San Antonio Water System

GREEN MOUNTAIN PUMP STATION FACILITY
Solicitation Number: CO-00194
Job No.: 17-1121

ADDENDUM 2
October 9, 2018

To Bidder of Record:

This addendum, applicable to work referenced above, is an amendment to the bid proposal, plans and specifications and as such will be a part of and included in the Contract Documents. Acknowledge receipt of this addendum by entering the Addendum number and issue date on the space provided in submitted copies of the bid proposal.

CHANGES TO THE SPECIFICATIONS

1. **Section 00 0110 – Table of Contents:** Delete and replace with the revised Section 00 0110 Table of Contents, attached herein.

2. **Section 00 4100 – Bid Form:** Delete from Section 00 0110 Table of Contents. Reference revised Section 00 0110 Table of Contents, attached herein.

3. **Section 00 4373 – Proposed Schedule of Values Form:** Reference the specification section 00 4373 – Proposed Schedule of Values Form, attached herein.

4. **Section 01 0250 – Measurement and Payment:** Reference the specification section 01 250 – Measurement and Payment, attached herein.

5. **Section 01 2000 – Price and Payment Procedures:** Reference the specification section 01 2000 – Price and Payment Procedures, attached herein.

6. **Section 01 2100 – Allowances:** Delete from Section 00 0110 Table of Contents. Reference revised Section 00 0110 Table of Contents, attached herein.

7. **Section 01 3119.10 – Project Meetings:** Reference specification section 01 3119.10 – Project Meetings, attached herein.

8. **Section 01 3216 – Construction Progress Schedule:** Delete from Section 00 0110 Table of Contents. Reference revised Section 00 0110 Table of Contents, attached herein.

9. **Section 01 3217 – Daily Construction Project Report:** Reference specification section 01 3217 – Daily Construction Project Report, attached herein.

10. **Section 01 3233.10 – Construction Photographs:** Reference specification section 01 3233.10 – Construction Photographs, attached herein.

11. **Section 01 3553 – Security Procedures:** Reference specification section 01 3553 – Security Procedures, attached herein.

12. **Section 01 4000 – Quality Requirements:** Reference specification section 01 4000 – Quality Requirements, attached herein.

13. **Section 01 4216 – Definitions:** Reference specification section 01 4216 – Definitions, attached herein.

14. **Section 01 5100 – Temporary Utilities:** Reference specification section 01 5100 – Temporary Utilities, attached herein.

15. **Section 01 5500 – Vehicular Access and Parking:** Reference specification section 01 5500 – Vehicular Access and Parking, attached herein.

16. **Section 15 1200 – Control Valves:** Delete from Section 00 0110 Table of Contents. Reference revised Section 00 0110 Table of Contents, attached herein.

17. **Section 15 1520 – Altitude Control Valve:** Reference specification section 15 1520 – Altitude Control Valve and revised Table of Contents, attached herein.

END OF ADDENDUM 2

This Addendum, including these two (2) pages, is (297) pages with attachments in its entirety.

Attachments:
Section 00 0110 – Table of Contents
Section 00 4373 – Proposed Schedule of Values Form
Section 01 0250 – Measurement and Payment
Section 01 2000 – Price and Payment Procedures
Section 01 3119.10 – Project Meetings
Section 01 3217 – Daily Construction Project Report
Section 01 3233.10 – Construction Photographs
Section 01 3553 – Security Procedures
Section 01 4000 – Quality Requirements
Section 01 4216 – Definitions
Section 01 5100 – Temporary Utilities
Section 01 5500 – Vehicular Access and Parking
Section 15 1520 – Altitude Control Valve

Jason T. Diamond
10/9/18

Green Mountain Pump Station Facility

SAWS Project No. 17-1121

Design Professional of Record: Civil/Mechanical

I am responsible for the following specification divisions/sections:

DIVISION 01 – GENERAL REQUIREMENTS

DIVISION 02 – EXISTING CONDITIONS

DIVISION 03 – CONCRETE

DIVISION 04 – MASONRY

DIVISION 05 – METALS

DIVISION 09 – FINISHES

DIVISION 11 – EQUIPMENT

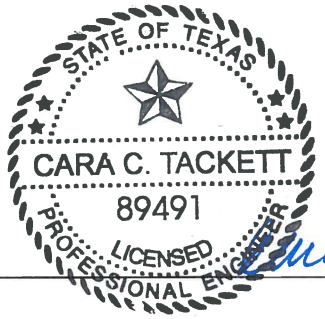
DIVISION 13 – SPECIAL CONSTRUCTION

DIVISION 15 – MECHANICAL

DIVISION 31 – EARTHWORK

DIVISION 32 – EXTERIOR IMPROVEMENTS

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT



10/05/18

(SEAL) _____

Discipline: Civil/Mechanical

Responsible Party: Pape-Dawson Engineers, Inc.

SECTION 00 0110

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E. 03 3000.10 – Controlled Low Strength Backfill

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A. 05 1200.10 – Pipe Railing and Brackets

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A. 09 9000 – Painting and Coating

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B. 11 2950 – Pressure Relief Valve

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END OF SECTION

DIVISION 16 – ELECTRICAL – Provided by Cleary-Zimmerman, Inc.
DIVISION 03 - STRUCTURAL – Provided by Structural Engineering Associates, Inc.

San Antonio Water System – Specification Sections – Provided by SAWS:
www.saws.org/business_center/specs

City of San Antonio – Specification Sections – Provided by CoSA:
www.SanAntonio.gov/TCI/Current-Vendor-Resources/standard specifications and details

SECTION 00 4373
PROPOSED SCHEDULE OF VALUES FORM

PART I - GENERAL

1.01 GENERAL

A. Prior to the first application for payment, Contractor shall submit to the Engineer, an expanded schedule of values which will define labor and material separately for each significant portion of the work to be performed.

B. Upon request of the Engineer, Contractor shall support the values with data which will substantiate their correctness.

C. The Schedule of Values, unless objected to by the Engineer, shall be used only as the basis for the Contractor's Applications for Payment.

1.02 FORM AND CONTENT OF SCHEDULE OF VALUES

A. Submit schedule on a form for review and approval by Engineer.

B. Schedule shall list the installed value of the component parts of the Work in sufficient detail to serve as a basis for computing values for progress payments during construction.

C. Follow the table of contents of this Project Manual as the format for listing component items. Identify each line item with the number and title of the respective major section of the specifications.

D. For each major line item list sub-values of major products or operations under the item.

E. For items on which progress payments will be requested for stored materials, break down the value into:
   1. The cost of the materials, delivered and unloaded, with taxes paid.
   2. The total installed value.

F. Submit a sub-schedule for each separate stage of work specified.

G. Submit a sub-schedule of unit costs for Products specified under a unit cost allowance.

H. The sum of all values listed in the schedule shall equal the total Contract Sum.

1.03 PARTICULARS

A. All items in the bid form priced as a Lump Sum basis shall have a detailed cost breakdown for use in monthly billing and project schedule reports.

PART II – NOT USED

PART III – NOT USED

END OF SECTION

SECTION 01 0100
SUMMARY OF WORK

PART 1 - GENERAL

1.01 GENERAL

A. The work of this Contract comprises the construction for the Green Mountain Pump Station and Composite Elevated Tank, with related piping, pavement, site work and appurtenances.

B. All work done under this Contract shall conform to all local ordinances. CONTRACTOR shall arrange and pay all cost of permits and inspection fees, and shall confine his operations to the limits set by law.

C. It is the intent of the OWNER to award this project to one CONTRACTOR.

D. Portions of this project may be subject to review and acceptance by various agencies. The CONTRACTOR will be required to coordinate with these agencies for such items as issuance of permits or work orders, inspections during construction, final acceptance, etc. The agencies for this project that may require coordination include but are applicable:

1. City of San Antonio Public Works
2. Bexar County Public Works
3. San Antonio Water System
4. Texas Commission on Environmental Quality

1.02 EXISTING CONDITIONS

A. Existing conditions are shown in the drawings. Locate and protect all existing utilities to remain impacted by this project using the construction drawings as a guide. Those affected by this project may include:

1. San Antonio Water Systems
2. AT&T
3. CPS Energy
4. Time-Warner Cable
5. MCI, Sprint

Many of the entities listed above can be contacted via 1-800-DIGTESS. Be aware, however, that it is the CONTRACTOR's responsibility to protect all utilities, including those whose entities may not be on the DIG TESS program.

1.03 SUMMARY OF PROJECT

Primary work tasks for the Project which are included in this Contract are as follows:

A. 2.5 million gallon composite elevated storage tank.

B. 9.0 MGD high service pump station with four (4) vertical turbine pumps, motors and controls

C. Emergency generator and automatic transfer switch

D. SCADA equipment

E. Yard piping, valves, fittings, etc.

F. Site paving, grading, drainage, security fencing and lighting.

1.04 WORK SEQUENCE

Construct work in stages to provide proper coordination with work by Others. Coordinate the construction schedule and operations with the OWNER's Representative.

1.05 CONTRACTOR'S USE OF PREMISES

A. CONTRACTOR shall limit his use of the premises for Work and for storage, to allow for work by other CONTRACTOR's.

B. Coordinate use of premises under direction of OWNER.

C. Assume full responsibility for the protection and safekeeping of Products under this Contract, stored on the site.

D. Move any stored Products, under CONTRACTOR's control, which interfere with operations of the OWNER or separate CONTRACTOR.

E. Obtain and pay for the use of additional storage or work areas needed for operations.

END OF SECTION

SECTION 01 0250
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 ADMINISTRATIVE SUBMITTALS

A. Schedule of Values: Submit schedule on CONTRACTOR's standard form.

B. Schedule of Estimated Progress Payments:

1. Submit with initially acceptable schedule of values.
2. Submit adjustments thereto with Application for Payment.

C. Application for Payment:

D. Final Application for Payment:

1.02 SCHEDULE OF VALUES

A. Prepare a separate schedule of values for each schedule of Work under the Agreement.

B. Unit Price Work; Reflect unit price quantity and price breakdown from conformed Bid Form.

C. Lump Sum Work:

1. Reflect schedule of values format included in conformed Bid Form, specified allowances, alternates, and equipment selected by OWNER, as applicable.
2. List Bonds and insurance premiums, mobilization, demobilization, facility startup, and contract closeout separately.
3. Breakdown by Division for each portion of the Project.

D. An unbalanced or front-end loaded schedule will not be acceptable.

E. Summation of the complete schedule of values representing all Work shall equal the Contract Price.

1.03 MEASUREMENT AND BASIS FOR PAYMENT:

A. Lump Sum Basis – Monthly amount based on completion of installation, construction, and/or delivery of product, equipment, or facility.

B. Unit Price Basis – Monthly amount based on completed quantity of items installed, constructed and/or delivered to the Project.

1.04 APPLICATION FOR PAYMENT:

A. Reference SAWS Agreement and General Conditions.

B. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of CONTRACTOR.

C. Provide separate form for each schedule as applicable.

D. Include accepted schedule of values for each schedule or portion of Work, the unit price breakdown for Work to be paid on unit price basis, a listing of OWNER-selected equipment if applicable, and allowances, as appropriate.

E. Preparation:

1. Round values to nearest dollar.

2. List each Change Order and Written Amendment executed prior to date of submission as separate line item. Totals to equal those shown on the Transmittal Summary Form for each schedule as applicable.
3. Submit Application for Payment, including a Transmittal Summary Form and detailed Application for Payment Form(s) for each schedule as applicable, a listing of materials on hand for each schedule as applicable and such supporting data as may be requested by OWNER.
4. Include copies of interim record drawings and monthly photographs.

1.05 MEASUREMENT-GENERAL:

A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.

B. Whenever pay quantities of material are determined by weight, the material shall be weighed on scales furnished by CONTRACTOR and certified accurate by the state agency responsible. A weight or load slip shall be obtained from the weigher and delivered to the OWNER at the point of delivery of the material.

C. If material is shipped by rail, the car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.

D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by OWNER. Each vehicle shall bear a plainly legible identification mark.

E. All materials that are specified for measurement by the cubic yard measured in the vehicle shall be hauled in vehicles of such type and size that the actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. All vehicles shall be loaded to at least their water level capacity. Loads hauled in vehicles not meeting the above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

F. Quantities will be based on ground profiles shown. Field surveys will not be made to confirm accuracy of elevations shown.

G. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of I foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.

H. Units of Measure shown on the Schedule of Values shall be as follows unless specified otherwise.

Item	Method of Measurement
AC	Acre-Field Measure by OWNER
CY	Cubic Yard Measure by Owner within the limits specified or shown.
CY-VM	Cubic Yard Measured in the Vehicle by Volume
EA	Each-Field Count by Owner
GAL	Gallon Field Measure by Owner

HR	Hour
LB	Pound(s)-Weight Measure by Scale
LF	Linear Foot-Field measure by Owner
LS	Lump Sum-Unit is one; no measurement will be made
MFBM	Thousand Foot Board Measure-Delivery Invoice
SF	Square Foot
SY	Square Yard
Ton	Ton-Weight Measure by Scale (2,000 pounds)

1.06 PAYMENT

A. Reference Contract Payment of the General Conditions:

B. General:

1. Progress payments will be made by the OWNER within 30 calendar days of receipt of an approved payment request.
2. The date for CONTRACTOR's submission of monthly Application for Payment shall be established at the Pre-Construction Conference.

C. Payment for all Work shown or specified in the Contract Documents is included in the Contract Price. No measurement or payment will be made for individual items.

1.07 NON-PAYMENT FOR REJECTED OR UNUSED PRODUCTS

A. Payment will not be made for the following:

1. Loading, hauling, and disposing of rejected material.
2. Quantities of material wasted or disposed of in a manner not called for under Contract Documents.
3. Rejected loads of material, including material rejected after it has been placed by reason of failure of CONTRACTOR to conform to provisions of Contract Documents.
4. Material not unloaded from transporting vehicle.
5. Defective Work not accepted by OWNER.
6. Material remaining on hand after completion of Work.

1.08 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT:

A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings or preliminary operation and maintenance manuals are acceptable to OWNER.

B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to CONTRACTOR unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 0400
COORDINATION

PART 1 - GENERAL

1.01 OPERATION OF EXISTING FACILITIES AND SHUTDOWNS:

A. Work under this Contract shall not unduly interfere with the operations of existing SAWS facilities.

B. Work under this Contract shall be executed in such fashion the existing SAWS facilities will be kept in continuous operation or readiness except for limited scheduled shutdowns. Other construction contracts may be scheduled for the site simultaneously that will require accommodation, cooperation and coordination by the Contractor.

C. Shutdowns of any existing utilities and facilities will be arranged at the convenience of the Owner and the affected utility or facility owner. No shutdowns shall be commenced without specific permission of the Owner and the affected utility or facility owner. The Owner and the affected utility or facility owner shall be notified in writing at least 5 workdays prior to shutdowns.

D. The Owner and the affected utility or facility owner reserves the right to cancel scheduled shutdowns if conditions warrant. Delays to the Contractor caused by cancellations will be considered in evaluating requests for time extensions.

E. Perform all construction necessary to complete connections and tie-ins to existing facilities.

F. Keep existing facilities in operation unless otherwise specifically permitted in these specifications or approved by the Owner and the affected utility or facility owner.

G. Contractor shall perform all construction activities so as to avoid interference with operations of the facility and the work of others.

1.02 CONTRACTOR COORDINATION:

A. Coordinate scheduling, submittals, and work of the various specifications sections to assure efficient and orderly sequence of installation of interdependent construction elements.

B. Verify that utility requirement characteristics of operating equipment are compatible with existing or planned utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equivalent.

C. Coordinate space requirements and installation of mechanical and electrical work which area indicated diagrammatically on drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance and for repairs.

D. Coordinate completion and clean up of work for Substantial Completion.

F. Coordinate access to site for correction of nonconforming work to minimize disruption of the affected utility or facility owner activities where the affected utility or facility owner is in partial occupancy of the site or newly constructed facilities.

1.03 SEQUENCING OF WORK (NOT USED)

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SECTION 01 2000
PRICE AND PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

B. Documentation of changes in Contract Sum and Contract Time.

C. Change procedures.

D. Correlation of Contractor submittals based on changes.

E. Procedures for preparation and submittal of application for final payment.

1.02 RELATED REQUIREMENTS

A. Contracting Documents (SAWS)

B. Agreement Form (SAWS)

C. General Conditions and Supplementary Conditions (SAWS)

1.03 SCHEDULE OF VALUES

A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Engineer for approval.

B. Submit Schedule of Values in duplicate and electronic format (Excel, Word, etc.) within 15 days after date established in Notice to Proceed.

C. Format: Utilize the Table of Contents of this Project Manual. Identify each line item with number and title of the specification Section. Identify site mobilization and bonds and insurance.

D. Include within each line item, a direct proportional amount of Contractor's overhead and profit.

E. Revise schedule to list approved Change Orders, with each Application For Payment.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement.

B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Engineer for approval.

C. Forms filled out by hand will not be accepted.

D. For each item, provide a column for listing each of the following:
   1. Item Number.
   2. Description of work.
   3. Scheduled Values.
   4. Previous Applications.
   5. Work in Place and Stored Materials under this Application.
   6. Authorized Change Orders.
   7. Total Completed and Stored to Date of Application.
   8. Percentage of Completion.
   9. Balance to Finish.
   10. Retainage.

E. Execute certification by signature of authorized officer.

F. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.

G. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of Work.

H. Submit a minimum number of copies of each Application for Payment per SAWS Agreement.

I. Include the following with the application:
   1. Transmittal letter.
   2. Construction progress schedule, revised and current.
   3. Monthly construction photographs.
   4. Partial release of liens from major Subcontractors and vendors.
   5. Any waivers.
   6. Interim project record documents, for review by Owner which will be returned to the Contractor.
   7. Affidavits attesting to off-site stored products.

J. When Engineer requires substantiating information, submit data justifying dollar amounts in question. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

1.05 MODIFICATION PROCEDURES

A. Submit name of the individual authorized to receive change documents and who will be responsible for informing others in Contractor's employ or subcontractors of changes to the Contract Documents.

B. For minor changes not involving an adjustment to the Contract Sum or Contract Time, Engineer will issue instructions directly to Contractor.

C. For other required changes, Engineer will issue a document signed by Owner instructing Contractor to proceed with the change, for subsequent inclusion in a Change Order.
   1. The document will describe the required changes and will designate method of determining any change in Contract Sum or Contract Time.
   2. Promptly execute the change.

D. For changes for which advance pricing is desired, Engineer will issue a document that includes a detailed description of a proposed change with supplementary or revised drawings and specifications and the period of time during which the requested price will be considered valid. Contractor shall prepare and submit a fixed price quotation within five days.

E. Contractor may propose a change by submitting a request for change to Engineer, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum and Contract Time with full documentation and a statement describing the effect on Work by separate or other contractors.

F. Computation of Change in Contract Amount: As specified in the Agreement and Conditions of the Contract.
   1. For change requested by Engineer for work falling under a fixed price contract, the amount will be based on Contractor's price quotation.
   2. For change requested by Contractor, the amount will be based on the Contractor's request for a Change Order as approved by Engineer.
   3. For pre-determined unit prices and quantities, the amount will based on the fixed unit prices.
   4. For change ordered by Engineer without a quotation from Contractor, the amount will be determined by Engineer based on the Contractor's substantiation of costs as specified for Time and Material work.

