:
            a) Red Lion.
3. Digital bar graph meter:
    a. Self-contained instruments that display process signals directly in engineering units, both in decimal format and as a bar graph display.
    b. Suitable for panel mounting.
    c. LED display:
        1) Not less than 3 decimal digits.
        2) Not less than a 101-segment LED bar graph.
    d. Input signal:
        1) All conventional current loops and voltage control signals.
    e. Minimum sample rate of once per second.
    f. Provisions for field-adjustable scaling and/or offset.
    g. Accuracy shall be within 1 least-significant digit.
    h. Manufacturer: One of the following or equal:
        1) Ametek Dixson.
        2) Yokogawa.
        3) Weschler Instruments.
4. Counters:
    a. 6 digits.
    b. Switch-selectable inputs:
        1) Switch contacts.
        2) CMOS.
        3) TTL.
        4) Magnetic pickup.
        5) RLC sensors.
    c. Selectable up/down control via external signal.
    d. Remote reset.
    e. Remote inhibit to prevent accumulating counts.
    f. Programmable to enable or disable front panel reset.
    g. Non-volatile memory to retain all data upon loss of supply power.

h. Sunlight readable.
i. Operating temperature: 0 to 50 degrees Celsius.
j. Manufacturer: The following or equal:
1) Red Lion PAX Series.

C. Pilot devices:
1. General:
a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
b. Size:
1) 30.5 millimeters.
c. Heavy duty.
d. Pushbuttons:
1) Contacts rated:
a) NEMA Type A600.
2) Furnish 1 spare normally open contact and normally closed contact with each switch.
e. Selector switches:
1) Contacts rated:
a) NEMA Type A600.
b) Knob type.
2) Furnish 1 spare normally open contact and normally closed contact with each switch.
3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
f. Pilot lights:
1) Type:
a) LED for interior installations.
2) Push to test.
3) Lamp color:
a) On/Running/Start: Red.
b) Off/Stop: Green.
c) Power: White.
d) Alarm: Amber.
e) Status or normal condition: White.
f) Opened: Amber.
g) Closed: Blue.
h) Failure: Red.
2. Indoor and outdoor areas:
a. NEMA Type 4/13.
b. Manufacturer: One of the following, no equal:
1) Allen-Bradley Type 800T.
2) Square D Class 9001, Type K.
3) General Electric Type CR104P.
4) IDEC TWTD Series.
3. Corrosive areas:
a. NEMA Type 4X.
b. Corrosion resistant.
c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.

d. Manufacturer: One of the following, no equal:
    1) Cutler Hammer Type E34.
    2) Square D Class 9001, Type SK.
    3) Allen-Bradley Type 800H.
    4) IDEC TWTD Series.
4. Hazardous (Classified) Areas/Class I Division 2:
    a. NEMA Type 4X.
    b. Corrosion resistant.
    c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc:
        1) All contacts contained within a hermetically sealed chamber:
            a) Pushbuttons.
            b) Selector switches.
            c) Push-to-test contacts on pilot lights.
        2) UL listed and labeled for Class I Division 2 areas.
    d. Manufacturer: One of the following, no equal:
        1) Cutler Hammer Type E34.
        2) Allen-Bradley Type 800H.

D. Potentiometer and slidewire transmitters:
1. Provide a DC output in proportion to a potentiometer input.
2. Potentiometer input:
    a. 100 ohms to 100 K ohms.
    b. Impedance Greater or equal to 1 M ohms.
    c. Zero turn-up: 80 percent of full-scale input.
    d. Span turn-down: 80 percent of full-scale input.
3. Field-configurable output:
    a. Voltage and current: All conventional current loops and voltage control signals.
4. Accuracy including linearity and hysteresis within 0.1 percent maximum at 25 degrees Celsius.
5. Operating temperature: 0 to 55 degrees Celsius.
6. Supply power: 9 to 30 VDC.
7. Manufacturer: The following or equal:
    a. Phoenix Contact.

E. Signal isolators and converters:
1. Furnish signal isolators that provide complete isolation of input, output, and power input:
    a. Minimum isolation level: 1.5 kilovolts AC/50 Hertz for at least 1 minute.
    b. Adjustable span and zero.
    c. Accuracy: Within 1.0 percent of span.
    d. Ambient temperature range: -20 to +65 degrees Celsius.
2. Manufacturer: One of the following or equal:
    a. Phoenix Contact MCR Series.
    b. Acromag 1500, 600T, 800T, Flat Pack, or ACR Series.
    c. Action Instruments Q500 Series or Ultra SlimPakII.
    d. AGM Electronics Model TA-4000.

F. Relays:
   1. General:
      a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
      b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
   2. General purpose:
      a. Magnetic control relays.
      b. NEMA Type A300 rated:
         1) 300 volts.
         2) 8 Amps continuous (minimum).
         3) 7,200 volt-amperes make.
         4) 720 volt-amperes break.
      c. Plug-in type.
      d. LED indication for energization status.
      e. Coil voltages: As required for the application.
      f. Minimum poles: DPDT.
      g. Touch-safe design: All connection terminals to be protected against accidental touch.
      h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
      i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
      j. Relays with screw-type socket terminals.
      k. Provide additional (slave/interposing) relays when the following occurs:
         1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
         2) Higher contact rating is required in order to interface with starter circuits or other equipment.
      l. DIN rail mounting on 35-millimeter rail.
      m. Ice-cube-type relays with retainer clips to secure relay in socket.
      n. Integrated label holder for device labeling.
      o. Manufacturer: One of the following or equal:
         1) Phoenix Contact PLC Series.
         2) Potter and Brumfield Type KRP or KUP.
         3) IDEC R* Series (* = H, J, R, S, U).
         4) Allen-Bradley Type 700 HC.
         5) Square D Type K.
   3. Latching:
      a. Magnetic-latching control relays.
      b. NEMA Type B300 rated:
         1) 300 volts.
         2) 10 Amps continuous.
         3) 3,600 volt-amperes make.
         4) 320 volt-amperes break.
      c. Plug-in type.
      d. DIN rail mounting on 35-millimeter rail.
      e. Coil voltage: As required for the application.
      f. Minimum poles: 2 PDT; as required for the application. Plus 1 spare pole.
      g. Touch-safe design: All connection terminals to be protected against accidental touch.
      h. Clear cover for visual inspection.

i. Provide retainer clip to secure relay in socket.
j. Manufacturer: One of the following or equal:
1) Square D 8501, Type K.
2) IDEC TWTD Series.

4. Time delay:
a. Provide time-delay relays to control contact transition time.
b. Contact rating:
1) 240 volts.
2) 10 Amps continuous.
3) 3,600 volt-amperes make.
4) 360 volt-amperes break.
c. Coil voltage: As required for the application.
d. Provide pneumatic or electronic type with on-delay, off-delay, and on/off-delay:
1) For off-delay, use true power-off time-delay relays. Where the required timing range exceeds capability of the off-delay relay use, signal off-delay where power loss will not cause undesirable operation or pneumatic time-delay relays.
e. Minimum poles: 2 PDT.
f. Units include adjustable dial with graduated scale covering the time range in each case.
g. Minimum timing range: 0.1 seconds to 10 minutes, or as required for the application.
h. Manufacturer: One of the following or equal:
1) IDEC RTE Series.
2) Agastat Series 7000 (pneumatic).
3) Allen-Bradley Type 700-HR.

G. Terminal blocks:
1. DIN rail mounting on 35-millimeter rail.
2. Suitable for specified AWG wire.
3. Rated for 15 amperes at 600 volts.
4. Screw terminal type.
5. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
6. Finger-safe protection for all terminals for conductors.
7. Construction: Polyamide insulation material capable of withstanding temperature extremes from - 40 to 105 degrees Celsius.
8. Terminals: Plainly identified to correspond with markings on the diagrams:
a. Permanent machine-printed terminal identification.
9. Disconnect-type field signal conductor terminals with socket/screw for testing.
10. Identify terminals suitable for use with more than 1 conductor.
11. Position:
a. So that the internal and external wiring does not cross.
b. To provide unobstructed access to the terminals and their conductors.
12. Provide minimum 25-percent spare terminals.
13. Manufacturer: One of the following or equal:
a. Phoenix Contact UK5 Series.
b. Allen-Bradley 1492 Series.

H. Wire duct:
   1. Provide flame retardant plastic wiring duct, slotted with dust cover.
   2. Type:
      a. Wide slot.
      b. Narrow slot.
      c. Round hole.
   3. Manufacturer: The following or equal:
      a. Panduit.

I. Din Rail:
   1. Perforated Steel.
   2. 35mm width.
   3. 15mm deep.
   4. Provide 2 inch offset using one of the following:
      a. Offset brackets.
      b. Preformed standoff Din Rail Channel.