G. Substantiation of Costs: Provide full information required for evaluation.
   1. On request, provide following data:

a. Quantities of products, labor, and equipment.
b. Taxes, insurance, and bonds.
c. Overhead and profit.
d. Justification for any change in Contract Time.
e. Credit for deletions from Contract, similarly documented.

2. Support each claim for additional costs with additional information:
a. Origin and date of claim.
b. Dates and times work was performed, and by whom.
c. Time records and wage rates paid.
d. Invoices and receipts for products, equipment, and subcontracts, similarly documented.

3. For Time and Material work, submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.

H. Execution of Change Orders: Engineer will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

I. After execution of Change Order, promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum.

J. Promptly revise progress schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.

K. Promptly enter changes in Project Record Documents.

1.06 APPLICATION FOR FINAL PAYMENT

A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Application for Final Payment will not be considered until the following have been accomplished:
1. All closeout procedures
2. All plan of record drawings are provided and approved by Engineer and SAWS.
3. All warranty documents are provided and approved by Engineer and SAWS.
4. All owner's manuals are provided and approved by Engineer and SAWS.
5. All as-built drawings for public improvements are provided and approved by Engineer and SAWS.
6. All testing results are provided and approved by Engineer and SAWS.
7. All observation records are provided and approved by Engineer and SAWS.
8. The owner's punch list has been completed and approved by Engineer and SAWS.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 3050.10
SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

PART 1 - GENERAL

1.01 SUBMITTALS

A. Submit four (4) prints of all Shop Drawings or one (1) electronic copy (PDF format) until final acceptance. One print will be returned to the General Contractor after Engineer's and Owner's reviews.

B. Submit a minimum of four copies of all Product Data or one (1) electronic copy (pdf format) until final acceptance. One copy of the Product Data will be returned to the Contractor after Engineer's review.

C. Submit a minimum of duplicates of all Samples. Additional samples may be required for specific items for coordination of finishes.

D. Submit additional copies of Samples and Product Data as necessary for distribution to subcontractors. Contractor shall obtain and distribute required prints of Shop Drawings made from reviewed and stamped reproducible. Exact number of copies of Product Data, Samples and Shop Drawings to be submitted shall be established in the pre-construction conference.

E. Contractor shall review and stamp with his approval all submittals. Any submittals which do not bear the Contractor's approval stamp shall be returned without review.

F. Where printed materials describe more than one product or model, clearly identify which is to be furnished.

G. Shop Drawings shall not be reproductions of Contract Documents.

H. Contractor shall make any corrections noted on Engineer's reviewed copies of submittals and shall resubmit the required number of corrected copies of Shop Drawings and Product Data or new Samples.

I. Each Shop Drawing, Sample and Product Data submittal shall be properly identified bearing the name and quality of the material, the manufacturer's name, the Contractor's name, the Subcontractor's name, the name of the Project and the date of submission, and referenced to the applicable Specification Section.

J. Engineer's checking of Shop Drawings, Samples or Product Data which deviates from the Contract Documents does not authorize changes to the Contract Sum. Submit in writing at the time of submission any changes to the Contract Sum affected by such Shop Drawings, Samples or Product Data, otherwise, claim for extras will not be considered.

K. Submit schedule of Shop Drawing and Sample Submittals within 15 days after Notice to Proceed.

L. Contractor may submit one (1) electronic copy (PDF format) of all submittals in lieu of paper copies. All electronic submittals shall be complete, and be provided to Engineer and Owner as required in Contract Document.

M. Owner and Engineer reserve the right to request paper copies of all submittals at no extra cost.

N. All submittals shall come through Contractor only. All submittals provided by Others will be immediately rejected.

END OF SECTION

SECTION 01 3119.10
PROJECT MEETINGS

PART 1 - GENERAL

1.01 PRE-CONSTRUCTION MEETING

A. Contractor will schedule and administer a pre-construction meeting within 10 days after date of Notice to Proceed.

B. Location: A central site, convenient for all parties, provided by Contractor.

C. Attendance
   1. Owner's Representative.
   2. Engineer's Representative.
   3. Contractor's Superintendent.
   4. Others as appropriate.

D. Agenda
   1. Contractor's progress and schedule chart.
   2. Review of required submittals.
   3. Processing of applications for payment.
   4. Critical work sequencing.
   5. Equipment and supply deliveries.
   6. Storage areas, security housekeeping and Owner's needs.
   7. Record minutes and distribute copies within three days after meeting to participants, with one copy each to Engineer, Owner, participants, and those affected by decisions made.

1.02 PROGRESS MEETINGS

A. Contractor shall schedule regular periodic meetings, as required.

B. Hold called meetings as required by progress of the work.

C. Attendance:
   1. Engineer's Representative.
   2. Suppliers as appropriate to the agenda.
   3. Others as appropriate.

END OF SECTION

SECTION 01 3217
DAILY CONSTRUCTION PROGRESS REPORT

PART 1 - GENERAL

1.01 CONTRACT

A. The Contractor shall submit to the Owner's Project Manager, Daily Reports, wherein the following data is provided relative to his Work and the Work of his Subcontractors:
   1. Location and description of work being performed.
   2. Problems, if any, encountered during the course of the day's work.
   3. Number of personnel on job for Contractor and each Subcontractor (broken down as to the number of journeymen, apprentices, etc.).
   4. Temperature and weather conditions.
   5. Discrepancies, if any, noted in Plans and Specifications.

END OF SECTION

SECTION 01 3233.10
CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 CONSTRUCTION PHOTOGRAPHS

A. Construction progress photographs shall be taken once every two weeks with the time, direction of view and vantage points as directed by the Engineer. Contractor shall take bi-weekly photographs (electronic) of all aspects of the project. All photographs shall have date codes imprinted on the image.

B. Photograph from locations to adequately illustrate the condition of construction and the state of the Project.
   1. At successive periods of photography, take at least one photograph from the same overall view as previously.
   2. Consult with Engineer at each period of photography for instructions concerning the views required.

C. Furnish electronic copies (.jpg, tif) of each photograph to the Engineer and Owner with each Application for Payment on compact disk or memory stick.

D. All photographs by date shall be retained by the Contractor until the completion of the Project, at which time they shall be delivered to the Owner and shall become the property of the Owner.

END OF SECTION

SECTION 01 3553
SECURITY PROCEDURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Security measures including entry control, guard service, and miscellaneous restrictions.

1.02 RELATED REQUIREMENTS

A. SAWS Contract Documents

B. Section 01 5000 - Temporary Facilities and Controls.

1.03 SECURITY PROGRAM

A. Protect Work, existing premises and Owner's operations from theft, vandalism, and unauthorized entry.

B. Initiate program at project mobilization.

C. Maintain program throughout construction period until Owner occupancy.

1.04 ENTRY CONTROL

A. Restrict entrance of persons and vehicles into Project site and existing facilities.

B. Allow entrance only to authorized persons with proper identification.

C. Maintain log of workers and visitors, make available to Owner on request.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 4000
QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. References and standards.

B. Quality assurance submittals.

C. Mock-ups.

D. Control of installation.

E. Tolerances.

F. Testing and inspection services.

G. Manufacturers' field services.

1.02 RELATED REQUIREMENTS

A. Section 02-3000 Subsurface Investigation.

B. Contract Documents and General Conditions – San Antonio Water System (SAWS).

C. Administrative Requirements – San Antonio Water System (SAWS).

D. Section 01 4216 - Definitions.

E. SAWS Standard Specifications www.saws.org/business_center/specs

F. City of San Antonio Standard Specifications www.SanAntonio.gov/TCI/Current-Vendor-Resources/standard specifications and details

1.03 REFERENCE STANDARDS

A. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation; 2014.

B. ASTM C1093 - Standard Practice for Accreditation of Testing Agencies for Masonry; 2013.

C. ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction; 2012a.

D. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing; 2014a.

E. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2013.

1.04 SUBMITTALS

A. See SAWS Contract Documents and General Conditions - Administrative Requirements, for submittal procedures.

B. Testing Agency Qualifications:

1. Prior to start of Work, submit agency name, address, and telephone number, and names of full time registered Engineer and responsible officer.
2. Submit copy of report of laboratory facilities inspection made by Construction Materials Reference Laboratory during most recent inspection, with memorandum of remedies of any deficiencies reported by the inspection.

C. Design Data: Submit for Engineer's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents, or for Owner's information.

D. Test Reports: After each test/inspection, promptly submit one copy of report directly to Contractor, Owner, and Engineer.
   1. Include:
      a. Date issued.
      b. Project title and number.
      c. Name of inspector.
      d. Date and time of sampling or inspection.
      e. Identification of product and specifications section.
      f. Location in the Project.
      g. Type of test/inspection.
      h. Date of test/inspection.
      i. Results of test/inspection.
      j. Conformance with Contract Documents.
      k. When requested by Engineer, provide interpretation of results.
   2. Test report submittals are for Engineer's and Owner's knowledge as contract administrator for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

E. Certificates: When specified in individual specification sections, submit certification by the manufacturer and Contractor to Engineer, in quantities specified for Product Data.
   1. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
   2. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

F. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

G. Manufacturer's Field Reports: Submit reports for Engineer's benefit as contract administrator or for Owner.
   1. Submit report within seven (7) days of observation to Engineer for information.
   2. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

H. Erection Drawings: Submit drawings for Engineer's benefit as contract administrator or for Owner.
   1. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.
   2. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer or Owner.

1.05 REFERENCES AND STANDARDS

A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard of date of issue current on date specified in the individual specification sections, except where a specific date is established by applicable code.

C. Obtain copies of standards where required by product specification sections.

D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

E. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.

F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Engineer shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.06 TESTING AND INSPECTION AGENCIES

A. Owner will employ and pay for services of an independent testing agency to perform other specified testing, inspection, and reporting not specifically required of the Contractor in the technical specifications.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 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. Should 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. Have Work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 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. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

3.03 TESTING AND INSPECTION

A. See individual specification sections for testing, inspection, and reporting required.

B. Testing Agency Duties:
   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 and inspections required by Engineer.
7. Attend preconstruction meetings and progress meetings.
8. Submit reports of all tests/inspections specified.

C. Limits on Testing/Inspection Agency Authority:
1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Agency may not approve or accept any portion of the Work.
3. Agency may not assume any duties of Contractor.
4. Agency has no authority to stop the Work.

D. Contractor Responsibilities:
1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
2. Cooperate with laboratory personnel, and provide access to the Work .
3. Provide incidental labor and facilities:
a. To provide access to Work to be tested/inspected.
b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
c. To facilitate tests/inspections.
d. To provide storage and curing of test samples.
4. Notify Engineer and laboratory 48 hours prior to expected time for operations requiring testing/inspection services.
5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Engineer.

F. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

3.04 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Engineer 21 days in advance of required observations.
1. Observer subject to approval of Engineer.
2. Observer subject to approval of Owner.

C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.05 DEFECT ASSESSMENT

A. Replace Work or portions of the Work not conforming to specified requirements.

B. If, in the opinion of Engineer, it is not practical to remove and replace the Work, Engineer will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01 4216
DEFINITIONS

PART 1 - GENERAL

1.01 SUMMARY

A. References to standards, codes, Specifications, recommendations and regulations refer to the latest edition or printing prior to the date of issue of the Contract Documents.

B. Applicable portions of standards listed that are not in conflict with Contract Documents are hereby made a part of the Specifications.

C. Modifications or exceptions to Standards shall be considered as amendments and unmodified portions shall remain in full effect. In cases of discrepancies between standards, the more stringent requirements shall govern.

D. Where two or more standards are specified to establish quality, the product and workmanship shall meet or exceed the requirements of the most stringent.

E. Where both a standard and a brand name are specified for a product in the Contract Documents, the proprietary product named shall meet or exceed the requirements of the specified reference standard.

F. Copies of standards and specifications of technical societies.

1. Copies of applicable referenced standards have not been bound in these Contract Documents.
2. Where copies of standards are needed by the CONTRACTOR, obtain a copy or copies directly from the publication source and maintain in an orderly manner at the site as Work site records, available to the CONTRACTOR's personnel, Subcontractors, and Owner.

1.02 DEFINITION OF PARTIES

A. Owner shall mean the San Antonio Water System, San Antonio, Texas.

B. Engineer shall mean Pape-Dawson Engineers, Inc., 2000 NW Loop 410, San Antonio, TX 78213

1.03 DEFINITIONS

A. Furnish: To supply, deliver, unload, and inspect for damage.

B. Install: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use.

C. Product: Material, machinery, components, equipment, fixtures, and systems forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never before used, or re-used materials or equipment.

D. Project Manual: The book-sized volume that includes the procurement requirements (if any), the contracting requirements, and the specifications.

E. Provide: To furnish and install.

F. Supply: Same as Furnish.

1.04 ABBREVIATIONS AND NAMES

A. The following acronyms or abbreviations as referenced in contract documents are defined to mean the associated names. Names are subject to change, and are believed to be, but are not assured to be, accurate and up-do-date as of date of contract documents:

1. AA Aluminum Association

2. AAMA American Architectural Manufacturers Association
3. AAN American Association of Nurserymen
4. AASHTO American Association of State Highway and Transportation Officials
5. AATCC American Association of Textile Chemists and Colorists
6. ABMA Amercian Bearing Manufacturer's Association
7. ACI American Concrete Institute
8. ACIL American Council of Independent Laboratories
9. ACPA American Concrete Pipe Association
10. ADC Air Diffusion Council
11. AFBMA Anti-Friction Bearing Manufacturers Association, Inc.
12. AGA American Gas Association
13. AGMA American Gear Manufacturers Association
14. AHAM Association of Home Appliance Manufacturers
15. AI Asphalt Institute
16. AIA American Institute of Architects
17. AIA American Insurance Association
18. AISC American Institute of Steel Construction
19. AISI American Iron and Steel Institute
20. AITC American Institute of Timber Construction
21. ALSC American Lumber Standards Committee
22. AMCA Air Movement and Control Association
23. ANSI American National Standards Institute
24. APA American Plywood Association
25. APA American Parquet Association
26. ARI Air Conditioning and Refrigeration Institute
27. ASC Adhesive and Sealant Council
28. ASCE American Society of Civil Engineers
29. ASHREA Architectural Society of Heating, Refrigerating and Air-Conditioning Engineers
30. ASME American Society of Mechanical Engineers
31. ASPE American Society of Plumbing Engineers
32. ASSE American Society of Sanitary Engineers
33. ASTM American Society for Testing and Materials
34. AWI Architectural Woodwork Institute
35. AWPA American Wood-Preservers' Association
36. AWPB American Wood-Preservers Bureau
37. AWS American Welding Society
38. AWWA American Water Works Association
39. BHMA Builders Hardware Manufacturers Association
40. BIA Brick Institute of America
41. BIFMA Business and Institutional Furniture Manufacturer's Association
42. CBM Certified Ballast Manufacturers
43. CDA Copper Development Association
44. CE Corps of Engineers (U.S. Dept. of the Army)
45. CFFA Chemical Fabrics and Film Association, Inc.
46. CFR Code of Federal Regulations
47. CGA Compressed Gas Association
48. CISPI Cast Iron Soil Pipe Institute
49. CLFMI Chain Link Fence Manufacturer's Institute

50. CPSC Consumer Product Safety Commission
51. CRA California Redwood Association
52. CRI Carpet and Rug Institute
53. CRSI Concrete Reinforcing Steel Institute
54. CS Commercial Standard of NBS (U.S. Dept. of Commerce)
55. CTI Ceramic Tile Institute
56. DHI Door and Hardware Institute
57. DLPA Decorative Laminate Products Association
58. DOC Department of Commerce
59. DOT Department of Transportation
60. EAA Edwards Aquifer Authority
61. EIA Electronic Industries Association
62. EPA Environmental Protection Agency
63. FAA Federal Aviation Administration (U.S. Dept of Transportation)
64. FCC Federal Communications Commission
65. FCI Fluid Controls Institute
66. FGMA Flat Glass Marketing Association
67. FHA Federal Housing Administration (U.S. Dept. of HUD)
68. FM Factory Mutual System
69. FS Federal Specification (General Services Admin.)
70. FTI Facing Tile Institute
71. GA Gypsum Association
72. GSA General Services Administration
73. HI Hydraulic Institute
74. HPMA Hardwood Plywood Manufacturers Association
75. IEEE Institute of Electrical and Electronic Engineers, Inc.
76. IESNA Illuminating Engineering Society of North America
77. IGCC Insulating Glass Certification Council
78. ILI Indiana Limestone Institute of America
79. IMIAC International Masonry Industry All-Weather Council
80. IMIAWC International Masonry Industry All Weather Council
81. IRI Industrial Risk Insurance
82. ISA Instrument Society of America
83. MBMA Metal Building Manufacturer's Association
84. MCAA Mechanical Contractors Association of America
85. MIA Marble Institute of America
86. MIL Military Standardization Documents (U.S. Dept. of Defense)
87. ML/SFA Metal Lath/Steel Framing Association
88. MSS Manufacturers Standardization Society of the Valve and Fittings Industry
89. NACE National Association of Corrosion Engineers
90. NAAMM National Association of Architectural Metal Manufacturers
91. NBGQA National Building Granite Quarries Association
92. NBS National Bureau of Standards (U.S. Dept. of Commerce)
93. NCMA National Concrete Masonry Association
94. NCRPM National Council on Radiation Protection and Measurement
95. NEC National Electrical Code (by NFPA)
96. NECA National Electrical Contractors Association
97. NEII National Elevator Industry, Inc.
98. NEMA National Electrical Manufacturers Association

99. NFPA National Fire Protection Association
100. NFPA National Forest Products Association
101. NHLA National Hardwood Lumber Association
102. NKCA National Kitchen Cabinet Association
103. NOFMA National Oak Flooring Manufacturers Association
104. NPA National Particleboard Association
105. NPCA National Paint and Coatings Association
106. NPDES National Pollutant Discharge Elimination System
107. NRCA National Roofing Contractors Association
108. NRMCA National Ready-Mix Concrete Association
109. NSF National Sanitation Foundation
110. NSSEA National School Supply and Equipment Association
111. NTMA National Terrazzo and Mosaic Association
112. NWMA National Woodwork Manufacturers Association
113. OSHA Occupational Safety Health Administration (U.S. Dept. of Labor)
114. PCA Portland Cement Association
115. PCI Prestressed Concrete Institute
116. PDI Plumbing and Drainage Institute
117. PEI Porcelain Enamel Institute
118. PS Product Standard of NBS (U.S. Dept. of Commerce)
119. RFCI Resilient Floor Covering Institute
120. RIS Redwood Inspection Service (Grading Rules)
121. SAE Society of Automotive Engineers
122. SAMA Scientific Apparatus Makers Association
123. SDI Steel Deck Institute
124. SGCC Safety Glazing Certification Council
125. SHLMA Southern Hardwood Lumber Manufacturers Association
126. SIGMA Sealed Insulating Glass Manufacturers Association
127. SJI Steel Joist Institute
128. SMACNA Sheet Metal and Air Conditioning Contractors' National Association
129. SPIB Southern Pine Inspection Bureau (Grading Rules)
130. SPIB Southern Pine Inspection Bureau
131. SSPC Steel Structures Painting Council
132. SWI Steel Window Institute
133. SWPPP Storm Water Pollution Prevention Plan
134. TCA Tile Council of America
135. TCEQ Texas Commission on Environmental Quality
136. TIMA Thermal Insulation Manufacturers Association
137. TPI Truss Plate Institute
138. TxDOT Texas Department of Transportation
139. UBC Uniform Building Code
140. UL Underwriters Laboratories
141. UPC Uniform Plumbing Code
142. USCOE Corps of Engineers or US Army Corps of Engineers
143. USDA United States Department of Agriculture
144. USPS United States Postal Service
145. WCLIB West Coast Lumber Inspection Bureau (Grading Rules)
146. WPAP Water Pollution Abatement Plan
147. WRI Wire Reinforcement Institute

148. WSC Water Systems Council
149. WSFI Wood and Synthetic Flooring Institute
150. WWPA Western Wood Products Association (Grading Rules)
151. WWPA Woven Wire Products Association

1.05 GENERAL SPECIFICATION ABBREVIATIONS

A.	Cubic Foot	cu. ft.
B.	Degree	deg.
C.	Diameter	dia.
D.	Feet or Foot	ft.
E.	Inch	in.
F.	Inside Diameter	i.d.
G.	Kips (1000 pounds)	K
H.	Millimeter	mm
I.	Ounce	oz.
J.	Outside Diameter	o.d.
K.	Pound	lb.
L.	Pounds per Cubic Foot	pcf
M.	Pounds per Square Foot	psf
N.	Pounds per Square Inch	psi
O.	Square Foot	sq. ft.
P.	Square Inch	sq. in.