J. Surge protection devices:
   1. Control panel power:
      a. 120-volt control power source: Non-UPS powered:
         1) Provide surge protection device (SPD) for panel power entrances:
            a) Nominal 120-VAC with a nominal clamping voltage of 200 volts.
            b) Non-faulting and non-interrupting design.
            c) A response time of not more than 5 nanoseconds.
         2) Control panel power system level protection, non-UPS powered:
            a) Designed to withstand a maximum 10-kA test current of an 8/20 µs waveform according to IEEE C62.41.1 Category C Area.
            b) For panels receiving power at 120 VAC, provide surge protection at secondary of main circuit breaker.
            c) Provide both normal mode noise protection (line to neutral) and common mode (neutral to ground) surge protection.
            d) DIN rail mounting.
            e) Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
               (1) Gas-tight connections.
               (2) The terminal block: Fabricated of non-ferrous, non-corrosive materials.
            f) Visual status indication of MOV status on the input and output circuits.
            g) Dry contact rated for at least 250 VAC, 1 Amp for remote status indication.
            h) Meeting the following requirements:
               (1) Response time: Less than or equal to 100 ns.
               (2) Attenuation: Greater than or equal to -40 dB at 100 kilovolt-Hertz as determined by a standard 50-ohm insertion test.
               (3) Safety approvals:
                  (a) UL 1283 (EMI/RFI Filter).
                  (b) UL 1449 2nd Edition.

i) Manufacturer: One of the following or equal:
(1) Phoenix Contact Type SFP TVSS/Filter.
(2) Liebert Accuvar Series.
(3) Islatrol.

b. 120-volt control power source: UPS powered:
1) Provide surge protection on the control power source at each panel containing power supplies, or electronic components including PLCs, I/O, HMI, and digital meters.
2) Location:
a) For panels with a UPS, install surge protection ahead of UPS and maintenance bypass switch:
(1) Surge protection is not required for 120-VAC circuits that are only used for panel lights and receptacles.
b) For panels receiving power at 480 VAC, provide surge protection on the 120-VAC control power transformer secondary.
3) MCOV: 150 VAC.
4) Surge capability (8/20 µs wave): 10 kA.
5) Peak let-through: 620V L-N, 850V L-G.
6) Manufacturer: One of the following or equal:
a) Phoenix Contact Plugtrab PT Series.
b) MTL Surge Technologies MA15 Series.

2. Instrument, data, and signal line protectors (traditional I/O) – panel mounted:
a. Surge protection minimum requirements: Withstand a 10-kA test current of an 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
b. DIN rail mounting on 35-millimeter rail (except field-mounted SPDs).
c. SPDs consisting of 2 parts:
1) A base terminal block.
2) A plug protection module:
a) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
b) Base and plug coded to accept only the correct voltage plug.
d. SPD manufacturer: One of the following or equal:
1) Phoenix Contact Plugtrab Series.
2) Bournes Series 1800.

3. Instrument, data, and signal line protectors (traditional I/O) – field mounted:
a. Surge protection minimum requirements: Withstand a minimum 10-kA test current of an 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
b. Manufacturer: One of the following or equal:
1) Plugtrab PT Series.
2) MTL TP48 Series.

4. Fieldbus network protectors: Panel mounted:
a. DeviceNet network surge protectors:
1) Manufacturer: One of the following or equal:
a) Phoenix Contact Trabtech MCR-Plugtrab PT PE/S+1x2-BE header with PT PE/S+1x2-24-ST plug.
b) Transtector Systems Inc. DN-24 Series.
2) Nominal operating voltage: 24 VDC.
3) Maximum continuous operating voltage: 35 VDC.

4) Shall withstand a surge current (8/20 µs combination wave) of 700 amperes.
5) Operating temperature range: -40 to 85 degrees Celsius.

K. Horns and beacons:
1. Beacons/horn combination units:
a. Manufacturer: One of the following or equal:
1) Federal Signal Multi-Status LED 108i with tone module.
2) LED Colors: Red, Green, Amber.
3) Power: 120VAC.
4) Provide accessories such as pipe mount flange, pipe extensions, corner mount brackets, or wall mount brackets as needed.
b. Horn rated 80 dB minimum at 10 feet.
2. Dedicated beacon unit:
a. Manufacturer: One of the following or equal:
1) Federal Signal Corp Starfire Series.
2) Allen-Bradley 855 B *-* 10 Series.
3) Edwards 102 Series.
3. Dedicated horn unit:
a. Electromechanical:
1) Manufacturer: One of the following or equal:
a) Federal Signal 350 or 31X Series.
b) Edwards 878EX or 879EX Series.
b. Electronic:
1) Manufacturer: One of the following or equal:
a) Federal Signal 300GCX or 300X Series.
b) Allen-Bradley 855H or 855XH Series.
c) Edwards 5530M or 5533MD Series.
c. Rated for 80 dB minimum at 10 feet.

L. Power supplies:
1. Design power supply systems so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the system operation.
2. Convert 120 VAC to 24 volt DC or other DC voltages required or as required for the application.
3. Provide backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure:
a. Provide automatic switchover upon module failure.
b. Alarm contacts monitored by the PLC.
5. Sized to provide 40-percent excess rated capacity.
6. UL 508C listed to allow full rated output without de-rating.
7. Provide fuse or short-circuit protection.
8. Provide a minimum of 1 set of dry contacts configured to change state on failure for monitoring and signaling purposes.
9. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change:
a. With remote voltage sensing.
10. Operating temperature range: 0 to 50 degrees Celsius.

11. Touch-safe design: All connection terminals to be protected against accidental touch.
12. DIN rail mounting on 35-millimeter rail.
13. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
14. Manufacturer: One of the following or equal:
    a. Fully redundant:
        1) Phoenix Contact Quint Power Supply with SFB technology:
            a) Phoenix Contact Quint - O-ring redundancy module
        2) IDEC PS5R Series:
            a) With redundancy Diode
    b. Sola.
    c. Acopian.
    d. PULS.

M. Intrinsic safety barriers:
1. Transformer isolated barrier:
    a. Containing a transformer to provide complete:
        1) Isolation between the safe and hazardous areas for loop-powered devices.
        2) 3-way isolation between the safe area, hazardous area, and power supply powered devices.
    b. Resistor for current limitation.
    c. Fuses for short-circuit protection.
    d. Provide barriers with pluggable connectors that are coded for easy replacement.
    e. Transmission error shall be less than or equal to 0.1 percent of full scale.
    f. DIN rail mounting on 35-millimeter rail.
    g. Approvals:
        1) FM.
        2) UL 913.
2. Types:
    a. Switch isolators:
        1) Designed and approved for use with discrete inputs.
        2) Supply power: 20 to 30 VDC.
        3) Output to track input.
        4) LED in the cover to indicate the status of the input.
        5) Selector switch to change the logic of the input.
        6) Input: Dry contact.
        7) Output: SPDT relay.
    b. Transmitter and converters for use with 4- to 20-milliampere signals without Hart® communications capability:
        1) Designed and approved for use with 4- to 20-milliampere analog signals.
        2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
        3) Supply voltage: 20 to 30 VDC.
    c. Transmitter and converters for use with 4- to 20–milliampere signals with Hart® communications capability:
        1) Designed and approved for use with 4- to 20-milliampere analog signals.

2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
3) Transfer digital signals from the hazardous area to the safe area.
4) Complete bi-directional communication between a smart transmitter located in the field and the suitable equipment located in the safe area.
5) Supply voltage: 20 to 30 VDC.

3. Manufacturer: One of the following or equal:
   a. Phoenix Contact ME Series.
   b. Pepperl + Fuchs.

N. Starters:
1. Magnetic motor starters:
   a. As specified in Section 16422.

O. Variable frequency drives:
1. As specified in Section 16262.

P. Limit switches:
1. NEMA Type 4X.
2. AC contact rating 120 volts, 10 A.
3. DC contact rating 125 volts, 0.4 A.
4. Provide robust actuation mechanism not prone to degradation.
5. Provide complete actuator mechanism with all required hardware.
6. Allows for contact opening even during contact weld condition.
7. UL approved.
8. Operating temperature range: -18 to +110 degrees Celsius (0 to 230 degrees Fahrenheit).
9. Manufacturer: One of the following or equal:
   a. Allen-Bradley 802 Series.
   b. Honeywell HDLS Series.
   c. Omron D4 Series.
   d. Eaton E47, E49, E50.
   e. ABB.

Q. Current switches:
1. Operate from 120-VAC supply voltage.
2. 1 normally open and normally closed contacts.
3. Adjustable current setting.
4. Manufacturer:
   a. Zelio® RM35.

2.07 ACCESSORIES

A. As specified in Section 17050.

B. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

C. Provide 15-inch floor stands or legs where needed or as indicated on the Drawings.

D. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.

E. Provide nameplate to each panel as indicated on the Drawings:
   1. Provide as specified in Section 16075 on all internal and external instruments and devices.
   2. Provide a nameplate with the following markings that is plainly visible after installation:
      a. Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
      b. Supply voltage, phase, frequency, and full-load current.
      c. Power source or circuit ID.
      d. Short-circuit current rating of the panel based on one of the following:
         1) Short-circuit current rating of a listed and labeled assembly.
         2) Short-circuit current rating established utilizing an approved method.

F. Provide a window kit where indicated on the Drawings or where a transmitter with display is mounted inside a control panel. The window shall meet the following requirements:
   1. Safety plate glass.
   2. Secured by rubber locking seal.
   3. Allow full viewing of devices issuing visual process data or diagnostics.

G. Lighting:
   1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
      a. Covered or guarded.
      b. Provide On-Off door-activated switches where indicated on the Drawings.
      c. 120-volt, single-phase, 15-amp style plug.
      d. Provide 4,000 K, 900 Lumens – LED fixture:
         1) Provide additional fixtures for every 36 inches of width.