1.06 REFERENCE STANDARDS - GENERAL

A. Publications of organizations and societies listed in individual Specification Sections shall be considered integral with Contract Documents to extent referenced.

B. Publications are referred to in text by basic designation only with organizations and societies referenced by abbreviations.

C. When standard is referenced to in individual Specification Section but is not listed in this Section by title and date, it shall be considered to be latest revision at date of Project Manual issuance.

D. Make available at site, copies of referenced documents as Engineer or Owner may request.

E. Following listings include full title and applicable revision date.

1.07 REFERENCE STANDARDS

A. American Concrete Institute (ACI):
   1. 211.1-81 (Revised 1985), Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
   2. 211.2-81, Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
   3. 211.3-75 (Revised 1987), Standard Practice for Selecting Proportions for No-Slump Concrete.
   4. 301-84 (Revised 1987), Specification for Structural Concrete for Buildings.
   5. 304R-85, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
   6. 306R-77 (Revised 1982), Hot Weather Concreting.
   7. 306R-78 (Revised 1983), Cold Weather Concreting.

8. 308-81 (Revised 1986), Standard Practice for Curing Concrete.
9. 309-72 (Revised 1982), Standard Practice for Consolidation of Concrete.
10. 315-80, Details and Detailing of Reinforced Concrete (included in SP-66).
11. 318-83 (Revised 1986), Building Code Requirements for Reinforced Concrete.
12. 347-78 (Reapproved 1984), Recommended Practice for Concrete Formwork.
13. SP-66, ACI Detailing Manual (1980 Edition).

B. American Institute of Steel Construction (AISC):
1. Code of Standard Practice for Steel Buildings and Bridges (with Commentary), September 1, 1976.
2. Manual of Steel Construction, Eighth Edition.
3. Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings (with Commentary), November 1, 1978.
4. Specification for Structural Joints Using ASTM A325 or A490 Bolts, April 26, 1978.

C. American Society for Testing and Materials (ASTM)
1. A 36-84a, Specification for Structural Steel.
2. A 47-84, Specification for Ferritic Malleable Iron Castings.
3. A 53-84a, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
4. A 82-85, Specification for Steel Wire, Plain, for Concrete Reinforcement.
5. A 108-81, Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality.
6. A 116-81, Specification for Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric.
7. A 123-84, Specification for Zinc (Hot-Galvanized) Coatings on Iron and Steel Products.
8. A 153-84, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
9. A 185-85, Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.
10. A 242-87, Specification for High-Strength Low-Alloy Structural Steel.
11. A 307-86, Specification for Carbon Steel Bolts and Studs, 6000 psi Tensile Strength.
12. A 325-86a, Specification for High-Strength Bolts for Structural Steel Joints.
13. A 370-86a, Methods and Definitions for Mechanical Testing of Steel Products.
14. A 416-86, Specification for Steel Strand, Uncoated Seven-Wire Stress-Relieved for Prestressed Concrete.
15. A 421-80 (1985), Specification for Uncoated Stress-Relieved Wire for Prestressed Concrete.
16. A 446-85, Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) Quality.
17. A 475-85, Specification for Zinc-Coated Steel Wire Strand.
18. A 490-85, Specification for Heat-Treated, Steel Structural Bolts 150 KSI Tensile Strength.
19. A 500-84, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
20. A 501-84, Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
21. A 514-87a, Specification for High-Yield Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
22. A 525-83, Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements.
23. A 572-84, Specification for High-Strength Low-Alloy Columbium-Vanadium Steel of Structural Quality.
24. A 576-81, Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.

25. A 588-87, Specification for High-Strength Low-Alloy Structural Steel with 50,000 psi Minimum Yield Point to 4 in. Thick.
26. A 611-85, Specification for Steel, Sheet, Carbon, Cold-Rolled Structural Quality.
27. A 615-87, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
28. A 706-84a, Specification for Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
29. A 775-85, Specification for Epoxy-Coated Reinforcing Steel Bars.
30. A 633-85, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
31. C 31-85, Method for Making and Curing Concrete Test Specimens in the Field.
32. C 33-86, Specification for Concrete Aggregates.
33. C 39-86, Test for Compressive Strength of Cylindrical Concrete Specimens.
34. C 42-84a, Methods for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
35. C 90-85, Specification for Hollow Load-Bearing Concrete Masonry Units.
36. C 91-86, Specification for Masonry Cement.
37. C 94-86, Specification for Ready-Mixed Concrete.
38. C 109-86, Test Method for Compressive Strength of Hydraulic Cement Mortars.
39. C 138-81, Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete.
40. C 140-75 (1980), Method of Sampling and Testing Concrete Masonry Units.
41. C 143-78, Test Method for Slump of Portland Cement Concrete.
42. C 144-87, Specification for Aggregate for Masonry Mortar.
43. C 150-85a, Specification for Portland Cement.
44. C 171-69 (1986), Specification for Sheet Materials for Curing Concrete.
45. C 172-82, Method of Sampling Freshly Mixed Concrete.
46. C 173-78, Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
47. C 190-85, Test Method for Tensile Strength of Hydraulic Cement Mortars.
48. C 207-79 (1984), Specification for Hydrated Lime for Masonry Purposes.
49. C 231-82, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
50. C 260-85, Specification for Air-Entraining Admixtures for Concrete.
51. C 270-86b, Specification for Mortar for Unit Masonry.
52. C 309-81, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
53. C 311-85, Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete.
54. C 330-87, Specification for Lightweight Aggregates for Structural Concrete.
55. C 404-87, Specification for Aggregates for Masonry Grout.
56. C 476-83, Specification for Grout for Reinforced and Non-reinforced Masonry.
57. C 494-86, Specification for Chemical Admixtures for Concrete.
58. C 567-85, Test Method for Unit Weight of Structural Lightweight Concrete.
59. C 595-86, Specification for Blended Hydraulic Cements.
60. C 618-85, Specification for Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement.
61. C 780-80 (1985), Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
62. C 827-82, Test Method for Early Volume Change of Cementitious Mixtures.
63. C 938-80 (1985), Practice for Proportioning Grout Mixtures for Preplaced-Aggregate Concrete.

64. C 942-86, Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
65. C 989-85a, Specification for Ground Iron Blast-Furnace Slag for Use in Concrete and Mortars.
66. D 98-80, Specification for Calcium Chloride.
67. D 994-71 (Reaffirmed 1982), Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
68. D 1751-83, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
69. D 1752-84, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
70. D 2092-86, Recommended Practices for Preparation of Zinc-Coated Galvanized Steel Surfaces for Painting.
71. D 2240-86, Test for Rubber Property - Durometer Hardness.
72. D 3034, Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
73. E 164-81, Practice for Ultrasonic Contact Examination of Weldments.
74. E 329-77 (1983), Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction.
75. E 447-84, Test Methods for Compressive Strength of Masonry Prisms.

D. American Welding Society (AWS):
1. A5.1-81, Specification for Carbon Steel Covered Arc-Welding Electrodes.
2. A5.5-81, Specification for Low-Alloy Steel Covered Arc-Welding Electrodes.
3. A5.17-80, Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc-Welding.
4. A5.20-79, Specification for Carbon Steel Electrodes for Flux Cored Arc-Welding.
5. B2.1-84, Welding Procedure and Performance Qualification.
6. D1.1-86, Structural Welding Code - Steel.
7. D1.3-81, Specification for Welding of Sheet Metal in Structures.
8. D1.4-79, Structural Welding Code - Reinforcing Steel.
9. QC-1-86, Standard for Qualification and Certification of Welding Inspectors.

E. Prestressed Concrete Institute (PCI):
1. MNL 116-77, Manual for Quality Control for Plants and Production of Precast Prestressed Concrete Products.
2. MNL 117-77, Manual for Quality Control of Plants and Production of Architectural Precast Concrete Products

F. Steel Deck Institute (SDI):
1. Specification for Composite Steel Floor Deck, 1987.
2. Specification for Non-Composite Steel Form Deck, 1987.
3. Specification for Steel Roof Deck, 1987.

G. Steel Joist Institute (SJI):
1. Recommended Code of Standard Practice for Steel Joists, November 4, 1985.
2. Standard Specification for Joist Girders, November 4, 1985.
3. Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series, November 4, 1985.
4. Standard Specification for Open Web Steel Joists, K-Series, November 1, 1985.

END OF SECTION

SECTION 01 5000
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Temporary utilities.

B. Temporary telecommunications services.

C. Temporary sanitary facilities.

D. Temporary Controls: Barriers, enclosures, and fencing.

E. Security requirements.

F. Vehicular access and parking.

G. Waste removal facilities and services.

H. Project identification sign.

I. Field offices.

1.02 RELATED REQUIREMENTS

A. Section 01 3553 - Security Procedures.

B. Section 01 5100 - Temporary Utilities.

C. Section 01 5213 - Field Offices and Sheds.

D. Section 01 5500 - Vehicular Access and Parking.

E. Section 01 5813 - Temporary Project Signage.

1.03 TEMPORARY UTILITIES

A. See Section 01 5100 for additional requirements.

B. Provide and pay for all electrical power, lighting, water, heating and cooling, and ventilation required for construction use by Contractor.

C. Existing facilities may be used with Owner approval.

D. New permanent facilities may be used with Owner approval.

E. Use trigger-operated nozzles for water hoses, to avoid waste of water.

1.04 TELECOMMUNICATIONS SERVICES

A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

B. Telecommunications services shall include:

1. Windows-based personal computer dedicated to project telecommunications, with necessary software and laser printer.
2. Telephone Land Lines: One line, minimum; one handset per line. If not available, dedicated cellular service phone number with automatic voice message recording capabilities shall be provided.
3. Internet Connections: Minimum of one.
4. Email: Account/address reserved for project use.
5. Facsimile Service: Minimum of one dedicated fax machine/printer, with dedicated phone line, or
6. Fax-to-email software on personal computer.

1.05 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.

B. Maintain daily in clean and sanitary condition.

1.06 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for Owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Provide barricades and covered walkways required by governing authorities for public rights-of-way .

C. Provide protection for plants designated to remain. Replace damaged plants.

D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

E. Traffic Controls: To be installed and maintained per State or local requirements..

1.07 FENCING

A. Construction: Commercial grade chain link fence with three (3) stranded barbed-wire.

B. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.08 SECURITY

A. See Section 01 3553 for additional requirements.

B. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

C. Coordinate security program with Owner.

1.09 VEHICULAR ACCESS AND PARKING

A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.

B. Coordinate access and haul routes with governing authorities and Owner.

C. Provide and maintain access to fire hydrants, free of obstructions.

D. Provide means of removing mud from vehicle wheels before entering streets.

E. Existing on-site roads or public streets shall not be used for construction traffic.

F. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

G. Do not allow vehicle parking on existing roadway pavement.

1.10 WASTE REMOVAL

A. See Section 01 7419 - Waste Management, for additional requirements.

B. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.

C. Provide containers with lids. Remove trash from site.

D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.

E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.11 PROJECT IDENTIFICATION

A. Provide project identification sign of design, construction, and location approved by Owner.

B. No other signs are allowed without Owner permission except those required by law.

1.12 FIELD OFFICES

A. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment .

B. Provide space for Project meetings, with table and chairs to accommodate a minimum of 8 persons.

C. Locate offices a minimum distance of 30 feet from new structures.

1.13 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.

B. Remove temporary underground installations to a minimum depth of 2 feet.

C. Clean and repair damage caused by installation or use of temporary work.

D. Restore existing facilities used during construction to original condition.

E. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 5100
TEMPORARY UTILITIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Temporary Utilities: Electricity, water, sanitary sewer, and telecommunications.

1.02 RELATED REQUIREMENTS

A. Section 01 5000 - Temporary Facilities and Controls.

1.03 TEMPORARY ELECTRICITY

A. Cost: By Contractor.

B. Provide power service required from electric service purveyor (CPS Energy).

C. Complement existing power service capacity and characteristics as required.

D. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required. Provide flexible power cords as required.

E. Provide main service disconnect and over-current protection at the meter.

F. Permanent convenience receptacles may be utilized during construction.

G. Provide adequate distribution equipment, wiring, and outlets to provide single phase branch circuits for power and lighting.

H. Comply with Federal, State and local codes and regulations and with utility company requirements.

1.04 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

A. Materials and equipment may be new or used, but must be adequate in capacity for the required usage, must not create unsafe conditions, and must not violate requirements of applicable codes and standards.

B. Provide and maintain lighting for construction operations.

C. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.

D. Contractor shall provide for his extension cords and any additional lighting that may be required to complete his work.

E. Maintain lighting and provide routine repairs.

F. Permanent building lighting may be utilized during construction.

1.05 TEMPORARY TELEPHONE SERVICE

A. Provide SAWS and Engineer with list of Contractor’s project manager’s and foreman’s email addresses and phone numbers.

1.06 TEMPORARY WATER SERVICE

A. Cost of Water Used for general construction: By Contractor.

B. Provide and maintain suitable quality water service for construction operations at time of project mobilization.

C. Extend branch piping with outlets located so water is available by hoses with threaded connections. Provide temporary pipe insulation to prevent freezing.

D. The Owner will provide necessary potable water for testing of the elevated storage tank and pump station.

1.07 TEMPORARY SANITARY FACILITIES

A. Provide and maintain adequate temporary outside toilet facilities for use of persons working at the Site.

B. Keep toilets clean and in sanitary condition. Provide toilet tissue in suitable holders. Comply with applicable legal and health requirements.

C. Remove temporary toilets when construction is completed.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 5213
FIELD OFFICES AND SHEDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Temporary field offices for use of Contractor.

B. Maintenance and removal.

1.02 RELATED REQUIREMENTS

A. Section 01 5000 - Temporary Facilities and Controls:

B. Section 01 5500 - Vehicular Access and Parking.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and Equipment: Serviceable, new or used, adequate for required purpose.

2.02 CONSTRUCTION

A. Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations, with steps and landings at entrance doors.

B. Construction: Structurally sound, secure, weather tight enclosures for office. Maintain during progress of Work; remove when no longer needed.

C. Temperature Transmission Resistance of Floors, Walls, and Ceilings: Compatible with occupancy requirements.

D. Exterior Materials: Weather resistant.

E. Interior Materials in Offices: Sheet type materials for walls and ceilings, prefinished or painted; resilient floors and bases.

F. Fire Extinguishers: Appropriate type fire extinguisher at each office.

2.03 Contractor OFFICE AND FACILITIES

A. Size: For Contractor's needs and to provide space for project meetings.

B. Telephone: As specified in Section 01 5000.

C. Furnishings in Meeting Area: Conference table and chairs to seat at least eight persons; racks and files for Contract Documents, submittals, and project record documents.

D. Other Furnishings: Contractor's option.

E. Sanitary Facilities: As specified in Section 01 5000.

F. Drinking Fountain: Convenient access by workers and visitors.

PART 3 EXECUTION

3.01 PREPARATION

A. Fill and grade sites for temporary structures to provide drainage away from buildings.

3.02 INSTALLATION

A. Install office spaces ready for occupancy within 15 days after date fixed in Notice to Proceed.

B. Parking: Gravel parking area near field office.

3.03 MAINTENANCE AND CLEANING

A. Weekly janitorial services for offices; periodic cleaning and maintenance for offices.

B. Maintain approach walks free of mud, water, and snow.

3.04 REMOVAL

A. At completion of Work remove buildings, foundations, utility services, and debris. Restore all areas damaged by construction.

END OF SECTION

SECTION 01 5500
VEHICULAR ACCESS AND PARKING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Access driveway.

B. Parking.

E. Construction parking controls.

F. Flag persons.

G. Haul routes.

H. Maintenance.

I. Removal, repair.

J. Mud from site vehicles.

1.02 RELATED REQUIREMENTS

A. Section 01 5713 - Temporary Erosion and Sediment Control.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials for Permanent Construction: As specified in product specification sections, including earthwork, paving base, and paving.

2.02 SIGNS, SIGNALS, AND DEVICES

A. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As required by local jurisdictions.

B. Traffic Control Signals: As approved by local jurisdictions.

C. Traffic Cones and Drums, Flares and Lights: As approved by local jurisdictions.

D. Flag Person Equipment: As required by local jurisdictions.

PART 3 EXECUTION

3.01 PREPARATION

A. Clear areas, provide surface and storm drainage of road, parking, area premises, and adjacent areas.

B. Contractor shall obtain all permits and comply with all state and local codes for onsite fuel storage.

3.02 ACCESS ROADS

A. Use of existing on-site streets and driveways for construction traffic is permitted.

B. Tracked vehicles not allowed on paved areas.

C. Construct new temporary all-weather access roads from public thoroughfares to serve construction area, of a width and load bearing capacity to provide unimpeded traffic for construction purposes.

E. Extend and relocate as Work progress requires, provide detours as necessary for unimpeded traffic flow.

F. Provide unimpeded access for emergency vehicles. Maintain 20 foot width driveways with turning space between and around combustible materials.

G. Provide and maintain access to fire hydrants and control valves free of obstructions.

3.03 PARKING

A. All parking for employees, vendors, subcontractors, etc. shall be accommodated on project site. Parking within public right-of-way is prohibited.

B. Use of designated areas of existing parking facilities by construction personnel is permitted.

C. Use of new parking facilities by construction personnel is not permitted.

D. Do not allow heavy vehicles or construction equipment in paved areas.

E. Arrange for temporary parking areas to accommodate use of construction personnel.

F. When site space is not adequate, provide additional off-site parking.

3.04 NEW PERMANENT PAVEMENTS

A. Prior to Substantial Completion the base for permanent roads and parking areas may be used for construction traffic.

B. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.