H. Receptacles:
   1. Provide 1 duplex receptacle located every 4 feet of enclosure width, spaced evenly along the back mounting panels.
   2. GFCI, 120-volt, single-phase, 15-amp style plug.
   3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.

I. Grounding:
   1. Provide the following:
      a. Grounding strap between enclosure doors and the enclosure.
      b. Equipment grounding conductor terminals.
      c. Provide equipment ground bus with lugs for connection of all equipment grounding wires.
      d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding bus.
   2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND," the letter "G," or the color green.

3. Signal (24 VDC) grounding: Terminate each drain wire of a signal (shielded) cable to a unique grounding terminal block, or common ground bus at the end of the cable as shown on the Loop Drawings.
4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
8. Connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.
10. Bond together all remote and local control panels, processor racks, and conductive enclosures of power supplies and connect to the equipment-grounding circuit to provide a common ground reference.

J. Provide sunshades and insulation for all outdoor installations.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finishes:
1. Metallic (non-stainless):
a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
b. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry-film thickness and allowed to dry before applying the finish coat.
c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.
2. Stainless steel:
a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

B. Colors:
1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
3. Panel interiors shall be manufacturer's standard white.

2.11 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install enclosures so that their surfaces are plumb and level within 1/8 inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.

B. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.

C. Provide floor stand kits for wall-mounted enclosures larger than 48 inches high.

D. Provide 3-1/2-inch high concrete housekeeping pads for freestanding enclosures.

E. Install gasket and sealing material under panels with floor slab cutouts for conduit:
   1. Undercoat floor-mounted panels.

F. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

G. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or mis-cut holes shall require that the entire enclosure be replaced.

H. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule, but shall be shown on the Loop Drawings prepared by the Contractor.

I. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.

J. Side Panels:
   1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05 REPAIRS/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 17050.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 17050.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 17050.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17733

CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Materials and equipment used in process control and LAN networks including:
      a. Network switches.
      b. Media converters.
      c. Patch panels and other data network hardware.
      d. Related accessories.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.
      b. Section 16075 - Identification for Electrical Systems.
      c. Section 16125 - Fiber Optic Cable and Appurtenances.
      d. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
      e. Section 17730 - Control Systems: PCS Computer Equipment.
      f. Section 17950 - Testing, Calibration, and Commissioning.

1.02 REFERENCES

A. As specified in Section 17050.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 802.3 - Ethernet.
   2. 802.11 - Wireless LANs.

1.03 DEFINITIONS

A. As specified in Section 17050.

1.04 SYSTEM DESCRIPTION

A. Provide all network equipment identified in the Contract Documents.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 and 17050.

B. Product data:
   1. Include information on all network equipment.
   2. Manufacturer’s operation and installation instructions.

C. Shop drawings:
   1. Complete set of drawings including but not limited to:
      a. System block diagram showing relationship and connections between devices provided under this Contract and existing equipment. Include manufacturer and model information, and address settings.
      b. Network riser diagram.
      c. Network port diagram, which physically locates all ports within the facility, and identifies their patch panel and switch port.
      d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
      e. Electrical connection diagrams.
      f. Complete grounding requirements.
   2. Furnish data sheets for each component together with a technical product brochure or bulletin:
      a. Manufacturer's model number.
      b. Project equipment tag.
   3. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
      a. Quantity.
      b. Description.
      c. Manufacturer.
      d. Part numbers.

D. Test reports:
   1. As specified in Sections 16125 and 17950, and noted in this Section.
   2. Signed test results as described in this Section.
   3. Test results shall include:
      a. Narrative describing the test procedures followed.
      b. Block diagram of test set up.
      c. Manufacturer’s information on test equipment used.
      d. Detailed test results.
      e. A narrative summarizing the results of the testing and identifying any further action required.

E. Operating manuals:
   1. Complete installation, operation, calibration, and testing manuals as specified in Section 17050.

F. Record drawings:
   1. As specified in Section 17050.
   2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.06 QUALITY ASSURANCE

A. As specified in Section 17050.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 17050.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Ethernet switches:
   1. Managed Process Floor Ethernet switches:
      a. Manufacturers: One of the following, no equal:
         1) Cisco Catalyst 2000.
         2) N-TRON 7000.
         3) Hirschmann Power MICE.
      b. Properties:
         1) Hardware:
            a) Power supply:
               (1) Redundant power supplies.
               (2) 24 VDC, 350 Watts per power supply.
            b) No fans or moving parts.

2) Performance:
    a) Switch fabric speed: 8 Gbps, minimum.
    b) Gigabit throughput.
    c) Latency 2.9 microseconds.
    d) Enclosure:
        (1) All metal hardened housing.
        (2) 15g Shock for 10ms minimum.
        (3) Cat 6 grounding for shield drains.
    e) 10/100Base-TX RJ-45 Copper Ports (quantity as indicated on the Drawings).
    f) 100Base-FX Full Duplex Fiber Optic Ports (quantity as indicated on the Drawings).
    g) 1,000Base-T Mini GBIC Full Duplex (quantity as indicated on the Drawings).
    h) Ports will auto negotiate speed duplex and MDIX.
    i) MTBF of 2M Hours.
    j) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
        (1) Full SNMP and Web Browser Management.
        (2) Detailed Ring Map and Fault Location Charting Web Browser display.
        (3) VLAN.
        (4) QoS.
        (5) Trunking.
        (6) CIP Messaging.
        (7) Port Mirroring.
        (8) DHCP Server with Option 61, Option 82 Relay Agent and Local IP Addressing.
    k) OPC 2.0 Compliant Monitoring.
    l) IGMP Snooping with Ethernet I/P plug & play compatibility.
    m) RJ-45 Copper Ports Auto Negotiates Speed, Duplex, and MDIX.
    n) Store-and-forward technology.
    o) Redundant Power Inputs (10-30 VDC).
    p) 802.1d, 802.1w, 802.1D RSTP.
    q) Rapid Spanning Tree protocol.
    r) Ring Management with 30ms heal times.
3) Environment:
    a) Operating temperature range: 32 to 140 Degrees Fahrenheit.
    b) Humidity: 15 to 95 percent, non-condensing.
4) Connector type:
    a) Fiber: SC.
    b) Copper: RJ-45:
        (1) Quantity of copper and fiber ports as required to provide connections as indicated on the Drawings: As required to provide the number of connections required plus 20 percent spare or 2 ports of each type used, whichever is greater.
5) Mounting:
    a) DIN Rail mounting.

2. Unmanaged Ethernet switches:
    a. Manufacturers: One of the following or approved equal:
        1) Moxa 308/305 Series.
        2) Cisco equivalent.
    b. Properties:
        1) Hardware:
            a) 10/100 BaseFX.
            b) 100Base-FX.
            c) Power supply:
                (1) Provide redundant power supplies.
                (2) 24 VDC, 200 Watts/per power supply.
                (3) Store and forward.
            d) No fans or moving parts.
        2) Performance:
            a) Full/half-Duplex.
            b) MDI/MDI-X Auto-sensing.
        3) Environment:
            a) Operating temperature range: 32 to 140 Degrees Fahrenheit.
            b) Humidity: 5 to 95 percent, non-condensing.
        4) The Ethernet switch shall be capable of performing basic switching without special programming or configurations.
        5) Ports:
            a) As required to provide the number of connections required plus 20 percent spare of each type used.
        6) Connector type:
            a) Fiber: SC.
            b) Copper: RJ-45.
        7) Mounting:
            a) Din Rail.

B. Media converters:
    1. Copper to fiber transceiver:
        a. Manufacturers: One of the following or approved equal:
            1) N-TRON.
            2) Transition Networks.
            3) Phoenix Contact.
        b. Transceiver shall be used to convert from Half/Full Duplex Ethernet to multimode fiber Ethernet 100Base-FX:
            1) Meets requirements of IEEE 802.3 Ethernet standard.
            2) Supports Half/Full Duplex.
            3) Connector type:
                a) Fiber: SC.
                b) Copper: RJ-45.
            4) Power supply:
                a) 110 VAC, 60 hertz.
                b) 24 VDC, 6 watts.
            5) Mounting:
                a) Provide mounting hardware.
                b) DIN rail mounting, unless otherwise indicated on the Drawings.

C. Patch panels:
    1. General:
        a. Fiber:
            1) All optical fibers shall be provided with strain relief and terminated at a fiber patch panel. Final connections between the patch panel and the fiber optic network equipment shall be made via fiber optic patch cords.
            2) All fibers, active and dark, shall be terminated at the patch panels.
            3) Interconnect and patch panel housings shall provide space for excess fiber and provide strain relief for the fiber cable.
            4) Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
        b. Copper:
            1) Final connections between the patch panel and network equipment shall be by patch cords.
            2) All premises cables shall be terminated at the patch panels.
            3) Cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out conductors.
            4) Maintain twist of broken out conductors per EIA/TIA standards.
    2. Cabinet style fiber patch panels:
        a. Wall mounted interconnect:
            1) Use for the termination of a single cable outside of cabinets, in small enclosures or as indicated on the plans.
            2) Wall mounted fiber interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
            3) Wall mounted fiber interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
            4) Capacity:
                a) As shown on the plans, minimum 6 connections.
            5) Accessories:
                a) Door lock.
                b) Blanks for unused connector panels.
            6) Manufacturers: The following or equal:
                a) Corning Cable Systems, Wall-Mountable Interconnect Center.
        b. DIN rail mounted:
            1) Use for the termination of a single cable inside of cabinets, in small enclosures or as indicated on the plans.
            2) DIN rail mounted fiber interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
            3) DIN rail mounted fiber interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
            4) Capacity:
                a) As shown on the plans, minimum 6 connections.
            5) Accessories:
                a) Blanks for unused connector panels.
            6) Manufacturers: The following or equal:
                a) Hirshmann MIPP.
                b) DINSpace SNAP XL.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.

B. Furnish accessories as specified in Section 17730.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

B. Provide installation and configuration for the new and existing managed Ethernet switches. Provide configuration of the Ethernet switch network for a complete, functioning plant control system as indicated on the Drawings and as specified herein:
   1. Refer to SCADA block diagrams for all new network connections.
   2. Provide configuration for all managed Ethernet switches and other components including but not limited to VLAN (virtual local area network), additional Plant PLC communication cards and separate managed Ethernet switches as required, such that there is isolation of the following networks:
      a. Field and PLC I/O network: This includes the connections between the Plant PLC and:
         1) Plant PLC expansion racks.
         2) Plant PLC remote I/O (RIO) racks.
         3) Field Networks.
         4) HMI(s) part of a Plant PLC.
         5) Vendor furnished Ethernet network components.
      b. Valve Actuator network: This includes the connections between the Plant PLC and the valve master stations.
      c. Process Control network: This includes the connections between the Plant PLC and other Plant PLCs.
      d. SCADA network: This includes the connections between the various SCADA equipment including but not limited to servers (existing), workstations and printers.

e. Security network: This includes any security hardware with Ethernet communication as provided by the security/telephone/internet sub-contractor.

3. The process floor managed Ethernet switches for the process control network shall be configured and programmed for rapid fail over protection.
4. The enterprise level managed Ethernet switches shall be configured for a communication protocol that is compatible with the process control network's rapid fail over protocol.

C. All racks shall be level and plumb.

D. Install Velcro wrap on all cable bundles within the network rack/enclosure.

E. All cables and equipment shall be installed in strict conformance with the manufacturer's recommendations:
1. Cables shall be installed avoiding sharp bends.
2. Install cable using lubricant designed for cable pulling.
3. Cable ties or other cable supports shall be installed without crimping the LAN cables.
4. Install LAN cables without splices.
5. Installed bend radii shall not exceed 4 times the cable diameter.
6. Terminated all pairs at the jack and the patch panel.

F. Install cables a minimum of 40 inches away from electrical motors and transformers.

G. Install cables a minimum of 12 inches away from fluorescent lighting.

H. Individual pairs will be untwisted less than 1/2 inch at termination points.

I. All cables and terminations shall be labeled with cable designations as specified in Section 16075.

J. Each data port shall be individually labeled with its patch panel/switch port ID:
1. Labeling must be printed - no handwritten labels will be allowed.

K. At the completion of the wiring installation, provide the following documentation:
1. A plan-view of the premise(s) showing the jack numbering scheme.
2. A printed certification report for the entire wiring installation showing compliance with all EIA/TIA specifications for data cable.
3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.
4. Each device with a unique IP address shall be individually labeled with its IP address. The labeling must be printed; handwritten labels will not be allowed.

L. Managed Ethernet switches:
1. Configure switches to prevent broadcast storms.
2. Installations utilizing Rockwell PLCs and multicast messaging shall employ IGMP and snooping on all Rockwell components.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING

A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

3.09 CLEANING

A. As specified in Section 17050.

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

B. After completion of the cable system tests and before placing the system in operation, power all devices installed on the LAN and verify communication between the devices.

C. Verify that all equipment is operable on the network simultaneously. Confirm that all network device communications settings are properly configured.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17950

TESTING, CALIBRATION, AND COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Testing requirements that apply to process control and instrumentation systems for the entire Project.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents:
      a. Section 01330 - Submittal Procedures.
      b. Section 01756 - Commissioning and Process Start-Up.
      c. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
      d. Section 17100 - Control Strategies.
      e. Section 17101 - Specific Control Strategies.
      f. Section 17710 - Control Systems - Panels, Enclosures, and Panel Components.

1.02 REFERENCES

A. As specified in Section 17050.

B. Electronics Industries Alliance (EIA).

C. Telecommunications Industry Association (TIA).

1.03 DEFINITIONS

A. As specified in Sections 01756 and 17050.

B. Specific definitions:
   1. PTO: Profibus Trade Organization.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 01330.

B. General:
   1. Reference additional detailed test submittal scheduling and prerequisite requirements as specified in the Sequencing article of Section 17050.

C. Test procedures:
   1. Develop and submit detailed test procedures to show that the integrated SCADA system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
   2. Provide a statement of test objectives for each test.
   3. Prepare specific procedures for each process system.
   4. Describe sequentially the steps to be followed in verifying the correct operation of each process system, including all features described in the loop descriptions, control strategies, and shown in the P&IDs. Implied or generic test procedures are not acceptable.
   5. Specify who will perform the tests, specifically what testing equipment will be used (including serial numbers and NIST-traceable calibration), and how the testing equipment will be used.
   6. Describe the expected role of the Engineer, as well as any requirements for assistance from Owner's staff.
   7. Provide the forms and checklists to be used.

D. Test forms:
   1. Provide test and calibration forms and checklists for each of the following:
      a. Calibration.
      b. Factory acceptance tests (FAT).
      c. Loop validation tests.
      d. Installation tests.
      e. Functional tests.
      f. Instrumentation and Controls Performance test.
      g. Communication Testing including all digital bus and all forms of Ethernet.
   2. Test forms shall include the detailed test procedures, or shall include clear references to separate pages containing the complete test procedure applicable to each form. If references to procedures are used, the complete procedure shall be included with each test binder.
   3. Every page of each test form shall include project name, date, time, name of person conducting the test, signature of person conducting the test, and for witnessed tests, place for signature of person (Engineer and Owner) witnessing the test.
   4. Some sample test forms are included at the end of this Section. These test forms show the minimum required test form content. They are not complete, and have not been customized for this Project. The Contractor is to develop and submit test forms customized for the Project and meeting all of the specified test and submittal requirements.

E. Testing binders:
   1. Sub-system to be tested, provide and submit a test binder containing all test procedures and individual test forms for the test. References to other documents for test procedures and requirements are not acceptable.

2. Fill out in advance headings and all other information known before the test.
3. Include applicable test plan information, as well as a list of all test prerequisites, test personnel, and equipment.
4. Include or list reference material and provide separately at the time of the test.
5. Record test results and verify that all test requirements and conditions have been met.

F. FAT procedure additional minimal requirements:
1. Prepare and submit a FAT procedure which includes:
a. Control system testing block diagram.
b. Estimated test duration.
c. Details on the simulator construction, components, and operation.

G. Test reports:
1. At the conclusion of each test, submit a complete test report, including all test results and certifications.
2. Include all completed test binders, forms, and checklists.
3. Submission, review, and acceptance of each test report is required before the start of the sub-system.

1.06 QUALITY ASSURANCE

A. Test personnel:
1. Furnish qualified technical personnel to perform all calibration, testing, and verification. The test personnel are required to be familiar with this Project and the equipment, software, and systems before being assigned to the test program.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. As specified in Section 17050.

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050.

B. Installation supervision:
   1. Provide as specified in Section 17050.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING AND PROCESS START-UP

A. Source Testing:
   1. Provide manufacturer services as specified in the table below:

Section Number	Section Title	Source Testing (Witnessed or Non-Witnessed)
17100	Control Strategies	Witnessed
17101	Specific Control Strategies	Witnessed
17710	Control Systems - Panels, Enclosures, and Panel Components	Witnessed
17950	Testing, Calibration, and Commissioning	Witnessed

2. FAT - general:
    a. Performed during the Commissioning Phase, source testing activity.
    b. Before shipment to the Project Site, the complete PCIS system including all operator stations, servers, network equipment, printers, PCMs, PLCs, RTUs, LCPs, CCS, peripherals, communications equipment, and other SCADA equipment, shall be assembled, connected, and all software loaded for a fully functional FAT of the integrated system.
    c. Perform tests to show that the integrated system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
    d. Additional factory tests are specified in other sections of the Instrumentation and Control Specifications.
    e. For systems that contain RTUs or remote communications with other devices, the complete communications system must be factory tested, including actual interfacing with telephone company equipment and/or the actual radios used for radio based telemetry systems.
    f. The FAT will be witnessed.
    g. Right of observation: The Owner retains the right to observe all factory test activities including any and all subsystem preparation, pretests, troubleshooting, retests, warm-up, and software modification and/or update.
    h. The Owner reserves the right to test any specified function, whether or not explicitly stated in the test submittal.
    i. Correction of deficiencies: Any deficiencies observed during the test shall be corrected and retested before completion of the test.
    j. Any changes and/or corrections shall be noted on the test forms. Engineer shall witness the revisions and/or corrections prior to leaving the test site.
    k. If the corrections and/or revisions are too extensive to be made while the Engineer is scheduled to be at the FAT test site, the FAT shall be, at the Engineer's sole discretion, considered failed, and the test shall be restarted at a later date. All costs for the re-test shall be borne by the Contractor.
3. Testing simulation:
    a. The FAT shall make use of hardware simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, which shall be connected to the I/O points within the SCADA system. All inputs and outputs shall be simulated and proper control and system operation shall be validated.
    b. The use of jumper wires, terminal block mounted pilot lights, and loose meters to act as or supply the functionality of a simulator shall not be allowed.
    c. The hardware simulator may consist of a PLC, operating under a SCADA software package, or other approved software that has its I/O points wired to PLC's I/O points. Software operating on a PC may then act as the switches, pilot lights, variable analog signal generators, and analog signal level displays.
4. Preliminary FAT:
    a. A complete preliminary FAT (pre-FAT) shall be conducted utilizing test procedures approved by the Engineer. The pre-FAT test procedure shall be a subset of the full FAT.
    b. The purpose of the pre-FAT is to provide assurance to the Engineer that the SCADA system is ready for the full, witnessed FAT, in terms of both

stability and functionality. Debugging of software and troubleshooting of hardware shall occur during and before the pre-FAT, not during the FAT. The Contractor shall fully test the SCADA system and fix all deficiencies found before the full FAT.