3.05 CONSTRUCTION PARKING CONTROL

A. Control vehicular parking to prevent interference with public traffic and parking, access by emergency vehicles, and Owner's operations.

B. Monitor parking of construction personnel's vehicles in existing facilities. Maintain vehicular access to and through parking areas.

C. Prevent parking on or adjacent to access roads or in non-designated areas.

3.06 FLAG PERSONS

A. Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

3.07 FLARES AND LIGHTS

A. Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

3.08 HAUL ROUTES

A. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.

B. Confine construction traffic to designated haul routes.

C. Provide traffic control at critical areas of haul routes to regulate traffic, to minimize interference with public traffic.

3.09 TRAFFIC SIGNS AND SIGNALS

A. At approaches to site and on site, install at crossroads, detours, parking areas, and elsewhere as needed to direct construction and affected public traffic.

B. Install and operate automatic traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control, and areas affected by Contractor's operations.

C. Relocate as Work progresses, to maintain effective traffic control.

3.10 MAINTENANCE

A. Maintain traffic and parking areas in a sound condition free of excavated material, construction equipment, Products, mud, snow, and ice.

B. Maintain existing and new permanent paved areas used for construction; promptly repair breaks, potholes, low areas, standing water, and other deficiencies, to maintain paving and drainage in original, or specified, condition.

3.11 REMOVAL AND REPAIR

A. Remove temporary roads when permanent paving is usable and approved for use by Engineer.

B. Remove underground work and compacted materials to a depth of 2 feet; fill and grade site as specified.

C. Repair existing and new permanent facilities damaged by use, to original condition.

D. Remove equipment and devices when no longer required.

E. Repair damage caused by installation.

F. Remove post settings to a depth of 2 feet.

3.12 MUD FROM SITE VEHICLES

A. Provide means of removing mud from vehicle wheels before entering public streets.

END OF SECTION

SECTION 01 5713
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Revegetation of disturbed areas.

E. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.02 RELATED REQUIREMENTS

A. Section 31 1000 - Site Clearing.

B. Section 31 2200 - Grading.

C. Section 31 2316 - Excavation.

D. Section 31 2323 - Fill.

E. Section 31 3700 – Riprap – see City of San Antonio (CoSA) Spec Section 505.

1.03 REFERENCE STANDARDS

A. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit; Current Edition.

B. FHWA FLP-94-005 - Best Management Practices for Erosion and Sediment Control; 1995.

C. Texas Commission on Environmental Quality - Storm Water Pollution Prevention Plan (SWPPP) requirements.

D. State, local, County and Municipal SWPPP requirements.

1.04 PERFORMANCE REQUIREMENTS

A. Comply with all requirements for erosion and sedimentation control, as specified for the Texas Pollutant Discharge Elimination System (TPDES), Phases I and II, under requirements for the Construction General Permit (CGP); current edition.

B. Comply with all more stringent requirements of the County and municipal.

C. Comply with all requirements of the SWPPP for erosion and sedimentation control.

D. Best Management Practices Standard: Federal Highway Administration Best Management Practices for Erosion and Sediment Control.

E. Develop and follow an Erosion and Sedimentation Prevention Plan and submit periodic inspection reports.

F. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.

1. Contractor will obtain permits and pay for securities required by authority having jurisdiction.
2. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.

G. Timing: Put preventive measures in place before disturbance of surface cover and before precipitation occurs.

H. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
   1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
   2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 10 years.

I. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
   1. Control movement of sediment and soil from temporary stockpiles of soil.
   2. Prevent development of ruts due to equipment and vehicular traffic.
   3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

J. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
   1. Prevent windblown soil from leaving the project site.
   2. Prevent tracking of mud and sediment onto public roads outside site.
   3. Prevent mud and sediment from flowing onto sidewalks and pavements.
   4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

K. Open Water: Prevent standing water that could become stagnant.

L. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mulch:
   1. Straw or hay.
   2. Wood waste, chips, or bark.
   3. Erosion control matting or netting.

B. Grass Seed For Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.

C. Bales: Bound, rectangular straw bales.

D. Bale Stakes:
   1. Steel U- or T-section.
   2. Wood.
   3. Minimum Length: 3 feet.

E. Silt Fence Fabric: Polypropylene, polyethylene, or polyamide woven or nonwoven geotextile fabric resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
   1. Minimum Unit Weight: 4.5 oz/yd.
   2. Minimum Width: 36 inches.
   3. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D4751.

4. Mullen Burst Strength: 190 lb/sq in.
5. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D4491.
6. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355 after 500 hours exposure.
7. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632.
8. Tear Strength: 55 lb-f, minimum, when tested in accordance with ASTM D4533.
9. Color: Manufacturer's standard.
10. Woven Wire Backing: 2"x4" 12 gauge (min.), welded wire, galvanized.

F. Silt Fence Posts:
1. Steel Y- or T-section, with minimum mass of 1.25 lb per linear foot.
2. Minimum Length: 4 feet.
3. Galvanized or painted surface.
4. Brindle Hardness: Greater than 140.

G. Riprap: See Section 31 3700.

H. Filter Bags: Polypropylene, polyethylene or polyamide woven fabric.
1. Unit Weight: 4 oz/sq yd.
2. Mullen Burst Strength: Greater than 300 psi.
3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D 4355 after 500 hours exposure.
4. Filter Bag Fill: Washed pea gravel to coarse ground (0.31" to 0.75" diameter).

I. Rock Berms
1. Rock: Clean, open graded, 3 to 5 inch diameter; high velocity areas should use 5 to 8 inch diameter.
2. Woven wire; 20 gauge, maximum 1" opening, galvanized, secured with shoat rings.

J. Stabilized Construction Entrance
1. Rock: 4" to 8", washed.
2. Fabric: Geotextile specific for soil filtration; 6 oz/sq yd; Mullen burst rating of 140 lb/sq in, greater than #50 sieve opening size.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 SCOPE OF PREVENTIVE MEASURES

A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.

B. Construction Entrances: Traffic-bearing aggregate surface.
1. Width: 20 feet, minimum, or full width of driveway, whichever is greater.
2. Length: 50 feet, minimum.
3. Provide at each construction entrance from public right-of-way.
4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.

C. Linear Sediment Barriers: Made of silt fences or rock riprap.
1. Provide linear sediment barriers as detailed on drawings with the following parameters:

a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
b. Along the top of the slope or top bank of drainage channels and swales that traverse disturbed areas.
c. Along the toe of cut slopes and fill slopes.
d. Perpendicular to flow across the bottom of existing and new drainage channels and swales that traverse disturbed areas or carry runoff from disturbed areas; space as indicated on drawings.
e. Across the entrances to culverts that receive runoff from disturbed areas.

D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
1. Bagged gravel inlet protection: As detailed on drawings.

E. Storm Drain Inlet: As detailed on drawings.

F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.

G. Soil Stockpiles: Protect using one of the following measures:
1. Cover with polyethylene film, secured by placing soil on outer edges.
2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 4 inches of straw or hay.

H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.
1. Wood Waste: Use only on slopes 3:1 or flatter; no anchoring required.

I. Temporary Seeding: Use where temporary vegetated cover is required.

3.04 INSTALLATION

A. Traffic-Bearing Aggregate Surface:
1. Excavate minimum of 3 inches.
2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.
3. Place and compact at least 8 inches of 4 to 8 inch diameter stone.
4. Reference details on the drawings.

B. Silt Fences:
1. Install with top of fabric at nominal height and embedment indicated on drawings.
2. Embed bottom of fabric in a trench on the upslope side of fence, with 6 inches of fabric laid flat on bottom of trench facing upslope; backfill trench and compact.
3. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
4. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
5. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches high with post spacing not more than 4 feet.
6. Reference details on the drawings.

C. Straw Bale Rows:
1. Install bales in continuous rows with ends butting tightly, with one bale at each end of row turned uphill.
2. Install bales so that bindings are not in contact with the ground.
3. Embed bales at least 4 inches in the ground.
4. Anchor bales with at least two stakes per bale, driven at least 18 inches into the ground; drive first stake in each bale toward the previously placed bale to force bales together.
5. Fill gaps between ends of bales with loose straw wedged tightly.
6. Place soil excavated for trench against bales on the upslope side of the row, compacted.

D. Mulching Over Large Areas:
   1. Dry Straw and Hay: Apply 2-1/2 tons per acre; anchor using dull disc harrow or emulsified asphalt applied using same spraying machine at 100 gallons of water per ton of mulch.
   2. Wood Waste: Apply 6 to 9 tons per acre.
   3. Erosion Control Matting: Comply with manufacturer's instructions.

E. Mulching Over Small and Medium Areas:
   1. Dry Straw and Hay: Apply 4 to 6 inches depth.
   2. Wood Waste: Apply 2 to 3 inches depth.
   3. Pine Needles: Apply 2 to 3 inches depth.
   4. Erosion Control Matting: Comply with manufacturer's instructions.

F. Temporary Seeding:
   1. When hydraulic seeder is used, seedbed preparation is not required.
   2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
   3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000 sq ft.
   4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000 sq ft.
   5. Incorporate fertilizer into soil before seeding.
   6. Apply seed uniformly; if using drill or cultipacker seeders place seed 1/2 to 1 inch deep.
   7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
   8. Repeat irrigation as required until grass is established.

G. Rock Berms
   1. Layout the woven wire mesh sheathing perpendicular to the direction of runoff.
   2. Rock berm will have a minimum top width of 2 feet with side slopes being 2:1 (h:v) or flatter.
   3. Place rock along the sheathing to a height not less than 18".
   4. Wrap the wire sheathing around the rock and secure with tie wire so that the ends of the sheathing overlap a minimum of 2 inches.
   5. Tie the ends of the berm into the existing upslope grade and bury the berm 3 to 4 inches into existing ground slope.

H. Stabilized Construction Entrance
   1. Remove vegetation and grade for positive drainage.
   2. Construct entrance a minimum 12 feet wide (or full width of road) by 50 feet long.
   3. If slope towards a paved street exceeds 2 percent, construct a ridge 6 to 8 inches high with 3:1 (h:v) side slopes across the foundation 15 feet from the entrance to divert runoff away from street.
   4. Place geotextile woven fabric in graded foundation.
   5. Place stone over geotextile woven fabric per the drawings.
   6. Grade to drain runoff to a sediment trap or basin.
   7. Install drain pipe, as needed, to maintain street drainage in right-of-way.

3.05 MAINTENANCE

A. Inspect preventive measures daily, within 24 hours after the end of any storm that produces 0.25 inches or more rainfall at the project site, and daily during prolonged rainfall.

B. Repair deficiencies immediately.

C. Silt Fences:
   1. Promptly replace fabric that deteriorates.
   2. Remove silt deposits that exceed one-third of the height of the fence.
   3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

D. Straw Bale Rows:
   1. Promptly replace bales that fall apart or otherwise deteriorate unless need has passed.
   2. Remove silt deposits that exceed one-half of the height of the bales.
   3. Repair bale rows that are undercut by runoff or otherwise damaged, whether by runoff or other causes.

E. Filter Bags:
   1. Promptly replace bags that have deteriorated or have been damaged.
   2. Remove silt deposits that exceed one-third the height of the bag.
   3. Repair or replace bags that are undercut by runoff or otherwise are damaged, whether by runoff or other causes.

F. Stabilized Construction Entrance
   1. Promptly replace rock that has deteriorated or been damaged.
   2. Remove excess dirt and sediment accumulations as needed.

G. Rock Berms
   1. Promptly repair or replace rock berms that have been undercut by runoff or otherwise damaged.
   2. Remove silt deposits that exceed one-third the height of the rock berm.
   3. Repair any loose wire sheathing.

H. Clean out temporary sediment control structures weekly and relocate soil on site.

I. Place sediment in appropriate locations on site; do not remove from site.

3.06 CLEAN UP

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Engineer.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

SECTION 01 5713.10
SPILL RESPONSE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Guideline for Contractors for handing petroleum hydrocarbon spills and leaks on the project site.

1.02 RELATED SECTIONS -- NOT USED

1.03 REFERENCES

A. Texas Commission on Environmental Quality Regulations, TAC Ch. 327.

B. Edwards Aquifer Authority, Ch. 713, Subchapter E.

1.04 SUBMITTALS

A. Summary report of procedures and operational sequence for review and approval by Pape-Dawson Engineers, Inc. (Engineer) as Owner's Representative.

B. Manifest and disposal records.

C. Testing and laboratory sampling results.

PART 2 PRODUCTS

2.01 MATERIALS

A. Contractor to pay for any and all testing, excavation, disposal, and consultants/contractors required for the execution of the work.

PART 3 EXECUTION

3.01 CONDITIONS

A. Texas Commission on Environmental Quality (TCEQ) and Edwards Aquifer Authority (EAA) regulations require reporting of fuel spills or leaks of 25 gallons or more to the land surface, or any quantity sufficient to create a sheen on surface water. For oils, the reporting requirements are a spill of 20-gallons to the land surface or a quantity sufficient to create a sheen on surface water.

B. Spills of quantities to the land in excess of 1-gallon, or spills that affect more than 10-square feet of ground surface, although not large enough to require reporting to TCEQ, must be reported by the Contractor to the Owner and Engineer and appropriate emergency response actions should be implemented.

C. Cleanup of any spills related to the project shall be completed to non-detect conditions, unless the constituent is naturally occurring in which case TCEQ State specific background concentrations may be used as cleanup goals, as determined by the Engineer.

3.02 SPILL RESPONSE ACTIONS

A. Appropriate response actions may vary, depending on the volume spilled or leaked and the location of the spill.
   1. In all cases, attempts to minimize the volume lost and the size of the area affected should be made.
   2. Spills/leaks on asphalt, concrete or other impervious surface, may be cleaned using absorbent materials, i.e., oil absorbent pads or socks, or granular material.
   3. Spills/leaks to soil or bedrock will likely require excavation.

B. Contractor to take immediate action to contain the spill. Implement emergency response measures to stop and contain leak/spill. Appropriate emergency response measures include, but

are not limited to, placement of absorbent materials on top of and downstream of leak/spill or construction of berm downstream of leak/spill to prevent further spread of material.

C. Contact Fire Department or other appropriate Emergency Management Agency as necessary to minimize loss of property or life.

D. Notify Engineer within 24 hours of the leak/spill.

E. Notify TCEQ and EAA if the project is within the Edwards Aquifer Recharge Zone or 5 miles upgrade within 24 hours if quantity of material leaked/spilled meets Section 3.01, A. above.

3.03 CLEANUP

A. Impacted material should be segregated from material not impacted by the leak/spill. Impacted materials may include loose material, absorbent material, or excavated material.

B. Excavated and segregated materials should be stored on plastic and covered with plastic, or stored within a drum, roll-off box, or other covered container, pending characterization and disposal at an approved disposal facility.

C. The volume of material segregated and disposed should be recorded, and copies of disposal manifests should be provided to the Engineer.

D. After excavation of impacted soil, the Engineer will evaluate the area excavated and determine if sampling of remaining subgrade will be necessary.

E. The determination will be made on a site-specific basis and will be a function of volume spilled/leaked, size of area affected, soil type, type of product spilled/leaked, location of spill/leak, etc.

F. If sampling and analysis indicate constituents of concern are detected in the soil or rock subgrade, then additional excavation will be necessary. The Contractor shall continue to excavate at the direction of the Engineer until further sample and analysis results indicate that constituents of concern are no longer detected.

G. After Engineers approval, the excavated area may be backfilled with new, clean materials.

H. The Contractor may hire their own environmental consultant/contractor to perform sampling, analysis, and cleanup oversight. In this case the Contractor's consultant must coordinate all their activities with the Engineer prior to each step, phase, or course of action.

I. The Engineer may collect additional confirmation samples if warranted, and will provide approval that corrective actions are complete before the excavation is backfilled.

J. Contractor must notify Engineer 48-hours in advance of sample collection and disposal. Contractor must provide Engineer or designated construction observer with opportunity to observe Contractor's implementation of approved cleanup method and to collect and split samples, is so desired by Engineer.

END OF SECTION

SECTION 01 5813
TEMPORARY PROJECT SIGNAGE

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Project identification sign.

B. Project informational signs.

1.02 RELATED REQUIREMENTS – Ref. SAWS General Conditions

1.03 REFERENCE STANDARDS -- NOT USED

1.04 QUALITY ASSURANCE

A. Design sign and structure to withstand 30 miles/hr wind velocity.

B. Sign Painter: Experienced as a professional sign painter.

C. Finishes, Painting: Adequate to withstand weathering, fading, and chipping for duration of construction.

1.05 SUBMITTALS

A. Shop Drawing: Show content, layout, lettering, and color to the Owner for approval prior to installation .

PART 2 PRODUCTS

2.01 SIGN MATERIALS

A. Structure and Framing: New or used, wood or metal, structurally adequate.

B. Sign Surfaces: Exterior grade plywood with medium density overlay, minimum 3/4 inch thick, standard large sizes to minimize joints.

C. Rough Hardware: Galvanized, aluminum, or brass.

D. Paint and Primers: Exterior quality, two coats; sign background of color as selected.

E. Lettering: Exterior quality paint, colors as selected.

2.02 PROJECT IDENTIFICATION SIGN

A. One painted sign of construction, design, and content shown on Drawings, location designated.

B. Content:

1. Project title and name of Owner as indicated on Contract Documents.
2. Names and titles of authorities.
3. Name of Prime Contractor.
4. Name of Engineer

C. Graphic Design, Colors, Style of Lettering: Designated by Owner.

2.03 PROJECT INFORMATIONAL SIGNS

A. Painted informational signs of same colors and lettering as Project Identification sign, or standard products; size lettering to provide legibility at 100 foot distance.

B. Provide at each field office, storage shed, and directional signs to direct traffic into and within site. Relocate as Work progress requires.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install project identification sign within 20 days after date fixed by Notice to Proceed.

B. Erect at designated location.

C. Erect supports and framing on secure foundation, rigidly braced and framed to resist wind loadings.

D. Install sign surface plumb and level, with butt joints. Anchor securely.

E. Paint exposed surfaces of sign, supports, and framing.

F. No other signs or advertising will be permitted on the site without specific authorization.

G. Maintain sign in good condition for the duration of the job.

3.02 MAINTENANCE

A. Maintain signs and supports clean, repair deterioration and damage.

3.03 REMOVAL

A. Remove signs, framing, supports, and foundations at completion of Project and restore the area.

END OF SECTION

SECTION 01 6400
MANUFACTURERS' FIELD SERVICES

PART 1 - GENERAL

1.01 SCOPE

This section shall govern the requirements established for manufacturer's field services associated with the installation of equipment.

1.02 RELATED WORK

Related work not found in this section can be found in the following sections:

A. Section 01 3050.10, Shop Drawings, Product Data

B. Section 01 7800, Closeout Submittals

1.03 DESCRIPTION OF WORK

CONTRACTOR shall arrange for and coordinate the manufacturer's services as specified below.

1.04 SUBMITTALS

A. Submit qualifications of manufacturer's representative to provide service.

B. Manufacturer's Certificate of Proper Installation:

1. When specified in the individual Specifications, submit certificate certifying:

(a) The product or system has been installed in accordance with the manufacturer's recommendations, inspected by a manufacturer's authorized representative, and serviced with the proper lubricants.