c. The Owner shall have the right to witness any or all of the pre-FAT testing and shall be notified in writing 20 days before the start of the pre-FAT.

d. The pre-FAT test results submittal shall include a letter, signed by the Contractor's project manager or company officer, certifying that the system is complete, has been tested successfully, and is fully ready for the full, witnessed FAT. The submittal shall include completed pre-FAT test forms, signed by the Contractor's staff, and shall be submitted for review before the start of the FAT.

5. Panel inspections:
   a. The Engineer will inspect each control panel for completeness, workmanship, fit and finish, and compliance with the Contract Documents and the accepted shop drawings.
   b. Provide panel inspection forms as part of the FAT procedures submittal.
   c. Inspection to include, as a minimum: Layout, mounting, wire and data cable routing, wire tags, power supply, components and wiring, I/O components layout (including terminals, wiring and relays), device layout on doors and front panels, and proper ventilation operation.
   d. A sample FAT control panel form has been provided at the end of this Section.
6. I/O test:
   a. Verify that I/O is properly wired to field terminals and is properly mapped into the PLC and the rest of the SCADA system, including all operator interface devices.
   b. Test methodology:
      1) Use the submitted and approved system simulator for this test.
      2) Discrete inputs: Apply appropriate input from simulator at panel terminal, observe input card indicator, observe data value at each indicated data address, observe data received on all operator interface displays (SCADA workstations and local operator interface (LOI) displays).
      3) Discrete outputs: Issue commands from operator interface screen, verify output card. Repeat for each operator interface screen.
      4) Analog inputs: Apply appropriate analog input signal at panel terminals, observe data value at each indicated data address, and observe data properly received at each operator screen. Check each point at 0 percent, 50 percent, and 100 percent of scale.
      5) Analog outputs: Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response at panel wiring terminals.
   c. Test forms to include, but not be limited to:
      1) PLC and panel number.
      2) I/O type.
      3) I/O tag name.
      4) Panel terminal block numbers.
      5) Rack/slot/number of I/O point.
      6) Check-off for correct response for each I/O point.
      7) Space for comments.

8) Initials of individual performing test.
9) Date test was performed.
10) Witness' signature lines.

7. System configuration test:
   a. Demonstrate and test the setup and configuration of all operator stations, servers, development stations, and peripherals.
   b. Demonstrate all utility software and functions, such as virus protection, backup, optical drive burning, network monitoring, etc.
   c. Demonstrate the proper operation of all peripheral hardware.
   d. Demonstrate all general SCADA functions.
   e. Demonstrate proper operation of log-on and other access security functions.
   f. Demonstrate the proper operation of all historical data storage, trend, display, backup, and report functions.
   g. Test automatic fail over of redundant equipment.
   h. Demonstrate the proper operation of the alarm display and acknowledgement functions.
   i. Test forms:
      1) For each test, list the specification page and paragraph of the function demonstrated, and provide a description of the function.
      2) List the specific tests and steps to be conducted.
      3) For each function, list all of the different sub-functions or ways the function can be used, and provide a test check-off for each:
         a) Include signature and date lines.
8. Control logic test:
   a. The purpose of this test is to verify that all software functions and logic work as specified, along with any hardwired logic or functions in the tested control panels.
   b. Testing requirements:
      1) Demonstrate each function described in Section 17100. Demonstrate in detail how each function operates under a variety of operating scenarios. Test to verify the application of each general control strategy function to each specific control strategy or loop description.
      2) Demonstrate the proper operation of the programming and configuration for each control strategy or loop description. Test each strategy or loop description on a sentence by sentence and function by function basis. Loops with similar or identical logic must each be tested individually.
      3) Demonstrate the proper operation of all digital communication links and networks. Verify each digital communication I/O point.
      4) Failure testing: In addition to demonstrating correct operation of all specified features, special effort shall be made to demonstrate how the system responds to and recovers from abnormal conditions including, but not limited to: equipment failure, operator error, communications subsystem error, communications failures, simulated/forced software lockups, power failure (both utility power and power to SCADA hardware), process equipment failure, and high system loading conditions.
   c. Test forms:
      1) Include the fully revised and approved control strategy for the loop being tested.

2) Identify the cause and effect as each I/O point is toggled through the simulator. Check boxes shall be provided to track proper and/or improper operation of the loop.
3) Any deficiencies or operational changes shall be noted on the forms for correction and documentation:
a) Include signature and date lines.

B. Owner Training:
1. Complete Owner training as specified in Section 17050.

C. Installation Testing:
1. General:
a. The Owner reserves the right to test any specified function, whether or not explicitly stated in the test submittals.
b. Failure testing:
1) In addition to demonstrating correct operation of all specified features, demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
a) Equipment failure.
b) Operator error.
c) Communications sub-system error.
d) Power failure.
e) Process equipment failure.
f) High system loading conditions.
c. Conduct testing Monday through Friday during normal working hours for no more than 8 hours per day:
1) Testing at other times requires approval of the Engineer.
2. Sequencing:
a. See additional requirements specified in the Sequencing article of Section 17050.
3. Calibration:
a. After installation but before starting other tests, calibrate and adjust all instruments, devices, valves, and systems, in conformance with the component manufacturer's instructions and as specified in these Contract Documents.
b. Components having adjustable features are to be set carefully for the specific conditions and applications of this installation. Test and verify that components and/or systems are within the specified limits of accuracy.
c. Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
d. Calibration points:
1) Calibrate each analog instrument at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, using test instruments with accuracies traceable to NIST.
e. Field verify calibration of instruments that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
f. Analyzer calibration:
1) Calibrate and test each analyzer system as a workable system after installation. Follow the testing procedures directed by the manufacturers' technical representatives.

g. Complete instrument calibration sheets for every field instrument and analyzer.
h. Calibration tags:
    1) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
    2) Sign the tag when calibration is complete.

4. LAN cable post-testing:
    a. After installing the cable and connectors, test all cables using the LAN certification to confirm the installation meets the requirements of the specification.
    b. Provide test documentation that includes the cable number, total length of cable, a permanent hard copy, as well as a-USB or CD copy of all traces:
        1) After installing connectors.
        2) Perform cable end-to-end testing on all installed cables from both ends of the cable. Test shall include cable system performance tests and confirm the absence of wiring errors.
        3) Submit a signed test report presenting the results of the cable testing.
        4) Repair or replace any portions of the system not meeting ANSI/TIA/EIA standards for a Category 5e installation. Repaired sections shall be retested.
    c. Submit 3 copies of all final documentation (including traces), using the approved test form, to the Engineer upon successful completion of the testing.
5. Ultrasonic and radar check out:
    a. Check response under all operating conditions.
    b. Track all responses through trend charts in the SCADA system.
    c. Provide Echo Transmission and signal quality on all level transmitters including guided and unguided units:
        1) Provide printout of the actual transmission and all parameters.
6. Loop check/validation:
    a. Check all control loops under simulated operating conditions by causing a range of input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA system. Issue commands from the SCADA system and verify proper responses of field devices. Use actual process inputs wherever available.
    b. Provide “end-to-end” tests:
        1) Test SCADA system inputs from field device to SCADA system operator workstations.
        2) Test SCADA system outputs from SCADA operator workstations to field devices and equipment.
        3) Observe and record responses at all intermediate devices.
        4) Test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
        5) For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.

c. Retest any loop following any necessary corrections.
d. Apply simulated sensor inputs corresponding to 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span for networks that incorporate analog elements, and monitor the resulting outputs to verify compliance to accuracy tolerance requirements.
e. Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
f. Apply provisional settings on controllers and alarm setpoints.
g. Record all analog loop test data on test forms.
h. Exercise each field device requiring an analog command signal, through the SCADA system. Vary, during the validation process, the output from the PLC SCADA system and measure the end device position, speed, etc. to confirm the proper operation of the device for the supplied analog signal. Manually set the output from the SCADA screen at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent and measure the response at the final device and at any intermediate devices.
i. Exercise each field device providing a discrete input to the SCADA system in the field and observe the proper operation shall be observed at the operator workstation:
    1) Test limit switches, set limits mechanically, and observe proper operation at the operator workstation.
    2) Exercise starters, relay contacts, switch contacts, and observe proper operation.
    3) Calibrate and test instruments supplying discrete inputs, and observe proper operation.
j. Test each device accepting a discrete output signal from the SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device:
    1) Stroke valves through outputs from the SCADA system, and confirm proper directional operation. Confirm travel limits and any feedback signals to the SCADA system.
    2) Exercise motors starters from the SCADA system and verify proper operation through direct field observation.
    3) Exercise solenoids and other field devices from the SCADA system and verify proper operation through direct field observation.
k. Include in the test forms:
    1) Analog input devices:
        a) Calibration range.
        b) Calibration data: Input, output, and error at each test value.
        c) Analog input associated PLC register address.
        d) Value in PLC register at each test point.
        e) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
    2) Analog output devices:
        a) Calibration range.
        b) Test value at each test point.
        c) Analog output associated PLC register address.
        d) Control variable value at field device at each test point.
        e) Physical device response at each test point:
            (1) Response to be actual valve position, or motor speed, etc.