(b) Necessary safety equipment has been properly installed.

(c) Electrical and mechanical connections have been made meeting quality and safety standards and as required.

(d) Free from undue stress imposed by exterior connections or loads.

(e) Proper adjustments have been made and the product or system is ready for testing, facilities startup, and operation.

C. Certificate of Successful Testing and Startup: Prepare and submit for all mechanical systems upon completion of successful testing and startup of respective equipment system, subsystem or component.

1.05 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

Authorized representative of the manufacturer, factory trained, and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system.

1.06 MANUFACTURER'S FIELD SERVICES

1. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, additional time required to perform the specified services shall be considered incidental work.

2. Schedule manufacturer's field services to avoid conflicting with other field testing or other manufacturer's field services. Determine that all conditions necessary to allow successful testing have been met before scheduling field services.

3. Only those days of service approved by OWNER will be credited to fulfill the specified minimum services.

4. If specified, manufacturer's services shall include as a minimum:
    a. Assistance during installation to include observation, guidance, instruction of CONTRACTOR's assembly, erection, installation or application procedures.
    b. Inspection, checking, and adjustment as required for equipment to function as warranted by manufacturer and necessary to provide written approval of installation.
    c. Revisiting the site as required to correct problems and until installation and operation are acceptable to OWNER.
    d. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

GREEN MOUNTAIN PUMP STATION

EQPT SERIAL NO.:_____

EQPT TAG NO.:_____ EQPT/SYSTEM:_____

PROJECT NO:_____ SPEC. SECTION:_____

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 and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer.

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 his equipment and (iii) authorized to make recommendations required to assure that the equipment 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:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

SECTION 01 7123.10
FIELD ENGINEERING

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Contractor shall, at his expense, perform the following:
   1. Engage a licensed Surveyor, approved by the Owner, and acceptable to the Engineer, to locate all surveyor marks, including bench marks in order that the exact lines of the property, building and grades may be determined.
   2. Lay out entire Project prior to start of construction.
   3. Locate and protect control points prior to starting site work, and preserve all permanent reference points during construction. Replace project control points which may be lost or destroyed.
   4. Establish and maintain a minimum of three permanent bench marks on the site, referenced to data established by survey control points. Record locations, with horizontal and vertical data, on Project Record Documents.
   5. Establish all construction lines and levels by instrumentation and similar appropriate means.

B. Any discrepancies arising in locating the work in respect to property and building line shall be reported immediately to the Owner and the Engineer.

END OF SECTION

SECTION 01 7800
CLOSEOUT SUBMITTALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Project Record Documents.

B. Operation and Maintenance Data.

C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

A. Individual Product Sections: Specific requirements for operation and maintenance data.

B. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to Engineer with claim for final Application for Payment.

B. Operation and Maintenance Data:
   1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Engineer and Owner will review draft and return one copy with comments.
   2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
   3. Submit one copy of completed documents 10 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Engineer and Owner comments. Revise content of all document sets as required prior to final submission.
   4. Submit two sets of revised final documents in final form within 10 days after final inspection.

C. Warranties and Bonds:
   1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
   2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
   3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed shop drawings, product data, and samples.
   6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish first floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.

B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.

C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

A. For Each Product, Applied Material, and Finish:
   1. Product data, with catalog number, size, composition, and color and texture designations.
   2. Information for re-ordering custom manufactured products.

B. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.

C. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional information as specified in individual product specification sections.

E. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

F. Provide a listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

A. For Each Item of Equipment and Each System:
   1. Description of unit or system, and component parts.

2. Identify function, normal operating characteristics, and limiting conditions.
3. Include performance curves, with engineering data and tests.
4. Complete nomenclature and model number of replaceable parts.

B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications.

D. Include color coded wiring diagrams as installed.

E. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

F. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

G. Provide servicing and lubrication schedule, and list of lubricants required.

H. Include manufacturer's printed operation and maintenance instructions.

I. Include sequence of operation by controls manufacturer.

J. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

K. Provide control diagrams by controls manufacturer as installed.

L. Provide Contractor's coordination drawings, with color coded piping diagrams as installed.

M. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

N. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

O. Include test and balancing reports.

P. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data into durable manuals for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.

B. Where systems involve more than one specification section, provide separate tabbed divider for each system.

C. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

D. Prepare data in the form of an instructional manual.

E. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.

F. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

G. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Engineer, Consultants, Contractor and subcontractors, with names of responsible parties.

H. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.

I. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.

J. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.

K. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

L. Arrange content by systems or process flow under section numbers and sequence of Table of Contents of this Project Manual.

M. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, in three parts as follows:
   1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.
   2. Part 2: Operation and maintenance instructions, arranged by system or process flow and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:
      a. Significant design criteria.
      b. List of equipment.
      c. Parts list for each component.
      d. Operating instructions.
      e. Maintenance instructions for equipment and systems.
      f. Maintenance instructions for special finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
   3. Part 3: Project documents and certificates, including the following:
      a. Shop drawings and product data.
      b. Air and water balance reports.
      c. Certificates.
      d. Photocopies of warranties and bonds.

N. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

O. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Engineer, Consultants, and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.

P. Provide Owner two copies, and Engineer 1 copy of all manuals in electronic format (pdf, etc.) on compact disk (CD) after receiving Owner’s and Engineer’s written approval of all manuals for the project.

3.06 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

E. Include photocopies of each in operation and maintenance manuals, indexed separately on Table of Contents.

F. Manual: Bind in commercial quality 8-1/2 by 11 inch three D side ring binders with durable plastic covers.

G. Cover: Identify each binder with typed or printed title WARRANTIES AND BONDS, with title of Project; name, address and telephone number of Contractor and equipment supplier; and name of responsible company principal.

H. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the specification section in which specified, and the name of product or work item.

I. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.

END OF SECTION

SECTION 01 7810
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. CONTRACTOR shall maintain and provide the Owner with project record documents as specified below.

B. Maintenance of Documents

1. Maintain in CONTRACTOR'S field office in clean, dry, legible condition complete sets of the following: Contract Drawings, Specifications, Addenda, approved Shop Drawings, Samples, Photographs, Change Orders, other Modifications of Contract, Test Records, Survey Data, Field Orders, and all other documents pertinent to CONTRACTOR'S Work.
2. Provide files and racks for proper storage and easy access. File in accordance with filing format of Construction Specification Institute (CSI) unless otherwise approved by Owner.
3. Make documents available at all times for inspection by Owner.
4. Record documents shall not be used for any other purpose and shall not be removed from the office without Owner approval.

C. Recording

1. Label each document "PROJECT RECORD" in 2-inch high printed letters.
2. Keep record documents current and updated at least weekly.
3. Do not permanently conceal any Work until required information has been recorded.
4. Contract Drawings - Legibly mark to record actual construction including:
   a. Depths of various elements of manhole foundation in relation to datum.
   b. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
   c. Field changes of dimensions and details.
   d. Changes made by Change Order or Field Order.
   e. Details not on original Contract Drawings.
   f. Coordinates of all valves, key fittings, reducers, special joints, valve boxes, underground utilities, conduit splices, etc., with specific dimensions to two fixed reference points.
   g. Confirmed alignments of all underground electrical and other utility facilities, piping, conduits, cables, etc.
5. Specifications and Addenda - Legibly mark up each Section to record:
   a. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
   b. Changes made by Change Order or Field Order.
   c. Other matters not originally specified.
6. Shop Drawings - Maintain as record documents and legibly annotate drawings to record changes made after review.

7. Interim Record Drawings shall be submitted monthly to the Owner with all monthly draw requests. All Interim Record Drawings shall be complete and include relative information to be included on the project's Final Record Drawings. Information to be included in the Interim Record Drawings shall include, but not be limited to the following:
   a. All installed underground utilities (water, sewer, gas, electric, fiber optic, etc.), including fittings, valves, appurtenances, vaults, conduits, splices, junction boxes, manholes, cables, valve markers, etc.
   b. Depths and elevations of all installed utilities and storm drainage piping and manholes.
   c. Limits of completed pavement.
   d. Connections to existing utilities
   e. Buildings, foundations, plumbing, piping, cleanouts, etc.
   f. Tanks, control valves.
   g. Pumps, manifold piping, fencing, gates
   h. Stormwater treatment facilities, ponds
   i. Landscape and irrigation systems
   j. Coordinates (Texas State Plane) for items listed in a-i above.
8. Interim Record Drawings may be submitted in hard copy/paper format (2 sets) or 1 electronic format (PDF) on memory stick or compact disk.
9. Record Documents are subject to review by the Owner on a monthly basis and failure to keep documents accurate and current can be basis for the Owner to withhold the CONTRACTOR's monthly payment in partial or full.

D. Final Record Drawings

1. Record drawings shall reflect completion of the installation of all equipment, piping, and other work by the CONTRACTOR. The drawings shall show all of the Work in plan and sections as required for clarity with reference dimensions and elevations for complete record drawings. The drawings shall be furnished not later than 20 days after substantial completion of the Work and prior to final payment.
2. The Contract Drawings may be used as a starting point in developing these drawings. Subcontractor and manufacturer drawings may be included in this drawing package. The drawing package must be fully integrated and include the necessary cross references between drawings. The drawing package shall include interconnection and termination details to equipment furnished under this Contract.
3. Field Record Drawings shall include all information required for Interim Record Drawings identified in Paragraph 1.01 C.7.

E. Final Submittal

1. At project completion, deliver record documents to the Owner. Place all letter-sized material in a three (3) ring binder which is neatly indexed by process and division number. Bind Contract Drawings and shop drawings in rolls of convenient size for ease of handling. Final Record Drawing Submittal shall include two (2) electronic copies (PDF format) provided on memory stick or compact disk media.

2. Accompany the submittal with a transmittal letter in duplicate containing the following:
   a. Date.
   b. Project title and number.
   c. CONTRACTOR's name and address.
   d. Title and number of each record document.
   e. Certification that each document as submitted is complete and accurate.
   f. Signature of CONTRACTOR.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION

SECTION 02 3000
SUBSURFACE INVESTIGATION

PART 1 - GENERAL

1.01 SUMMARY

A. A Geotechnical Report included with these technical specifications was obtained for use in preparing the design and is available for review in the office of the Engineer and is included with these contract specifications.

B. The Geotechnical Report is not a conclusive indication of the soil conditions other than where the borings were taken.

C. The accuracy of the Geotechnical Report is not guaranteed in any respect by the Owner, and the Owner accepts no responsibility for interpretation of conclusions drawn therefrom.

D. The information contained in the Geotechnical Report is made available in order that the Contractor may have ready access to the same information available to the Owner as of this date.

E. Contractor is invited and encouraged to make his own interpretation and evaluation of the information and by starting work shall be assumed to have fully accepted responsibility for the subsurface conditions that may hereafter be encountered in performing the excavation work.

F. Contractor is to examine the project site and the record of investigation and make, to whatever extent they deem appropriate, his own investigation of existing subsurface conditions to determine the nature, kind and character of materials to be encountered.

G. Extra payment will not be authorized for work which should have been anticipated or could have been anticipated upon careful examination of the site, or upon soil investigation, or upon consideration of factors generally recognized as being inherent in excavation work of the nature indicated by the Contract Documents.

H. The Contractor shall advise Engineer of discovery of any unknown or undetermined items.

I. The Contractor shall make their own investigation into the location and size of existing site utilities whether represented on the drawings or not.

END OF SECTION

SECTION 02 4100.10
SITE DEMOLITION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Selective demolition of existing site elements.

B. Abandonment and removal of existing utilities and utility structures.

1.02 RELATED REQUIREMENTS

A. Section 01 5713 - Temporary Erosion and Sediment Control.

B. Section 31 1000 - Site Clearing.

C. Section 31 1000.10 - Tree Protection.

D. Section 31 2200 - Grading.

E. Section 31 2316 - Excavation.

F. Section 31 2323 - Fill.

1.03 REFERENCE STANDARDS

A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.

B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2004.

1.04 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.05 QUALITY ASSURANCE

A. Demolition Firm Qualifications: Company specializing in the type of work required.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SCOPE

A. Install temporary erosion and sedimentation control measures.

B. Remove paving, curbs, and sidewalks as required to accomplish new work.

C. Break up paving as indicated on drawings to permit positive drainage. Remove all broken pavement and dispose of properly.

D. Within area of new construction, completely remove foundation walls and footings to a minimum of 4 feet below finished grade.

E. Remove concrete slabs on grade as indicated on drawings.

F. Remove underground tanks as indicated on drawings.

G. Remove manholes and manhole covers, curb inlets and catch basins as indicated on drawings.

H. Remove fences, gates, signs, poles, lighting and irrigation as indicated on drawings.

I. Coordinate with the Owner prior to removing landscaping and trees. Landscaping and trees that remain shall be fenced and protected from removal. Trees to remain will be protected in accordance with local standards for tree protection.

J. All obstructions which may not be indicated in the Contract Documents to be removed, but that do interfere with the completion of the work as indicated by this Contract, are also made a part of this Section and their removal shall be included in this Contract.

K. Any item not specifically designated for removal shall not be removed without Engineer's direction.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.
   1. Obtain and pay for required permits.
   2. Comply with applicable requirements of NFPA 241.
   3. Use of explosives is not permitted.
   4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
   5. Provide, erect, and maintain temporary barriers and security devices.
   6. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
   7. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
   8. Do not close or obstruct roadways or sidewalks without permit.
   9. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
   10. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.

B. Do not begin removal until receipt of notification to proceed from Owner.

C. Do not begin removal until existing elements to be salvaged or relocated have been removed.

D. Do not begin removal until vegetation to be relocated has been removed and specified measures have been taken to protect vegetation to remain.

E. Do not begin removal until all site utility services have been terminated, disconnected and capped.

F. Protect existing structures and other elements that are not to be removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Stop work immediately if adjacent structures appear to be in danger.

G. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

H. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.

I. If hazardous materials or narcotics are discovered during removal operations, stop work and notify Engineer and Owner; hazardous materials include regulated asbestos containing materials, lead, lead-based paint, PCB's, and mercury.

J. Perform demolition in a manner that maximizes salvage and recycling of materials.
   1. Comply with requirements of Section 01 7419 - Waste Management.
   2. Dismantle existing construction and separate materials.
   3. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

K. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.03 EXISTING UTILITIES

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits prior to terminating service.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Do not close, shut off, or disrupt existing life safety systems that are in use without prior written approval from Owner.

E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without prior approval from Owner.

F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

G. Unless otherwise indicated on the drawings remove unused underground piping within project limits.

3.04 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Remove from site all materials not to be reused on site.

C. Leave site in clean condition, ready for subsequent work.

D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 02 5100
GEOLOGIC FEATURE REMEDIATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work required to clean-out, fill, and seal geologic features (solution features) discovered during construction of utilities, drainage improvements, streets, parking, building foundations, other site work activities, and water pollution abatement basins.

B. Furnish all supplementary items necessary for their remediation in accordance with approved Texas Commission on Environmental Quality (TCEQ) requirements.

C. This specification shall apply to feature remediation not requiring use of reinforcing steel.

1.02 RELATED REQUIREMENTS

A. Section 03 3000.10 – Controlled Low Strength Backfill

B. Section 31 2316 – Excavation

C. Section 804 (SAWS) – Excavation, Trenching and Backfill

D. Section 550 (SAWS) – Trench Excavation Safety Protection

E. Section 816 (SAWS) – Steel Pipe Installation

F. Section 812 (SAWS) – Water Main Installation

G. Section 401 – (CoSA) – Reinforced Concrete Pipe

H. Section 403 (CoSA) – Storm Sewer Junction Boxes and Inlets

1.03 REFERENCES – NOT USED

1.04 CONDITIONS

A. If any caverns or sensitive features are discovered during utility or storm drain trenching activities, street or site grading, foundation and/or pier construction, or other site work activities, all regulated activities near the sensitive feature must be suspended immediately.

1. The Contractor must notify the Owner and Engineer immediately of the discovery.
2. The Engineer will notify the appropriate regional office of the Texas Commission on Environmental Quality in writing within two working days of the feature discovery.
3. The regulated activities near the feature may not proceed until the TCEQ Executive Director has reviewed and approved the methods proposed for disposition of the feature and protection of the Edwards Aquifer from any potentially adverse impacts to water quality while maintaining the structural integrity of the line where a utility or storm drain line is involved.

1.05 NOTIFICATION

A. Contractor must notify Engineer 48-hours in advance of beginning of sealing any geologic feature.

B. Contractor must provide Engineer or designated construction observer with opportunity to observe Contractor's implementation of approved treatment method.

C. Geologic features which are found during construction and approved for sealing by TCEQ must be shown and recorded on as-built drawings.

1.06 ACCESS

A. Contractor must maintain access to the feature until such time as Engineer, Geologist, and TCEQ Representative have had an opportunity to observe the feature(s).

B. Contractor will be notified by Engineer and/or Geologist when they will observe the feature.

C. Contractor must provide safe access to Engineer, Geologist and/or TCEQ personnel to the feature.

D. Trench excavation protection must be provided at all times in accordance with Section 31 2316.14 Trench Excavation Protection.

E. Upon discovery of a feature, Contractor shall immediately take measures to limit access to the feature to essential Contractor Personnel, Owner, Engineer, Geologist, TCEQ and SAWS Personnel.

F. Contractor will not allow any other access to the feature without the authorization of the Owner or Engineer.

G. The construction time period allowed for this project includes 10 days for delays associated with features remediated under this specification. Where no features requiring remediation under this specification are discovered, the time allowance for feature remediation will be deducted from the construction time period.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete shall conform to Class B and shall be mixed and placed in accordance with Item 420, "Concrete for Structures", TxDOT Standard Specifications.

B. Flowable fill shall conform to Section 03 3000.10 - Controlled Low Strength Backfill (CLSB).

2.02 MEASUREMENT

A. Concrete by the cubic yard.
   1. Contractor shall provide copies of concrete truck trip tickets to substantiate quantities of concrete used for feature remediation.
   2. Contractor shall clearly note on trip tickets the specific features remediated with a specific load.
   3. This item will be used only for payment of features where TCEQ approved remediation specifies concrete.

B. Controlled Low Strength Backfill (CLSB) by the cubic yard.
   1. Contractor shall provide copies of delivery truck trip tickets to substantiate quantities of flowable fill used for feature remediation.
   2. Contractor shall clearly note on trip tickets the specific features remediated with a specific load.
   3. This item will be used only for payment of features where TCEQ approved remediation specifies concrete.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Contractor shall construct feature remediation in accordance with plan approved by TCEQ.

B. Each feature remediation plan will apply to a specific feature or group of features and will be prepared by the Engineer.

C. In all cases construction shall be conducted in such a manner as to provide the best protection of the Edwards Aquifer.

D. Contractor shall not make changes to remediation measures without first getting Engineer's approval.

3.02 CLEANING

A. Upon the completion of the work of this Section, Contractor shall dispose of, away from the site, all debris, trash containers, residue, remnants and scraps which result from the work of this Section.

END OF SECTION

SECTION 03 0100
MAINTENANCE OF CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Cleaning of existing concrete surfaces.

B. Repair of exposed structural, shrinkage, and settlement cracks.

C. Resurfacing of concrete surfaces having spalled areas and other damage.

D. Repair of deteriorated concrete.

E. Repair of internal concrete reinforcement.

F. Scope of Work: As indicated on the drawings.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete: Finishing of concrete surface to tolerance; floating, troweling, and similar operations; curing.

1.03 PRICE AND PAYMENT PROCEDURES

A. Repair Surface: By the square foot. Includes surface preparation, repair, finishing.

B. Preparation for Resurfacing: By the square yard. Includes surface preparation, cleaning.

1.04 REFERENCE STANDARDS

A. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.

B. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement; 2009.

C. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2007b (Reapproved 2014).

D. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement; 2014.

E. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2015.

F. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2016.

G. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2015a.

H. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2013.

I. ASTM C150/C150M - Standard Specification for Portland Cement; 2016.

J. ASTM C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars; 2014.

K. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2011.

L. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2014.

M. ASTM C928/C928M - Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Material for Concrete Repairs; 2013.

N. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2013.

O. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel; 2011.

1.05 ADMINISTRATIVE REQUIREMENTS

1.06 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.07 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 CLEANING MATERIALS

A. Degreaser:
   1. Manufacturers:
      a. L&M Construction Chemicals, Inc., a subsidiary of Laticrete International, Inc.; CITREX: www.lmcc.com.
      b. SpecChem, LLC; Citrus Cleaner: www.specchemllc.com.
      c. W.R. Meadows, Inc.; Ultrite Degreaser: www.wrmeadows.com.
      d. Substitutions: See Section 01 6000 - Product Requirements.

B. Detergent: Non-ionic detergent.

2.02 CEMENTITIOUS PATCHING AND REPAIR MATERIALS

A. Manufacturers:

B. Cementitious Repair Mortar, Trowel Grade: One- or two-component, factory-mixed, polymer-modified cementitious mortar.

2.03 EPOXY PATCHING AND REPAIR MATERIALS

A. Manufacturers:
   1. Adhesives Technology Corporation: www.atcepoxy.com.

2.04 POLYURETHANE PATCHING AND REPAIR MATERIALS

A. Manufacturers:
   1. Adhesives Technology Corporation: www.atcepoxy.com.
   2. Substitutions: See Section 01 6000 - Product Requirements.

2.05 ACCESSORIES

A. Anchoring Adhesive: Self-leveling or non-sag as applicable.
   1. Self-Leveling Polyester-Based Products:
      a. W.R. Meadows, Inc.; Poly-Grip: www.wrmeadows.com. or approved
      b. Substitutions: See Section 01 6000 - Product Requirements.
   2. Self-Leveling Epoxy Products:
      a. SpecChem, LLC; SpecPoxy 2000; www.specchemllc.com.
      b. W.R. Meadows, Inc.; Rezi-Weld 1000, Rezi-Weld (IP), or Rezi-Weld 3/2: www.wrmeadows.com.
   3. Non-Sag Epoxy Products:
      a. Dayton Superior Corporation; Sure Anchor J50, Sure Anchor I J51, All Weather J51 AW, Pro-Poxy 300, Pro-Poxy 300 FAST, Pro-Poxy 400, or Pro-Poxy 500 : www.daytonsuperior.com.
      b. SpecChem, LLC; SpecPoxy 3000 or SpecPoxy 3000 FS: www.specchemllc.com.
      c. W.R. Meadows, Inc.; Rezi-Weld Gel Paste or Rezi-Weld Gel Paste State: www.wrmeadows.com.

B. Portland Cement: ASTM C150/C150M, Type I, grey.

C. Sand: ASTM C33/C33M or ASTM C404; uniformly graded, clean.

D. Water: Clean and potable.

E. Reinforcing Steel: ASTM A615/A615M Grade 40 (40,000 psi) billet-steel deformed bars, unfinished.

F. Reinforcing Steel: Deformed bars, ASTM A996/A996M Grade 40 (280), Type A.
   1. Galvanized in accordance with ASTM A767/A767M, Class I.
   2. Epoxy coated in accordance with ASTM A775/A775M.

G. Stirrup Steel: ASTM A1064/A1064M.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Beginning of installation means acceptance of substrate.

3.02 CLEANING EXISTING CONCRETE

A. Provide enclosures, barricades, and other temporary construction as required to protect adjacent work from damage.

B. Clean concrete surfaces of dirt or other contamination using the gentlest method that is effective.
   1. Try the gentlest method first, then, if not clean enough, use a less gentle method taking care to watch for impending damage.
   2. Clean out cracks and voids using same methods.

C. The following are acceptable cleaning methods, in order from gentlest to less gentle:
   1. Water washing using low-pressure, maximum of 100 psi, and, if necessary, brushes with natural or synthetic bristles.
   2. Increasing the water washing pressure to maximum of 400 psi.
   3. Adding detergent to washing water; with final water rinse to remove residual detergent.
   4. Steam-generated low-pressure hot-water washing.

3.03 CONCRETE STRUCTURAL MEMBER REPAIR

3.04 CONCRETE SURFACE REPAIR USING CEMENTITIOUS MATERIALS

A. Clean concrete surfaces, cracks, and joints of dirt, laitance, corrosion, and other contamination using method(s) specified above and allow to dry.

B. Apply coating of bonding agent to entire concrete surface to be repaired.

C. Fill voids with cementitious mortar flush with surface.

D. Apply repair mortar by steel trowel to a minimum thickness of 1/4 inch over entire surface, terminating at a vertical change in plane on all sides.

E. Trowel finish to match adjacent concrete surfaces.

END OF SECTION

SECTION 03 1000
CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Formwork for cast-in place concrete, with shoring, bracing and anchorage.

B. Form stripping.

1.02 RELATED REQUIREMENTS

A. Section 03 2000 – Concrete Reinforcing.

B. Section 03 3000 – Cast-in-Place Concrete.

1.03 PRICE AND PAYMENT PROCEDURES

A. See Section 01 0250 – Measurement and Payment

B. Measurement and payment of forming work will be by the unit price method.

C. Formwork (Vertical Structures): Measure by the square foot. Includes form materials, placement, placing accessories, stripping.

D. Formwork (Horizontal Structures): Measure by the square foot. Includes form materials, placement, placing accessories, stripping.

1.04 REFERENCE STANDARDS

A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.

B. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).

C. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.

D. ACI 347R - Guide to Formwork for Concrete; 2014.

E. ASME A17.1 - Safety Code for Elevators and Escalators; 2013.

F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.

G. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.

H. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2015a.

I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

J. PS 1 - Structural Plywood; 2009.

1.05 SUBMITTALS

A. See Section 01 3000 – Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on void form materials and installation requirements.

C. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.

D. Permanent Insulated Foam Panel Formwork Shop Drawings: Include calculations or selections from manufacturer's prescriptive design tables that indicate compliance with applicable building code and manufacturer's requirements.

1. Include test reports for performance criteria specified.

2. Include the design engineer's stamp or seal on each sheet of shop drawings.

E. Delegated Design Data: As required by authorities having jurisdiction.

1.06 QUALITY ASSURANCE

A. Perform work of this section in accordance with Highways standards of the State of Texas.

B. Designer Qualifications: Design formwork under direct supervision of a Professional Structural Engineer experienced in design of concrete formwork and licensed in the State in which the Project is located.

C. Maintain one copy of each installation standard on site throughout the duration of concrete work.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver prefabricated forms and installation instructions in manufacturer's packaging.

B. Store prefabricated forms off ground in ventilated and protected manner to prevent deterioration from moisture.

C. Protect plastic foam products from damage and exposure to sunlight.

PART 2 PRODUCTS

2.01 FORMWORK - GENERAL

A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.

B. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.

C. Chamfer outside corners of beams, joists, columns, and walls.

D. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.

E. Comply with relevant portions of ACI 347R, ACI 301, and ACI 318.

F. Comply with Highways standards of the State of Texas.

2.02 WOOD FORM MATERIALS

A. Lumber: Treated Pine species; two grade; with grade stamp clearly visible.

2.03 REMOVABLE PREFABRICATED FORMS

A. Pan Type: Glass fiber, of size and profile indicated.

B. Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set; 2 inches thick.

2.04 PERMANENT PREFABRICATED FOAM PANEL FORMWORK

A. Floor/Roof Deck Forms: Pre-engineered expanded polystyrene foam plastic deck and beam/joist forms with factory installed metal channel furring strips flush with face of panel and field installed form stiffener slots.

1. Structural Performance: In accordance with applicable code.
2. Form Cross Section: As indicated on the drawings; flat-bottomed solid foam blocks with voids only for stiffeners and beam/joist cross-section; interlocking long edges.

PART 3 EXECUTION

3.01 ERECTION - FORMWORK

A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.

3.02 FORM REMOVAL

A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.

END OF SECTION

SECTION 03 2000
CONCRETE REINFORCING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Reinforcing steel for cast-in-place concrete.

B. Supports and accessories for steel reinforcement.

1.02 RELATED REQUIREMENTS

A. Section 03 1000 – Concrete Forming and Accessories.

B. Section 03 3000 – Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

A. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).

B. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; 2011.

C. ACI SP-66 - ACI Detailing Manual; 2004.

D. ASTM A184/A184M - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement; 2006 (Reapproved 2011).

E. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement; 2015.

F. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2009a (Reapproved 2014).

G. ASTM A704/A704M - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement; 2006 (Reapproved 2011).

H. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement; 2014.

I. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement; 2009.

J. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars; 2007b (Reapproved 2014).

K. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement; 2014.

L. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement; 2014.

M. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2015.

N. ASTM D3963/D3963M - Standard Specification for Fabrication and Jobsite Handling of Epoxy-Coated Reinforcing Steel Bars; 2001 (Reapproved 2007).

O. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel; 2011.

P. CRSI (DA4) - Manual of Standard Practice; 2009.

Q. CRSI (P1) - Placing Reinforcing Bars; 2011.

1.04 SUBMITTALS

A. See Section 01 3050.10 – Shop Drawings, Product Data

B. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
   1. Prepare shop drawings under seal of a Professional Structural Engineer experienced in design of work of this type and licensed in the State in which the Project is located.

C. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Perform work of this section in accordance with ACI 301.
   1. Maintain one copy of each document on project site.

B. Provide Engineer with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.

PART 2 PRODUCTS

2.01 REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi).

B. Reinforcing Steel: ASTM A706/A706M, deformed low-alloy steel bars.

C. Reinforcing Steel: Deformed bars, ASTM A996/A996M Grade 40 (280), Type A.

D. Reinforcing Steel Mat: ASTM A704/A704M, using ASTM A615/A615M, Grade 40 (40,000 psi) steel bars or rods, unfinished.

E. Steel Welded Wire Reinforcement (WWR): Galvanized, deformed type; ASTM A1064/A1064M.
   1. Form: Flat Sheets.

F. Reinforcement Accessories:

2.02 Re-bar Splicing:

A. Coupler Systems: Mechanical devices for splicing reinforcing bars; capable of developing full steel reinforcing design strength in tension and compression.
   1. Products:
      a. Substitutions: See Section 01 6000 - Product Requirements.

B. Dowel Bar Splicer with Dowel-Ins: Mechanical devices for connecting dowels; capable of developing full steel reinforcing design strength in tension and compression.
   1. Products:

C. Taper Tie Hole Plug: Mechanical device for plugging tie holes; anchors optional flush or recessed grout.
   1. Products:

D. Grout: Cementitious, non-metallic, non-shrink grout for use with manufacturer's grout sleeve reinforcing bar coupler system.
   1. Products:

2.03 FABRICATION

A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.

B. Welding of reinforcement is not permitted.

PART 3 EXECUTION

3.01 PLACEMENT

A. Place, support and secure reinforcement against displacement. Do not deviate from required position.

B. Do not displace or damage vapor barrier.

C. Accommodate placement of formed openings.

D. Maintain concrete cover around reinforcing per ACI:

E. Conform to applicable code for concrete cover over reinforcement.

F. Bond and ground all reinforcement to requirements of Section 26 0526.

3.02 FIELD QUALITY CONTROL

A. An independent testing agency, as specified in Section 01 4000, will inspect installed reinforcement for conformance to contract documents before concrete placement.

3.03 SCHEDULES

A. Reinforcement For Superstructure Framing Members: Deformed bars, unfinished.

B. Reinforcement For Foundation Wall Framing Members and Slab-on-Grade: Deformed bars and welded wire reinforcement, galvanized finish.

END OF SECTION

SECTION 03 3000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.03 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.04 PREINSTALLATION MEETINGS

A. Pre-Installation Conference: Conduct conference at project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete Subcontractor.
   e. Special concrete finish Subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture submit alternate design mixtures when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
   1. Indicate amounts of mixing water to be withheld for later addition at project site.

C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement including bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
   1. Location of construction joints is subject to approval of the Engineer.

E. Samples: For water stops and vapor retarder.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer and manufacture

B. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials.
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Fiber reinforcement.
   6. Water stops.
   7. Curing compounds.
   8. Floor and slab treatments.
   9. Bonding agents.
   10. Adhesives.
   11. Vapor retarders.
   12. Semi-rigid joint filler.
   13. Joint-filler strips.
   14. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:
   1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.
   1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of pre-installation conference.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94 requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
   2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Retain "Welding Qualifications" Paragraph below if shop or field welding is required. If retaining, also retain "Welding certificates" Paragraph in "Informational Submittals" Article. AWS states that welding qualifications remain in effect indefinitely unless welding personnel have not welded for more than six months or there is a specific reason to question their ability.

E. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
   1. Build panel approximately 200 sq. ft. for slab-on-grade and 100 sq. ft. for formed surface in the location indicated or, if not indicated, as directed by Architect.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 PRE-CONSTRUCTION TESTING

A. Pre-Construction Testing Service: Engage a qualified testing agency to perform pre-construction testing on concrete mixtures.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

B. Water Stops: Store water stops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

1.010 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 degree Fahrenheit for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and as follows:
   1. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
   2. Maintain concrete temperature below 90 degree Fahrenheit at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

PART 2 - PRODUCTS

2.01 CONCRETE, GENERAL

A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
   1. ACI 301.
   2. ACI 117.

2.02 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
   1. Plywood, metal, or other approved panel materials.

2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
   a. High-density overlay, Class 1 or better.
   b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
   c. Structural 1, B-B or better; mill oiled and edge sealed.
   d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.

E. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

F. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

G. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.03 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706, deformed.

C. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064, flat sheet.

2.04 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A615, Grade 60 plain-steel bars, cut true to length with ends square and free of burrs.

B. Epoxy-Coated Joint Dowel Bars: ASTM A615, Grade 60, plain-steel bars, ASTM A775 epoxy coated.

C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775.

D. Zinc Repair Material: ASTM A780.

E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.05 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

B. Cementitious Materials:
   1. Portland Cement: ASTM C150, Type I.
   2. Fly Ash: ASTM C618, Class F.
   3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
   4. Silica Fume: ASTM C1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C33, Class 3M coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
   1. Maximum Coarse-Aggregate Size: 1 inch nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C260

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
   1. Water-Reducing Admixture: ASTM C494, Type A.
   2. Retarding Admixture: ASTM C494, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C494, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C1017, Type II.

F. Water: ASTM C94 and potable.

2.06 WATER STOPS

A. Flexible Rubber Water Stops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

B. Chemically Resistant Flexible Water Stops: Thermoplastic elastomer rubber water stops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

C. Flexible PVC Water Stops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. BoMetals, Inc.
      b. Paul Murphy Plastics Company.
      c. Sika Corporation.

D. Self-Expanding Butyl Strip Water Stops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Henry Company, Sealants Division.
   b. JP Specialties, Inc.
   c. Sika Corporation.

E. Self-Expanding Rubber Strip Water Stops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Adeka Ultra Seal/OCM, Inc.
   b. Sika Corporation.
   c. Vinylex Corp

2.07 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Grace Construction Products; W.R. Grace & Co. -- Conn.
   b. Meadows, W.R.,Inc.
   c. Stego Industries, LLC.

B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D4397, not less than 10 mils thick.

2.08 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Dayton Superior.
   b. Euclid Chemical Company (The); an RPM company.
   c. Meadows, W.R.,Inc.
   d. Symons by Dayton Superior.

2.09 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Dayton Superior.
   b. Euclid Chemical Company (The); an RPM company.
   c. Meadows, W.R.,Inc.
   d. Sika Corporation.

B. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a) BASF Construction Chemicals - Building Systems.
   b) Dayton Superior.
   c) Euclid Chemical Company (The); an RPM company.
   d) Meadows, W.R.,Inc.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BASF Construction Chemicals - Building Systems.
   b. Dayton Superior.
   c. Euclid Chemical Company (The); an RPM company.

G. Clear Penetrating Water Repellent Silane/Siloxane Sealer

1. Per National Cooperative Highway Research Program Report No. 244:
   a. Reduction in Water Absorption: 80%
   b. Water Vapor Transmission: 121%
   c. Reduction in Chloride Ion Intrusion: 83%
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Grace Construction Products, Milwaukee WI 53223
   b. HULS America, Inc. Piscataway NJ 08855
   c. Okon, Inc. Lakewood CO 80214

2.010 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Semi-rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80, or aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 according to ASTM D2240.

C. Bonding Agent: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.011 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4,000 psi at 28 days when tested according to ASTM C109/C109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 4,000 psi at 28 days when tested according to ASTM C109/C109M.

2.012 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI301.
1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Slag Cement: 50 percent.
4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.013 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. All uses: Normal-weight concrete.
   1. Minimum Compressive Strength: 4,000 psi at 28 days.
   2. Maximum W/C Ratio: 0.45.
   3. Slump Limit: 5 inches plus or minus 1 inch.
   4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

2.014 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.015 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94 and ASTM C1116, and furnish batch ticket information.
   1. When air temperature is between 85 and 90 degree Fahrenheit, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 degree Fahrenheit, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
   1. For mixer capacity of 1 cubic yard or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
   2. For mixer capacity larger than 1 cubic yard, increase mixing time by 15 seconds for each additional 1 cubic yard.
   3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.01 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
   1. Class A, 1/8 inch for smooth-formed finished surfaces.
   2. Class C, 1/2 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways, reglets, recesses, and the like, for easy removal.
   2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.02 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
   2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
   3. Install dovetail anchor slots in concrete structures as indicated.

3.03 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 degree Fahrenheit for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
   1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
   2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.04 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
   1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.05 VAPOR-RETARDER INSTALLATION

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

3.06 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.07 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls at 60-feet maximum. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.08 WATER STOP INSTALLATION

A. Flexible Water Stops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed water stops during progress of the Work. Field fabricate joints in water stops according to manufacturer's written instructions.