3) Discrete instrument input devices:
    a) Switch setting, contact action, and dead band.
    b) Valve position switches:
        (1) Response in the PLC as the valve is stroked from the PLC.
        (2) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
    c) Operator interface switches (control stations and other pilot devices) and associated response.
    d) Starter and drive auxiliary device contact response.
    e) Response of all other discrete inputs to the PLC.
4) Discrete output devices:
    a) Observed response of field device to the discrete output from the PLC.
    b) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
5) Test equipment used and associated serial numbers.

D. Functional Testing:
1. General:
    a. Commence Functional tests after completion of all loop check/validation tests:
        1) As specified in Section 17050, Sequencing and Scheduling article.
    b. Functional to demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
    c. Additional tests are specified in other Instrumentation and Control Sections.
    d. Follow approved detailed test procedures and check lists for Functional Test activities.
2. Control logic operational validation:
    a. The purpose of control logic validation is to field test the operation of the complete control system, including all parts of the SCADA system, all control panels (including vendor control panels), all control circuits, all control stations, all monitored/controlled equipment, and final control elements.
    b. Demonstrate all control functionality shown on the P&IDs, control schematics, and other drawings, and specified in the loop descriptions, control strategies, Electrical Specifications, and Mechanical Equipment Specifications.
    c. Test in detail on a function-by-function and sentence-by-sentence basis.
    d. Thoroughly test all hardware and software functions:
        1) Including all hardwired and software control circuit interlocks and alarms.
    e. Test final control elements, controlled equipment, control panels, and ancillary equipment under startup, shut down, and steady-state operating conditions to verify all logic and control is achieved.
    f. Control logic validation tests to include, but not limited to: a repeat of all control logic tests from the FAT, modified and expanded to include all field instruments, control panels, circuits, and equipment.
3. Loop tuning:
    a. Optimally tune all electronic control stations and software control logic incorporating proportional, integral, or derivative control. Apply control

signal disturbances at various process variable levels and adjusting the gain, reset, or rate settings as required to achieve proper response.

b. Verify the transient stability of final control elements operating over the full range of operating conditions, by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates. As a minimum, achieve 1/4 wave amplitude decay ratio damping (subsidence ratio of 4) under the full range of operating conditions.

c. If excessive oscillations or system instability occur, as determined by the Engineer, continue tuning and parameter adjustments, or develop and implement any additional control algorithms needed to achieve satisfactory control loop operation.

4. Functional validation sheets:
   a. Document each Functional test on an approved test form.
   b. Document loop tuning with a report for each loop, including two-pen chart recordings showing the responses to step disturbance at a minimum of 3 setpoints or process rates approved by the Engineer. Show tuning parameters on the charts, along with time, date, and sign-off by Contractor and Engineer.
   c. Include on the form, functions which can be demonstrated on a loop-by-loop basis:
      1) Loop number and P&ID number.
      2) Control strategy, or reference to specification tested.
      3) Test procedures: Where applicable, use the FAT function-by-function, sentence-by-sentence loop test checklist forms modified to meet the requirements of the Functional test. Otherwise, create new forms.
   d. For functions that cannot be demonstrated on a loop-by-loop basis (such as overall plant power failure), include on the test form a listing of the specific steps and tests to be conducted. Include with each test description the following information:
      1) Specification page and paragraph of function demonstrated.
      2) Description of function and/or text from specification.
      3) Test procedures: use the FAT loop test checklist forms modified to meet the specific testing conditions of the Functional test.
5. Functional certification:
   a. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756:
      1) Including all test forms with test data entered, submitted to the Engineer with a clear and unequivocal statement that all Functional test requirements have been satisfied.

E. Instrumentation and Controls Performance Testing:
1. After the Process Operational Period, test PCIS system for additional 60 days as specified in this Section to identify issues and make corrections, as needed.
2. General:
   a. The performance test is part of the Work that must be completed as a condition of substantial completion and final completion for the entire Project.
   b. The complete PLC control and SCADA system must run continuously for the duration of the performance test.

c. Test and use the entire process control system under standard operating conditions.
d. Exercise all system functions.
e. Log failure, any system interruption and accompanying component, subsystem, or program failure including time of occurrence, duration of each failure, failure classification, and cause:
    1) Provide a competently trained technician or programmer on call for the Project Site during all normal working days and hours from the start of the performance test until final acceptance of the system:
        a) Response time to the Project Site: 24 hours or less, for a major failure.

3. SCADA system testing:
    a. Exercise each system function, e.g., status report, alarms, logs, and displays several times at a minimum, and in a manner that approximates "normal" system operation.
    b. Failure of the SCADA system during testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications:
        1) Corrective action is required before restarting the performance test.
    c. Only those components, sub-systems, and systems covered in this Section and supplied under this Contract shall be considered for this acceptance test. Problems and failures of other systems shall not be considered as part of this test, except as they display the capabilities of this system to detect failures.
4. Failures:
    a. Classify failures as either major or minor:
        1) Minor failure:
            a) A small and non-critical component failure or software problem that can be corrected by the Owner's operators.
            b) Log this occurrence but this is not a reason for stopping the test and is not grounds for non-acceptance.
            c) Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.
            d) Failure of one printer or operator station is considered a minor failure providing all functions can be provided by backup equipment, i.e., alternate printers and operator station, and repairs can be made and equipment returned to service within 3 working days.
        2) Major failure:
            a) Considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
            b) Cause termination of the performance test.
            c) Start a new acceptance test when the causes of a major failure have been corrected.
            d) A failure is also considered major when failure of any control system that results in an overflow, underflow, overdose, or underdose condition occurs.

5. Technician report:
    a. Each time a technician is required to respond to a system malfunction, they must complete a report, which includes details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.
    b. If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report is required or logged as specified above.
    c. If a technician has performed work but no report is written, then a major failure is considered to have occurred.
    d. Each report shall be submitted within 24 hours to the Engineer and the Owner, or its representative.

3.08 FIELD QUALITY CONTROL (NOT USED)

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES

A. Example test forms:
    1. Example test forms are attached at the end of this Section. They may be used as a starting point for the development of Project-specific test forms for this Project.
    2. The example test forms are not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

END OF SECTION

	FACTORY ACCEPTANCE TEST – CONTROL PANELS	

1. GENERAL INSPECTION

A. Structural Inspection

- ☐ Verify Lifting Lugs Installed
- ☐ Verity enclosure has lock and lock is functional
- ☐ Confirm that seismic bracing components are provided per manufacturer's installation instructions

B. Exterior Inspection

- ☐ Cabinet exterior is clean, scratch, and dent free
- ☐ Inspect externally for corrosion and damage
- ☐ Verify enclosure door opens and closes easily
- ☐ Verify enclosure has a 3-point latch
- ☐ Verify enclosure has a flange mounted disconnect (where voltages greater than 120 VAC enter the cabinet)
- ☐ Verify enclosure has the appropriate NEMA rating (1, 1G, 12, 3R, 4, 4X, etc.)
- ☐ Verify enclosure is the appropriate size (not grossly larger than design, and will still fit in the plant)

Nameplates

- ☐ Cabinet has identification nameplate
- ☐ All door labels are straight, spelled correctly, and match the tagging defined in the Contract
- ☐ Cabinet has a nameplate that includes the following:
  - ☐ Power source(s)
  - ☐ Integrator's Logo
  - ☐ Circuit ID(s)
  - ☐ Short Circuit KAIC ratings
- ☐ If labels are screwed to door, silicone was utilized to cover screw holes (Labels screwed to the door of a NEMA 4/4X panel technically violates the NEMA rating.)