B. Self-Expanding Strip Water Stops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.09 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

3.010 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.011 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces to receive concrete floor toppings such as housekeeping pads.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces to receive trowel finish.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view.
2. Retain straightedge method in subparagraph below if deleting F-number system above.
3. Finish and measure surface, so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.012 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:
   1. Coordinate sizes and locations of concrete bases with actual equipment provided.
   2. Construct concrete bases 6 inches high unless otherwise indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
   3. Minimum Compressive Strength: 4,000 psi at 28 days.
   4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
   6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.013 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
   a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.014 LIQUID FLOOR TREATMENT APPLICATION

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete that is less than 28 days' old.
   3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.015 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.016 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.017 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:
   1. Steel reinforcement placement.
   2. Verification of use of required design mixture.
   3. Concrete placement, including conveying and depositing.
   4. Curing procedures and maintenance of curing temperature.
   5. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
   1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cubic yard, but less than 25 cubic yard, plus one set for each additional 50 cubic yard, or fraction thereof.
   2. Testing Frequency: Obtain at least one composite sample for each 100 cubic yard, or fraction thereof of each concrete mixture placed each day.
      a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   3. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   4. Air Content: ASTM C231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   5. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 degree Fahrenheit and below or 80 degree Fahrenheit and above, and one test for each composite sample.
   6. Unit Weight: ASTM C567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   7. Compression Test Specimens: ASTM C31.
      a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
      b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
   8. Compressive-Strength Tests: ASTM C39; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
      a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
      b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
   9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
   10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods as directed by Architect.
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

3.018 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION

SECTION 03 3000.10
CONTROLLED LOW STRENGTH BACKFILL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Contractor shall furnish all labor, materials, equipment and incidentals as shown, specified and required to provide for the proportioning, mixing, transportation and placement of Controlled Low Strength Backfill at the specified locations and dimensions shown on the plans, or as directed by the Engineer.

B. The Controlled Low Strength Backfill shall be composed of portland cement, fly ash, natural fine aggregate and water, proportioned and mixed as herein specified.

1.02 RELATED REQUIREMENTS

A. Section 31 2200 – Grading.

B. Section 31 2316 – Excavation.

C. Section 31 2323 – Fill.

1.03 QUALITY CONTROL

A. Testing
   1. Test materials for compliance with technical requirements of the Specifications shall be performed by a testing laboratory.
   2. Testing Services Include:
      a. Test the Contractor's proposed materials in the laboratory and/or field for compliance with the Specifications.
      b. Report test results to the Engineer and the Contractor.

1.04 PRICE AND PAYMENT PROCEDURES

A. Cement: By the cubic yard.

1.05 REFERENCE STANDARDS

A. Comply with applicable provisions and recommendation of the following, except as otherwise shown or specified.
   1. ASTM C 150, Portland Cement.
   2. ASTM C 618, Fly Ash.
   3. ASTM C 494, Water Reducing Admixtures.

1.06 SUBMITTALS

A. Certificates: Submit certificates of compliance with referenced standards.

B. The testing laboratory shall submit copies of the reports directly to the Engineer, with copy to the Contractor.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement: Furnish hydraulic cement that meets the requirements of TxDOT's DMS-4600, "Hydraulic Cement," TxDOT's Hydraulic Cement Quality Monitoring Program (HCQMP), and ASTM C-150 Type I Portland Cement. Sources not on the HCQMP or other sources to be used in combination with an approved source will require approval before use.

B. Fly Ash: Furnish fly ash conforming to TxDOT DMS-4610, "Fly Ash".

C. Chemical Admixtures: Furnish chemical admixtures conforming to TxDOT DMS-4640, "Chemical Admixtures for Concrete."

D. Fine Aggregate: Provide fine aggregate that will stay in suspension in the mortar to the extent required for proper flow and that meets the gradation requirements of Table 1. Test fine aggregate gradation in accordance with TxDOT standard laboratory test procedure Tex-401-A. Plasticity Index (PI) must not exceed 6 when tested in accordance with TxDOT standard laboratory test procedure Tex-l06-A.

TABLE 1 - GRADATION FOR FINE AGGREGATE

SIEVE SIZE	PERCENT BY WEIGHT PASSING SIEVES
3/8 inch	100
No. 8	80-100
No. 16	60-100
No. 30	45-80
No. 50	12-40
No. 100	1.5-25
No. 200	0-5

E. Admixtures
1. The use of any material added to the Controlled Low Strength Backfill shall be reviewed by the Engineer.
2. Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C494, Type A, water-reducing, or Type D, water reducing and retarding. Water reducing admixtures shall be added to the mixer in accordance with manufacturer's printed instructions.

F. Water
1. Water used in mixing shall be as clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product as possible.
2. Water will be tested and shall meet the suggested requirements of AASHTO T26.
3. Water known to be of potable quality may be used without testing.

PART 3 EXECUTIONS

3.01 MIXING AND PROPORTIONING

A. The Contractor or Controlled Low Strength Backfill supplier shall submit for acceptance test data from prior experience if available.

B. The supplier also must provide 5 copies of the recommended mix proportions and trial batch test results prepared by an independent testing laboratory three weeks prior to use.

C. Submitted data should include product performance curves indicating 1, 7 and 28 day unconfined compressive strengths.

D. Proportions must be selected to produce the specified unconfined compressive strength and workability designed below.

E. Proportions shall be selected on the basis of unconfined compressive strength tests of specimens continuously moist cured, for testing at the age or ages specified below.

3.02 PERFORMANCE

A. Strengths: for trench backfill, the Controlled Low Strength Backfill shall have an unconfined compressive strength of 21 psi minimum, no more than 24 hours after watering. The 28 day unconfined compressive strength shall not exceed 500 psi.

B. Workability: The Controlled Low Strength Backfill shall be flowable and shall have an initial slump greater than 9" and a minimum slump of 4-½" after one hour.

C. When a sample of Controlled Low Strength Backfill is poured out on the ground, the aggregate and mortar should stay well mixed with no separation. The Engineer may reject the mix if excessive separation is found.

3.03 PLACING

A. For pipe trench backfill, provide bulkheads at units of fill placement sufficient to confine backfill to area designated in the plans. Bulkheads may be structural or earthen.

B. During placement, station workers in a safe location where they can view inside of pipe to check for leakage. When any leakage into pipe is discovered, stop placement and repair leak before resuming placement.

3.04 TESTING

A. A minimum of three test cylinders per 250 cubic yards of Controlled Low Strength Backfill shall be drawn and tested for 7 and 28 day unconfined compressive strengths by the independent testing laboratory engaged by the Owner.

3.05 COVERING

A. Controlled Low Strength Backfill placed in pipe trenches may be covered when it adequately supports the weight of construction equipment, no less than 24 hours after completion of placement.

B. Other Controlled Low Strength Backfill should be allowed to cure for a minimum of 72 hours before covering.

END OF SECTION

SECTION 04 0511
MASONRY MORTARING AND GROUTING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Mortar for masonry.

B. Grout for masonry.

1.02 REFERENCE STANDARDS

A. ACI 530/530.1/ERTA - Building Code Requirements and Specification for Masonry Structures and Related Commentaries; 2011.

B. ACI 530.1/ASCE 6/TMS 602 - Specification for Masonry Structures; American Concrete Institute International; 2008.

C. ASTM C5 - Standard Specification for Quicklime for Structural Purposes; 2010.

D. ASTM C91/C91M - Standard Specification for Masonry Cement; 2012.

E. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2015.

F. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2011.

G. ASTM C150/C150M - Standard Specification for Portland Cement; 2016.

H. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2006 (Reapproved 2011).

I. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2014a.

J. ASTM C387/C387M - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar; 2011b.

K. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2011.

L. ASTM C476 - Standard Specification for Grout for Masonry; 2010.

M. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2012.

N. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2010.

O. ASTM C1019 - Standard Test Method for Sampling and Testing Grout; 2013.

P. ASTM C1072 - Standard Test Method for Measurement of Masonry Flexural Bond Strength; 2013.

Q. ASTM C1142 - Standard Specification for Extended Life Mortar for Unit Masonry; 1995 (Reapproved 2013).

R. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms; 2014.

S. ASTM E518/E518M - Standard Test Methods for Flexural Bond Strength of Masonry; 2010.

T. IMIAWC (CW) - Recommended Practices & Guide Specifications for Cold Weather Masonry Construction; International Masonry Industry All-Weather Council; 1993.

U. IMIAWC (HW) - Recommended Practices & Guide Specifications for Hot Weather Masonry Construction; International Masonry Industry All-Weather Council; current edition.

1.03 SUBMITTALS

A. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C270 is to be used.

B. Samples: Submit two samples of mortar, illustrating mortar color and color range.

C. Reports: Submit reports on mortar indicating conformance of component mortar materials to requirements of ASTM C 270 and test and evaluation reports per ASTM C 780.

D. Reports: Submit reports on grout indicating conformance of component grout materials to requirements of ASTM C476 .

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer's Instructions: Submit manufacturer's installation instructions.

1.04 QUALITY ASSURANCE

A. Comply with provisions of ACI 530/530.1/ERTA, except where exceeded by requirements of the contract documents.
   1. Maintain one copy of each document on project site.

B. Quality Control Submittals. Furnish the following:
   1. ASTM C1107-89a, Grade B certified testing laboratory reports, showing the grout tested at a fluid consistency for temperatures of forty-five (45) degrees F and ninety (90) degrees F with a pot lift of thirty (3) minutes at fluid consistency. The expansion at three (3) or fourteen (14) days shall not exceed the 28-day expansion and non-shrink property is not based on gas expansion.
   2. Twenty-four (24) hour evaluation of non-shrink grout. Test and report with independent test laboratory letterhead and signature, dated within the last eighteen (18) months. Test requirements and forms are specified hereinafter on attached form. Required only for non-specified grouts.
   3. Test results and service report from the demonstration and training session and from the field tests.
   4. Certification based on test results providing that all grout used on the project contains no chlorides or other chemicals causing corrosion.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.06 FIELD CONDITIONS

A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.

B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

PART 2 PRODUCTS

2.01 MORTAR AND GROUT APPLICATIONS

A. Mortar Mix Designs: ASTM C270, Property Specification.

2.02 MATERIALS

A. Masonry Cement: ASTM C 91, types as scheduled in this section.
   1. Colored mortar: Premixed cement.

B. Portland Cement: ASTM C 150, Type I - Normal.

C. Packaged Dry Mortar: ASTM C 387/C 387M.

D. Hydrated Lime: ASTM C 207

E. Quicklime: ASTM C5, non-hydraulic type.

F. Mortar Aggregate: ASTM C144.

G. Grout Aggregate: ASTM C404.

H. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
   1. Color(s): As indicated on drawings.

I. Water: Clean and potable.

J. Accelerating Admixture: Nonchloride type for use in cold weather.

K. Moisture-Resistant Admixture: Water repellent compound designed to reduce capillarity.

L. Bonding Agent: Latex or epoxy type.

M. Provide grout materials free of chlorides or other chemicals that cause corrosion.

2.03 MORTAR MIXES

A. Ready Mixed Mortar: ASTM C 1142.

B. Stain Resistant Pointing Mortar: One part Portland cement, 1/8 part hydrated lime, and two parts graded (80 mesh) aggregate, proportioned by volume. Add aluminum tristearate, calcium stearate, or ammonium stearate equal to 2 percent of Portland cement by weight.

C. Colored Mortar: Proportion selected pigments and other ingredients without exceeding manufacturer's recommended pigment-to-cement ratio.

2.04 MORTAR MIXING

A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C270 and in quantities needed for immediate use.

B. Maintain sand uniformly damp immediately before the mixing process.

C. Add mortar color and admixtures in accordance with manufacturer's instructions. Provide uniformity of mix and coloration.

D. Do not use anti-freeze compounds to lower the freezing point of mortar.

E. If water is lost by evaporation, re-temper only within two hours of mixing.

2.05 GROUT MIXES

A. Bond Beams and Lintels: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M, or mix in accordance with ASTM C 476.
   1. Fine grout for spaces with smallest horizontal dimension of 2 inches or less.
   2. Coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

B. Engineered Masonry: 3,000 psi strength at 28 days; 8-10 inches slump; provide premixed type in accordance with ASTM C 94/C 94M, or mix in accordance with ASTM C 476.
   1. Fine grout for spaces with smallest horizontal dimension of 2 inches or less.
   2. Coarse grout for spaces with smallest horizontal dimension greater than 2 inches.

2.06 GROUT MIXING

A. Mix grout in accordance with ASTM C94/C94M.

B. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476 for fine and coarse grout.

C. Add admixtures in accordance with manufacturer's instructions; mix uniformly.

D. Do not use anti-freeze compounds to lower the freezing point of grout.

2.07 PRECONSTRUCTION TESTING

A. Mortar Mixes: Test mortars prebatched by weight in accordance with ASTM C780 recommendations for preconstruction testing.
   1. Test results will be used to establish optimum mortar proportions and establish quality control values for construction testing.

B. Grout Mixes: Test grout batches in accordance with ASTM C1019 procedures.
   1. Test results will be used to establish optimum grout proportions and establish quality control values for construction testing.

PART 3 EXECUTION

3.01 PREPARATION

A. Apply bonding agent to existing concrete surfaces.

B. Plug clean-out holes for grouted masonry with brick or block masonry units. Brace masonry to resist wet grout pressure.

3.02 INSTALLATION

A. Install mortar and grout to requirements of section(s) in which masonry is specified.

B. Work grout into masonry cores and cavities to eliminate voids.

C. Do not install grout in lifts greater than 3 inches without consolidating grout by rodding.

D. Do not displace reinforcement while placing grout.

E. Remove excess mortar from grout spaces.

3.03 GROUTING

A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of contract documents.

B. Perform grouting by means of high-lift technique, except in locations that mandate use of low-lift grouting technique.
   1. Do not use high-lift grouting where size of cavities mandates use of fine grout.

C. Low-Lift Grouting:
   1. Limit height of pours to 12 inches.
   2. Limit height of masonry to 12 inches above each pour.
   3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
   4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.

D. High-Lift Grouting:
   1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
   2. Brick: Limit pours to maximum 16 feet in height and 25 feet horizontally.
   3. Hollow Masonry: Limit lifts to maximum 4 feet and pours to maximum height of 24 feet.
   4. Place grout for spanning elements in single, continuous pour.

3.04 FIELD QUALITY CONTROL

A. Test and evaluate mortar in accordance with ASTM C780 procedures.
   1. Test with same frequency as specified for masonry units.

B. Test and evaluate grout in accordance with ASTM C1019 procedures.
   1. Test with same frequency as specified for masonry units.

C. Prism Tests: Test masonry and mortar panels for compressive strength in accordance with ASTM C1314, and for flexural bond strength in accordance with ASTM C1072 or ASTM E518; perform tests and evaluate results as specified in individual masonry sections.

3.05 SCHEDULES

A. Exterior Cavity Wall: Type S mortar with Type N pointing mortar.

B. Loading Dock Area, No. 100: CMU partitions with Type N mortar.

C. Conference Room 102: Glass Unit Masonry with Type N mortar and Type O pointing mortar.

END OF SECTION

SECTION 05 1200.10
PIPE RAILING AND BRACKETS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Installation of handrail brackets.

B. Installation of pipe railing.

1.02 RELATED REQUIREMENTS

A. Section 09 9000 – Painting and Coating.

1.03 REFERENCE STANDARDS

A. ASTM A 53: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

1.04 SUBMITTALS

A. Submit shop drawings to the Engineer to indicate compliance with specifications. Show locations, methods of supporting, methods of anchoring and finishes.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe Railing: Shop fabricated black iron pipe of size, shape and detail indicated on the drawings. ASTM A 53, Type E or S, Grade B, Schedule 40.

1. Preassemble items in shop to greatest extent possible, so as to minimize field splicing and assembly of units at project site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for re-assembly and coordinated installation.
2. Use materials of size and thicknesses shown or if not shown of required size and thickness to produce adequate strength and durability in finished product for intended use. Work to dimensions shown or checked on shop drawings, using proven detail of fabrication and support.
3. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32" unless otherwise shown. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing the work.
4. Weld corners and seams continuously.
5. Grind exposed welds smooth and flush, to match and blend with adjoining surfaces
6. Join posts and rails by mitered and welded joints made by fitting post to top rail and intermediate rail to post, mitering corners, groove welding joints and grinding smooth.
7. Railings may be bent at corners instead of joining provided bends are uniformly formed in jigs with cylindrical cross-section of pipe maintained throughout entire bend.
8. Anchor posts in concrete by means of 4" long pipe sleeves set and anchored into concrete. Provide sleeves of galvanized, standard weight, steel pipe, not more than 1/2" greater than the outside diameter of inserted pipe post.

B. Finish: Shop prime paint interior, galvanize exterior.

PART 3 EXECUTION

3.01 INSTALLATION

A. Adjust railing prior to securing in place to insure proper matching at butting joints and correct alignment throughout their length. Space posts not more than 4 feet on centers. Plumb posts in each direction.

B. Anchor posts in concrete by means of pipe sleeves set and anchored into concrete. Set posts in sleeves and fill annular space between post and sleeve solid with molten lead and sulphur or a quick setting hydraulic cement.

C. Anchor rail ends to concrete and masonry with steel round flanges anchored into wall construction with lead expansion shield and bolts.

D. Space brackets one foot from each end of handrail and not over five foot on centers throughout run.

E. Securely anchor brackets to wall and/or foundations to resist a horizontal load of 300 lbs.

F. Immediately after erection, clean and brush field welds, bolted connections, and abraded areas of shop paint and paint all exposed areas with same material as used for ship painting.

G. Sand field welds and abraded areas which will be exposed in the finish work.

H. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils in accordance with Section 09 9000.

END OF SECTION

SECTION 09 9000
PAINTING AND COATING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Surface preparation.

B. Field application of paints and other coatings.

C. Scope: Finish all interior and exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.

D. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
   2. Items indicated to receive other finishes.
   3. Items indicated to remain unfinished.
   4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
   5. Stainless steel, anodized aluminum, bronze, terne, and lead items.
   6. Brick, architectural concrete, cast stone, integrally colored plaster and stucco.
   7. Glass.
   8. Concrete masonry in utility, mechanical, and electrical spaces.
   9. Acoustical materials, unless specifically so indicated.
   10. Concealed pipes, ducts, and conduits.

1.02 RELATED REQUIREMENTS

A. Section 32 1723.13 - Painted Pavement Markings.

1.03 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this section.

1.04 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. ASTM D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications; 2014.

C. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials; 2007.

D. GreenSeal GS-11 - Paints and Coatings; 2013.

E. SSPC (PM1) - Good Painting Practice: SSPC Painting Manual, Vol. 1; Society for Protective Coatings; Fourth Edition.

F. NSF 61-2016 – Drinking Water System Components – Health Effects

1.05 SUBMITTALS

A. Product Data: Provide data on all finishing products and special coatings, including VOC content.

B. Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded.

C. Certification: By manufacturer that all paints and coatings do not contain any of the prohibited chemicals specified; GreenSeal GS-11 certification is not required but if provided shall constitute acceptable certification.

D. Manufacturer's Instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.

E. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. Extra Paint and Coatings: 1 gallon of each color and type; store where directed.
   2. Label each container with color and type in addition to the manufacturer's label.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified.

B. Applicator Qualifications: Company specializing in performing the type of work specified.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

B. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.

B. Follow manufacturer's recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

C. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.

D. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.

B. Provide all paint and coating products from the same manufacturer to the greatest extent possible.

2.02 PAINTS AND COATINGS - GENERAL

A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
   1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
   2. Provide materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

3. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
4. Supply each coating material in quantity required to complete entire project's work from a single production run.
5. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.

B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.