Door Devices

- ☐ All devices penetrating the outside of panel have gaskets, silicone or both
- ☐ All door devices are installed (HMIs, Pilot Devices, etc.)
- ☐ Door mounted equipment is mounted straight and square
- ☐ All exterior or door mounted equipment present and accounted for, installed and securely fastened
- ☐ NEMA classification has not been violated due to penetrations
- ☐ Door mounted equipment has the same NEMA rating as the panel
- ☐ All door mounted equipment installed at the correct height
- ☐ All door mounted equipment installed in the correct positions and order (layout of door mounted equipment is grouped properly and in a logical manner)
- ☐ Doors with multiple penetrations have adequate bracing (if needed)
- ☐ Visually check condition of indicators , controllers and annunciators
- ☐ Check that pilot lights illuminate correctly
- ☐ Check the Push-To-Test function
- ☐ Ensure correct pilot light color

Peripheral Devices

- ☐ Horn / Beacon is installed (where required)
- ☐ Silence and Reset pushbutton

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

1. GENERAL INSPECTION (continued)

C. Interior Inspection

- ☐ Cabinet is cleaned of marks and dirt.
- ☐ Inspect internally for corrosion and damage.
- ☐ Back panel is clean of marks and dirt.
- ☐ Interior of panel vacuumed and shall be free of all debris.
- ☐ Check that the panel roof is clean and clear of foreign materials.
- ☐ Bottom of panel has been cut out (where bottom entry is required), with angle iron welded around the bottom perimeter. Re-painting has been performed.
- ☐ If internal light door limit switch is provided, ensure the light automatically turns "on" when the doors are open.
- ☐ Intrusion alarms (where required).

Interior Labeling

- ☐ All panel mounted equipment has identification labeling, by using either a Brothers or Phenolic type tags.
- ☐ Verify that door mounted components are mounted square and symmetrical.
- ☐ Verify that nameplates are straight, legible, and spelled correctly.
- ☐ All terminal blocks are identified/labeled with permanent labels including tight end blocks and caps.
- ☐ All wiring shrink labeled and or phased correctly to the specifications.
- ☐ All wire labels shrunk completely rotated and aligned alike for easy identification.
- ☐ All fuses and circuit breakers are labeled with ID and current rating.
- ☐ System Integrator's label or labels installed on door.
- ☐ Panel manufacturer model/serial number tag is present.
- ☐ All required safety/warning tags installed and straight.
- ☐ Correct UL (typically UL 508) or cUL tag installed and registered and all other associated tags installed and straight (the UL tag might not be installed in the panel at the factory test. If the panel is modified due to changes during the factory test or a punch list generated from the factory test, the UL labeling would need to be re-applied. Some UL shops do not apply the UL label until the panel is released to be shipped.).

Wireways

- ☐ Plastic wire way covers installed properly.
- ☐ Plastic wireways have no sharp edges.
- ☐ No wire Ties inside the wireways.
- ☐ No sharp edges on wire ties.
- ☐ Separation: White duct is used for DC voltages, Gray duct is used for AC voltages.
- ☐ Ensure wiring duct is not over-full, includes provision for 20% more wiring and the cover may easily be installed. Panduit recommends 50% duct fill, but 40% is a better practice.

PROJECT NAME:		TEST DATE:	
FACILITY NAME:		TESTED BY:	
PROCESS AREA:		COMPANY:	
NETWORK ID:		PAGE:	
WITNESSED BY:		SIGNATURE:	

1. GENERAL INSPECTION (continued)

C. Interior Inspection (continued)

Wiring

- ☐ Visually check terminals and condition of internal wirings
- ☐ Verify that the control panel has been assembled and wired as designed
- ☐ Verify that all components are operational and perform the functions intended
- ☐ Verify that all components are sized appropriately for the application
- ☐ Verify that equipment control circuits function as intended
- ☐ Back of door wiring is labeled and neatly formed
- ☐ Back panel to door wiring has sufficient bending radius with spiral wrap
- ☐ Wire connection has been verified wired to correct points within the panel
- ☐ Individual wires have been given a pull test to verify a good terminal connection
- ☐ Wire and cable minimum bending radius have not been violated
- ☐ All equipment installed straight and square to back panel
- ☐ Wire colors are correct:
  - ☐ Black and White > AC hot and neutral, respectively
  - ☐ Red > AC control signals
  - ☐ Blue > DC power and control (Blue w/White stripe for DC ground)
  - ☐ Yellow > Foreign voltages (those still present when panel power is disconnected)
  - ☐ Green > AC equipment ground
  - ☐ Black > TSP (+)
  - ☐ White> TSP(-)
- ☐ Analog wiring shields are continuous (connected by a dedicated terminal block for such shields)
- ☐ Analog shield wires are grounded within the panel, where not otherwise grounded at the transmitter itself
- ☐ Discrete inputs are separately fused or protected by a circuit breaker on a “per loop” basis
- ☐ Intrinsic Safety Wiring
  - ☐ Ensure wiring associated with intrinsic safety circuits or intrinsic safety barriers is kept away from all other wiring by UL minimum distances or by a physical (grounded metal) barrier preventing non-intrinsically safe wiring from coming in contact with intrinsically safe circuits or wiring
- ☐ Verify all spare terminals are installed according to the percentage listed in the specifications

Grounding

- ☐ Equipped with “Blackburn” or other grounding type lug
- ☐ Lug is securely fastened to the panel structure
- ☐ Verify Grounding bar is installed
- ☐ Verify Isolated ground bar is installed

PROJECT NAME:		TEST DATE:	
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2. POWER TEST

A. AC Power

- ☐ AC Power is routed correctly within the panel, and is isolated from DC and network wiring.
- ☐ All fuses are installed and sized properly.
- ☐ All breakers are installed and sized properly.
- ☐ 24 VDC Power Supplies are functional.
- ☐ 24 VDC Power fail contacts are functional.
- ☐ 24 VDC power supplies are redundant, and have diode modules enabling the hot swap-over between supplies.
  - ☐ 24 VDC supplies are equipped with dry contact failure alarms, wired as PLC inputs to signal failure of any DC power supply. Such alarm inputs to the PLC have been tested as being functional.
- ☐ Dedicated receptacle is wired to receive a dedicated AC supply.
- ☐ Verify continuity for all DC commons, ground and AC neutrals.
- ☐ Verify that the CP temporary input power is connected correctly and is the correct voltage.
- ☐ Close the CP main circuit breaker(s).
- ☐ Verify that voltages at subsequent circuit breakers are correct.
- ☐ Close circuit breakers.
- ☐ Verify that power feeding interruptible and uninterruptible power supplies is correct.
- ☐ Turn on power supplies if they are not already on.
- ☐ Verify that voltages at distribution terminals are correct.
- ☐ Energize any remaining hardware such as the PLC.

B. Uninterruptible Power Supply (UPS)

- ☐ Mounted appropriately within the cabinet, on a dedicated shelf, or rear of a swing-out sub panel.
- ☐ Is equipped with maintenance bypass switch (or at least plug/receptacle means for bypassing the unit).
- ☐ Test all UPS alarms (on inverter, failure, battery failure etc.)
- ☐ Turn off the AC power supply and verify that the UPS will be switched on to supply the designated vital loads in the control panel.

3. CONTROLS & AUXILIARY DEVICES TEST

- ☐ Verify all interposing and auxiliary relays are functioning.
- ☐ Verify panel lights are functioning.

Ventilation and Heating

- ☐ If ventilation fans are fitted , check the fans operate correctly any associated air filters are clean and not blocked.
- ☐ Verify components are installed in the correct orientation for proper air flow.

4. HARDWIRED INTERLOCK AND SAFETY TEST

- ☐ Verify that hardwired interlocks through the control panel as shown on schematic drawings are functioning. For example, outlet high pressure switch interlock to a pump.
- ☐ Verify that all hardwired safety devices through the control panel is functioning. For example, the pull cord emergency stops of conveyors.

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5. PLC TEST

A. Components

☐ PLC interior High Temperature alarm is installed, wired to the PLC, and is shown to be functional.

☐ Relays have transient suppression across their coils. This is particularly important for DC coil relays, where diodes in reverse polarity are often used.

☐ TVSS is installed across the main incoming 120 VAC.

PLC and PLC Rack

- ☐ Verify all cards are securely seated.
- ☐ Ensure clearance around PLC rack has been met, such that convective heat transfer is not impeded by devices erroneously mounted in the “no encroachment” area. Confirm with manufacturer clearance recommendations.

B. PLC I/O Test

☐ Furnish **I/O test forms** and test all the listed input and output points as follows:

- ☐ Discrete Inputs: Simulate a field contact closure by “shorting” across the appropriate terminal blocks. Observe the transition between a logical “0” and “1” in the PLC software.
- ☐ Discrete Outputs: Force the output bit to toggle between logical “0” and logical “1” using the PLC software. Measure contact resistance at the wired terminal blocks using a digital meter selected for the “ohms” setting.
- ☐ Analog Inputs: Connect a signal generator to the appropriate terminal blocks. Tailor the connection depending on whether a 2-wire or 4-wire simulation is required. Modulate the 4-20mA signal. Observe the associated PLC internal memory register to transition between 0-65535 or if scaled in engineering units, between 0 and the maximum scaled engineering unit. The latter method is preferred.
- ☐ Analog Outputs: Force the output register to a value between 0-65535 or 0-100%, if the scaling block can be manipulated. Observe the measured 4-20mA value increment and decrement using a digital ammeter.

C. Redundant Controllers (where required) Test

☐ Remove Communication cable from PLC-1 to verify switching to PLC-1A

☐ Remove Communication cable from PLC-1A to verify switching back to PLC-1

☐ Remove Power from PLC-1 to verify switching to PLC-1A

☐ Remove Power from PLC-1A to verify switching to PLC-1

☐ Remove Communication cable from PLC-1 to I/O rack and verify switching to PLC-1A

☐ Remove Communication cable from PLC -1A to I/O rack and verify switching to PLC-1

D. PLC Control Logic Verification

☐ The PLC control strategy is verified by following the Control Logic Verification Form based on the specifications. Each control strategy will be verified by simulating the process and checking the state or value of PLC outputs. The results of equipment status and alarms and process instrument values and trends shall also be verified on the Plant SCADA graphic screens stored in a temporary SCADA computer. Since all PLC input and output wiring has been verified and some field devices are not available during Factory Acceptance Testing, certain inputs will be simulated either by means of additional hardware and/or software as described below.

- ☐ DI states are either simulated by hardwired switches or forced inputs using a programming terminal.
- ☐ For example, when starters and drives are not provided as part of the contract, jumpers may be installed from the output call relays to the running confirmation inputs to simulate the running state of the motors.
- ☐ AI values are either simulated by an external source or within software using a programming terminal.
- ☐ For example, when a level transducer is not provided as part of the contract the level transducer loop current may be simulated with a loop powered potentiometer and adjusted manually for the level input.

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5. PLC TEST (continued)

D. PLC Control Logic Verification (continued)

Typical Fault Logic

- ☐ If the fault input is high and the disable (if applicable) for the fault is not high and the common disable (if applicable) is not high begin timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output. If the fault alarm is a shutdown alarm stop the associated motor and latch the alarm so that it remains present even if the condition clears.
- ☐ The fault condition must return to normal and the alarm must be reset for a latched alarm to clear.

Typical Fail to Start Logic

- ☐ If the motor is called to run (call output high) and no running feedback is received (running input is low) and the fail to start and common alarm disables (if applicable) are not high start timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output, stop calling the motor and latch the alarm.

6. HMI OR OIT TEST

HMI / OIT Functionality

- ☐ Communication with PLC
- ☐ Screen Layouts
- ☐ Screen Navigation
- ☐ Set Point Entry
- ☐ Animation
- ☐ Color Correctness (Green=Run, Red=Off, Amber=Alarm, or the agreed upon convention)
- ☐ Alarms
- ☐ Acknowledge and Reset
- ☐ Security / Access Levels / Passwords

7. NETWORK COMMUNICATION TEST

A. Network Components

- ☐ Fiber optic cabling terminates in a patch panel
- ☐ Media converters are installed and functional
- ☐ Terminating resistors have been installed for trunk/tap topologies or where required
- ☐ Wire and cable bending limitations have not been violated

B. Networking Functions

- ☐ Verify data transfer via the network to different PLCs as shown on the Network Block Diagrams
- ☐ Verify network traffic rate and error margin is acceptable

PROJECT NAME:		TEST DATE:	
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8. FAT DOCUMENTATION AND RECORD

Panel Documentation

- ☐ As-built panel drawings showing actual panel construction and devices arrangement and c/w Bill of Material.
- ☐ Panel schematic and interconnection drawings.
- ☐ P&ID drawings and schematic drawings for the process area controlled by the panel that is to be tested.
- ☐ I/O list test forms of the process area to be tested.
- ☐ FAT procedure of the process area to be tested.
- ☐ Test record forms of the process area to be tested. Forms shall include area for signature of responsible test personnel.
- ☐ Hard copy of the PLC application program of the process area to be tested.
- ☐ Hard copy of the HMI/OIT graphic screens of the process area to be tested.

9. FAT TOOLS AND SOFTWARE

- ☐ Simulation software if required
- ☐ Digital volt meter Fluke 87
- ☐ Process meter Fluke 787
- ☐ Laptop computer with PLC application program
- ☐ Temporary SCADA computer with HMI software and applicable graphic screens
- ☐ Jumper wires

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	INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

A COPY OF LATEST ISSUE OF THE FOLLOWING DOCUMENTS ARE INCLUDED IN THIS INSTRUMENT INSTALLATION CERTIFICATION FILE:

- ☐ INSTRUMENT SPECIFICATION SHEETS (FOR ALL INSTRUMENTS IN THE LOOP)
- ☐ INSTRUMENT INSTALLATION DETAILS (FOR ALL INSTRUMENTS IN THE LOOP)
- ☐ INSTRUMENT LOOP WIRING DIAGRAMS
- ☐ INSTRUMENT INSTALLATION CERTIFICATION CHECKLIST
- ☐ SIZING CALCULATIONS
- ☐ INSTRUMENT INSTALLATION SCHEDULE (APPLICABLE PART)
- ☐ NAMEPLATE SCHEDULE (APPLICABLE PART)
- ☐ VENDOR LITERATURE CALIBRATION INFORMATION

	☐ No	☐ Yes
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?		

REMARKS: _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

	SWITCHES **INSTALLATION AND CALIBRATION CHECKLIST**	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

	☐ No	☐ Yes
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?		

FIELD CALIBRATION CHECK

CONTACT NO.	FUNCTION	FOR SIGNAL	CONTACT IS TO	AT SPECIFIED VALUE FOR		ACTUAL TRIP POINT WAS	
1	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
2	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
3	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
4	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	

NOTE: PERM IS ABBREVIATION FOR PERMISSIVE

	SWITCHES **INSTALLATION AND CALIBRATION CHECKLIST**	

REMARKS: _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS? No Yes

INSTRUMENT TYPE ☐ TRANSMITTER ☐ CONTROLLER ☐ INDICATOR

☐ OTHER DESCRIPTION _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

BENCH CALIBRATION CHECK

INPUT RANGE = _____ OUTPUT RANGE = _____

HEAD CORRECTION = _____ ☐ LINEAR

CALIBRATED SPAN = _____ ☐ SQUARE ROOT

% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

FIELD CALIBRATION CHECK

INPUT RANGE = _____ OUTPUT RANGE = _____

% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ DIRECT ☐ REVERSE

☐ ACTION VERIFIED AT 50% SPAN

☐ ACTION VERIFIED AT _____ SPAN

CONTROLLER SETTINGS								
SETTING	**GAIN**	**PB**	**RESET (INTEGRAL)**	**DERIV. (RATE)**	**HIGH LIMIT**	**LOW LIMIT**	**ELEV. ZERO**	**ZERO SUPP**
PRE-TUNE								
POST-TUNE								

PRE-TUNE SETTINGS					
	GAIN	**PB**	**RESET (REPEAT/MIN)**	**RESET (MIN/REPEAT)**	**DERIVATION (MINUTES)**
FLOW	1.0	100	10	0.1	N/A
LEVEL	1.0	100	MIN.	MAX.	N/A
PRESSURE	2.0	50	2.0	0.5	N/A
TEMP.	4.0	25	0.1	10	OFF

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

	ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST	

☐ No ☐ Yes

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

TYPE OF INSTRUMENT _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, IF TRUE

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS? No Yes

☐ VALVE TAG NO. _____ SERIAL NO. _____

☐ TRANSDUCER TAG NO. _____ SERIAL NO. _____

☐ SOLENOID TAG NO. _____ SERIAL NO. _____

☐ VOLUME BOOSTER TAG NO. _____ SERIAL NO. _____

☐ POSITIONER _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

TRANSDUCER CHECK					
INPUT RANGE =			OUTPUT RANGE =		
CALIBRATED SPAN =			CALIBRATED SPAN =		
BENCH					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		
FIELD					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		

CHECK BELOW, IF TRUE:

☐ BENCH CALIBRATED PER ABOVE _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

- ☐ VALVE SPECIFICATION NO. _____
- ☐ TRANSDUCER SPECIFICATION NO. _____
- ☐ SOLENOID SPECIFICATION NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER INSTRUMENT INSTALLATION DETAILS _____

- ☐ VALVE DETAIL NO. _____
- ☐ TRANSDUCER DETAIL NO. _____
- ☐ SOLENOID DETAIL NO. _____

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

VALVE CHECK			
FLOW CHECK	☐ PROCESS FLOW DIRECTION THROUGH THE VALVE IS CORRECT		
SAFETY CHECK	ON LOSS OF AIR VALVE FAILS ☐ OPEN ☐ CLOSE	ON LOSS OF POWER SOLENOID FAILS ☐ TO VENT ☐ TO VALVE	
TRAVEL CHECK	FULL OPEN AT _____ PSI	FULL CLOSED AT _____ PSI	MEASURED TRAVEL _____ INCHES
SEATING CHECK	☐ ON BENCH ☐ IN-LINE	RESULTS	ACTUATOR BENCH SET
POSITIONER CHECK			
VALVE FULL OPEN AT _____ PSI TO POSITIONER			
VALVE FULL CLOSED AT _____ PSI TO POSITIONER			
VOLUME BOOSTER CHECK			
BYPASS VALVE (GAIN) ADJUSTING SCREW BACKED OUT _____ TURNS FROM CLOSED TO ENSURE QUICK BUT STABLE OPERATION (TYPICALLY 1-1/2 TO 2 TURNS)			

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

Network Power Supplies

Power Supply Equipment	Supply Source (120 VAC)	Network Power Tap (24 VDC)
☐ ODVA compliant	☐ Overcurrent protection	☐ Overcurrent protection
☐ Quantity and ratings	☐ Conductor size	☐ Conductor size

Comments: _____

CHECKED BY (COMPANY)	ACCEPTED BY (COMPANY)
SIGNATURE	SIGNATURE
DATE	DATE