C. Chemical Content: The following compounds are prohibited:
1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
2. Acrolein, acrylonitrile, antimony, benzene, butyl benzyl phthalate, cadmium, di (2-ethylhexyl) phthalate, di-n-butyl phthalate, di-n-octyl phthalate, 1,2-dichlorobenzene, diethyl phthalate, dimethyl phthalate, ethylbenzene, formaldehyde, hexavalent chromium, isophorone, lead, mercury, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, naphthalene, toluene (methylbenzene), 1,1,1-trichloroethane, vinyl chloride.

D. Flammability: Comply with applicable code for surface burning characteristics.

E. Colors: As indicated on drawings or as required by local jurisdictional authority.

F. All coatings for interior surfaces exposed to potable water shall be in accordance with NSF 61-2016, and must be certified by an individual or organization accredited by ANSI.

2.03 ACCESSORY MATERIALS

A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.

B. Patching Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin application of coatings until substrates have been properly prepared.

B. Verify that surfaces are ready to receive work as instructed by the product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.

D. If substrate preparation is the responsibility of another installer, notify Engineer of unsatisfactory preparation before proceeding.

E. Test shop-applied primer for compatibility with subsequent cover materials.

F. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is suitable.

3.02 PREPARATION

A. Clean surfaces thoroughly and correct defects prior to coating application.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Remove or repair existing coatings that exhibit surface defects.

D. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.

E. Seal surfaces that might cause bleed through or staining of topcoat.

F. Remove mildew from impervious surfaces. Rinse with clean water and allow surface to dry.

G. Concrete and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

H. Asphalt, Creosote, or Bituminous Surfaces to be Painted: Remove foreign particles to permit adhesion of finishing materials. Apply latex based or compatible sealer or primer.

I. Insulated Coverings to be Painted: Remove dirt, grease, and oil from canvas and cotton.

J. Concrete Floors and Traffic Surfaces to be Painted: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.

K. Aluminum Surfaces to be Painted: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.

L. Copper Surfaces to be Painted: Remove contamination by steam, high pressure water, or solvent washing. Apply vinyl etch primer immediately following cleaning.

M. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

N. Uncorroded Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand or power tool wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

O. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.

P. Exterior Wood Surfaces to Receive Opaque Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior calking compound after prime coat has been applied. Back prime concealed surfaces before installation.

3.03 APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

C. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

D. Apply each coat to uniform appearance.

E. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

F. Sand wood and metal surfaces lightly between coats to achieve required finish.

G. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

3.04 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.05 PROTECTION

A. Protect finished coatings until completion of project.

B. Touch-up damaged coatings after Substantial Completion.

END OF SECTION

SECTION 11 2120
VERTICAL TURBINE PUMPS

PART 1 - GENERAL

1.01 SCOPE OF WORK

This section covers vertical turbine pumps with motors mounted above ground. The CONTRACTOR shall provide pricing to furnish all labor, material, equipment, and incidentals required to install, test, and make ready for operation all vertical turbine pumps as specified herein and as shown on the Contract Drawings. All work shall be as per plans and specifications.

1.02 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete

B. Section 43 21 25 – Pre-Fabricated Packaged Pump Station

1.03 DEFINITIONS

Relevant terminology shall be defined according to the American National Standard for Vertical Pumps for Nomenclature, Definitions, Application and Operation Hydraulic Institute ANSI/HI 2.1-2.5-1994 and American Water Works Association Standard for Vertical Turbine Pumps -Line Shaft and Submersible Types ANSI/AWWA E101-88 or latest standard.

1.04 GENERAL

A. Pump shall be provided from SAWS approved manufacturers. No substitute products will be considered. All pump components including the pump, column, line shaft, bearings, motor, discharge head, and all associated parts and equipment shall be provided by the pump manufacturer for single-system responsibility.

B. All components of each pump system provided under this section shall be entirely compatible. Each unit of pumping equipment shall incorporate all basic mechanisms, couplings, electric motors' engine drives, necessary mountings, and appurtenances. Pump manufacturer shall coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

C. Pump and motor construction and performance shall conform to the below referenced standards.

1. American National Standard for Vertical Pumps for Nomenclature, Definitions, Application and Operation Hydraulic Institute ANSI/HI 2.1¬2.5-1994 or latest standard.
2. American National Standard for Vertical Pump Tests Hydraulic Institute ANSI/HI 2.6-1994 or latest standard.
3. American National Standard for Pumps -General Guidelines for Types, Definitions, Application and Sound Measurement Hydraulic Institute ANSI/HI 9.1-9.5-1994 or latest standard.
4. American Water Works Association Standard for Vertical Turbine Pumps -Line Shaft and Submersible Types ANSI/AWWA E101-88 or latest standard.
5. American National Standards Institute (ANSI): C50.41, Polyphase Induction Motors for Power Generating Stations or latest standard.
6. National Electrical Manufacturers Association (NEMA) NEMA MG 1 -Motors and Generators or latest standard.

D. CONTRACTOR to perform all operational, performance, and acceptance testing for pump, motor, controls, instrumentation, and electrical at his expense.

E. Pump manufacturer shall guarantee all components. Pump column, line shaft, and line shaft bearings shall be warranted for 3-years from date of Final Acceptance of project by Owner.

F. CONTRACTOR shall provide a complete pumping system capable of providing uninterruptible service under the conditions expected in pump station operation. Pumps selected and provided shall perform correctly under these conditions.

1.05 SUPPLEMENTS

Some specific requirements are attached to this section as supplements.

1.06 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location with manufacturer name, model number, serial number, gpm at rated head, rpm, pertinent bearing and bearing lube information, and date of manufacture.

B. Lifting Lugs: All equipment weighing over 100 pounds shall be equipped with lifting lugs.

C. Contractor shall provide Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 3/4-inch minimum diameter.

1.07 FACTORY FINISHING

Surfaces shall be coated in accordance with Section 09 900, Painting and Coatings.

1.08 SOURCE QUALITY CONTROL

A. Pumps and motors will be factory tested in accordance with the American National Standard for Vertical Pump Tests Hydraulic Institute ANSI/HI 2.6-1994, American National Standard for Pumps -General Guidelines for Types, Definitions, Application, and Sound Measurement Hydraulic Institute ANSI/HI 9.1-9.5-1994, and Institute of Electrical and Electronics Engineers, Inc. Standard Test Procedures for Polyphase Induction Motors and Generators IEEE 112.

B. Types of Tests:

1. Performance test to demonstrate hydraulic and mechanical integrity.
2. Hydrostatic test of pressure-containing components.
3. Vibration test.
4. Motor test per IEEE 112.

C. Records of all tests performed by the manufacturer shall be made in accordance with the American National Standard for Vertical Pump Tests Hydraulic Institute ANSI/HI 2.6-1994, American National Standard for Pumps -General Guidelines for Types, Definitions, Application, and Sound Measurement Hydraulic Institute ANSI/HI 9.1-9.5-1994 and Institute of Electrical and Electronics Engineers, Inc. Standard Test Procedures for Polyphase Induction Motors and Generators IEEE 112.

D. Factory Witness Test: OWNER will witness shop tests at CONTRACTOR's expense and inspect and check the testing equipment used. CONTRACTOR shall furnish OWNER a plan and elevation sketch of the test setup showing the piping and instrumentation and shall notify OWNER at least 30 calendar days in advance of the time that each shop test will be made. This does not mean the pump unit is to be setup and left for the 30 calendar day notice period. The pump unit needs to be setup in time for the manufacturer's pretest prior to OWNER witnessing the test. The factory test shall be performed with a lab calibrated motor allowing the factory to get the most accurate efficiency readings If the pump fails to operate properly or fails to meet the specified conditions or requirements during testing, the pump manufacturer shall modify the pump and perform additional tests. CONTRACTOR shall

provide all cost for round-trip for three (3) OWNER observers from San Antonio, Texas to the manufacturer's facility, to include making reservations, providing travel tickets and airport parking/transportation, lodging, meals, and rental car for use at the location of the manufacturer's facility.

E. All pumps shall have a continuously rising curve, or the system operating range shall not cross the pump curve at two different capacities or "dip region." Unless indicated otherwise, the required pump shaft horsepower at any point on the performance curve shall not exceed the rated horsepower of the motor or engine or encroach on the service factor.

F. All test records shall be bound permanently and provided in a report by the manufacturer. Five certified copies of the report shall be provided to the ENGINEER not less than 21 days prior to the shipment of the equipment from the factory.

G. Pump station components, including vertical turbine pumps, electric motors, steel skid, piping, valves, gauges, electronic meters, controls, conduits, and SCADA connections shall be provided and assembled by a single manufacturer. Refer to Section 43 21 25 Pre-Fabricated Pump Station for specifics on assembly, delivery and startup.

1.09 SUBMITTALS

A. Required Submittals: Submit product data and manufacturer's installation instructions under provisions of Section 01300 – Submittals.

Drawings & Data	Complete Assembly
	Materials List
	Foundation
	Installation
	Equipment
	Drawings
Pumps	Name of the Manufacturer
	Type, Model and Serial Number
	Design Rotative Speed
	Number of Stages
	Weight
	Complete Performance Curves
	Shop Coatings
	Centralizers or Bumpers for protection of casing coating from column installation
Motors	Name of Manufacturer
	Type and Model
	Type, Size, and Rating of Bearing & Lubrication
	Rated Size of Motor in Hp
	Temperature Rating
	Full Load Rotative Speed
	Weight
	Current at Full, 3/4 , and ½ Load
	Efficiency at Full, ¾ and ½ Load
	Power Factor at Full, 3/4 , and ½ Load
	Full Load Torque
	Operation and Maintenance Manuals with Connection Diagrams
	Motor Capabilities Curve

	Starting Current Curve
Product Data Section	Manufacturer's Technical Data Performance Charts and Curves Catalog Cuts Installation Instructions List of Parts with Price and Source List of Supplies with Price and Source
Drawing Section	Complete List of Equipment and Materials Wiring and Schematic Diagrams System Layout Anchorage of Equipment and Appurtenances
Instruction Section	Operating Instructions Maintenance Procedures System Checking Methods Staffing Training
Certification	Specify and Describe the Names and Qualifications of the Factory Trained Personnel
Operation and Maintenance Manuals	Specify and Describe the Six Complete Sets of the Manufacturer's Instructions System Layout Showing Piping, Valves, and Control, Approved Wiring and Control Diagrams Control Sequence Describing Startup, Operation, and Shutdown Operating and Maintenance Instructions for Each Piece of Equipment, Including Lubrication Instructions, and Troubleshooting Guide

B. Shop Drawings

1. Pump name, identification number, and specification Section number.
2. Make, model, weight, and horsepower of each equipment assembly.
3. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
4. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity with a minimum of five points. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
5. The CONTRACTOR shall require the manufacturer to indicate the operating range limits on the performance curves recommended for satisfactory operation without surge, cavitation, or vibration. The operating range shall be as wide as possible based on actual hydraulic and mechanical tests.
6. Detailed drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

7. Power and control wiring diagrams, including terminations between local control panels, junction terminal boxes, and equipment items.
8. Complete electrical schematic diagram.
9. Factory finish system.
10. Pump nameplate for each pump including manufacturer name, model number, serial number, gpm at rated head, rpm-pertinent bearing and bearing lube information, and date of manufacture.

C. Quality Control Submittals

1. Factory Functional and Performance Test Reports and Log (five copies).
2. Manufacturer's Certification of Compliance that the factory finish system is identical to the requirements specified herein.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer's printed installation instructions.
5. Manufacturer's Certificate of Proper Installation.
6. Suggested spare parts list to maintain the equipment in service for a period of 2 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and maintenance manual (six copies).
9. Results of bacteriological testing.
10. Factory quality control inspection report of line boring and machining work.

D. Instructions

1. Instructions shall be concise, complete, and typewritten.
2. Instructions shall include all relevant drawings and diagrams.
3. Control & wiring instructions with diagrams shall be comprehensive and include the layout of the entire pump system.
4. Control & wiring instructions shall be posted as directed and framed under glass or in approved laminated plastic.
5. Operating instructions with diagrams shall cover preventative maintenance procedures, methods of checking the system for normal operation, and procedures for safely starting and stopping the system.
6. Operating instructions shall be posted as directed and framed under glass or in approved laminated plastic.
7. The framed instructions shall be posted before acceptance testing of each pump system.
8. A pump system training course will be provided to SAWS staff by factory trained and certified instructors. A minimum of 16 hours of on-site training in system operations, trouble-shooting, and maintenance shall be provided as part of pump station costs.
9. Training course material including instructions shall be provided to SAWS 21 calendar days prior to the start of training.

E. Operation and Maintenance Manuals

1. Three complete sets of printed manuals and one full electronic copy provided on a DVD or external hard-drive, containing the manufacturer's operating and maintenance instructions shall be required for each piece of equipment.
2. One printed set is due at the time the test procedure is submitted. The remaining printed and electronic sets are due prior to the contract completion.
3. The Operation and Maintenance manuals shall be permanently hardcover bound and one copy in electronic PDF format.
4. The manuals shall be inscribed with the following information: "OPERATING AND MAINTENANCE INSTRUCTIONS", name and location of the building, name of the Contractor, and contract number.
5. Fly sheets shall be placed before the instruction sections for each subject.
6. Instruction sheets shall be 8 1/2 by 11 inches with large sheets of drawings folded in.
7. Instructions shall include the following items:
    a. System layout diagram.
    b. Wiring and control diagrams.
    c. Control sequence describing startup, operation, and shutdown.
    d. Maintenance and troubleshooting.

F. Delivery and Storage

1. Equipment delivered and stored shall be protected from the environment in compliance with the manufacturer’s written recommendations.

1.10 EXTRA MATERIALS

Furnish one complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 ACCEPTABLE PUMP MANUFACTURERS

A. Fairbanks Morse
B. Johnston
C. Peerless
D. Goulds
E. Flowserve
F. Afton

2.02 VERTICAL TURBINE PUMPS

A. Provide four (4) pumps with motors, including the unit designation below for potable water service.

1. Each pump and motor shall have an alphanumeric identifying tag. The CONTRACTOR shall submit a schedule of pumps and motors to be furnished, with stainless steel tags, in conformance with the following identification description:
    a. The first three positions (or less) shall include the pump type and/or service by the appropriate abbreviation (e.g., VTP for vertical turbine pump), followed by a dash;
    b. The dash is followed by the numeral “1”, which indicates field equipment;
    c. The following two digits should identify the pump number (e.g., 06 for Pump No. 6); and

d. The final position should identify as either pump or motor (e.g., "P" for pump, "M" for motor).

B. The pump shall be driven by a constant speed solid shaft electric motor connected via drive shafts and coupling.

C. Pump shall be constructed in accordance with the American National Standard for Vertical Turbine Pumps for Nomenclature, Definitions, Application and Operation Hydraulic Institute ANSI/HI 2.1-2.5-1994.

2.03 PUMP CHARACTERISTICS

A. The pump shall meet the operating conditions stated in the supplements to this section.

B. CONTRACTOR shall provide a complete pumping system capable of providing uninterruptible service under the conditions expected at the booster station.

C. Design Operating Conditions:

1. Vertical Pump No. 1

   Capacity, gpm – 1,850

   Total head, feet – 155

   NPSHA, feet – 150 (min)

   NPSHRE shall not exceed 25 feet

2. Vertical Pump No. 2

   Capacity, gpm – 1,850

   Total head, feet – 155

   NPSHA, feet – 150 (min)

   NPSHRE shall not exceed 25 feet

3. Vertical Pump No. 3

   Capacity, gpm – 1,850

   Total head, feet – 155

   NPSHA, feet – 150 (min)

   NPSHRE shall not exceed 25 feet

4. Vertical Pump No. 4

   Capacity, gpm – 1,850

   Total head, feet – 155

   NPSHA, feet – 150 (min)

   NPSHRE shall not exceed 25 feet

D. Design Requirements

1. General: The pumps shall be designed in accordance with applicable portions of ANSI/HI 1.1 – 1.6, 2.1 – 2.6 and ANSI/HI 9.1 – 9.6 and the requirements of this Section. The pumps shall operate without cavitation or damaging vibration at the specified range flow and head conditions.

2. Vertical Turbine Pump No. 1

   a. Bowl efficiency, minimum (percent) – 80

   b. Maximum shut off head (feet) – 300

   c. Maximum pump speed (rpm) – 1,800

d. Maximum motor size (HP) – 200 max
e. Duty – continuous

3. Vertical Turbine Pump No. 2
   a. Bowl efficiency, minimum (percent) – 80%
   b. Maximum shut off head (feet) – 300
   c. Maximum pump speed (rpm) – 1,800
   d. Maximum motor size (HP) – 200 max
   e. Duty – continuous
4. Vertical Turbine Pump No. 3
   a. Bowl efficiency, minimum (percent) – 80
   b. Maximum shut off head (feet) – 300
   c. Maximum pump speed (rpm) – 1,800
   d. Maximum motor size (HP) – 200 max.
   e. Duty – continuous
5. Vertical Turbine Pump No. 4
   a. Bowl efficiency, minimum (percent) – 80
   b. Maximum shut off head (feet) – 300
   c. Maximum pump speed (rpm) – 1,800
   d. Maximum motor size (HP) – 200 max
   e. Duty – continuous

E. Pump Dimensions
1. Vertical Turbine Pump No. 1
   a. Pump Bowl Setting (feet) – 6.0 feet below the centerline of the suction inlet pipe at the can
   b. Can Diameter (in) – 24 O.D.
   c. Size of discharge flange (in) – 10
   d. Discharge flange rating (psi) – 150
   e. Minimum strainer clearance above the bottom of the can (feet) – 0.50
2. Vertical Turbine Pump No. 2
   a. Pump Bowl Setting (feet) – 6.0 feet below the centerline of the suction inlet pipe at the can
   b. Can Diameter (in) – 24 O.D.
   c. Size of discharge flange (in) – 10
   d. Discharge flange rating (psi) – 150
   e. Minimum strainer clearance above the bottom of the can (feet) – 0.50
3. Vertical Turbine Pump No. 3
   a. Pump Bowl Setting (feet) – 6.0 feet below the centerline of the suction inlet pipe at the can.
   b. Can Diameter (in) – 24 O.D.

c. Size of discharge flange (in) – 10, or as required by manufacturer.

d. Discharge flange rating (psi) – 150

e. Minimum strainer clearance above the bottom of the can (feet) – 0.50

4. Vertical Turbine Pump No. 4

a. Pump Bowl Setting (feet) – 6.0 feet below the centerline of the suction inlet pipe at the can.

b. Can Diameter (in) – 24 O.D.

c. Size of discharge flange (in) – 10, as required by manufacturer.

d. Discharge flange rating (psi) – 150

e. Minimum strainer clearance above the bottom of the can (feet) – 0.50

F. The driver shall be equipped with non-reverse ratchet

2.04 PUMP REQUIREMENTS

A. Discharge Head

1. Pump discharge head construction shall be designed to support the pumping unit including motor.

2. The pump discharge nozzle shall be installed as indicated on the drawings. The discharge head shall have flanged end discharged conforming with ANSI b16.1, Class 150. The discharge head shall be fabricated from steel.

3. The discharge head access openings shall normally be covered with removable covers that meet OSHA coupling guard requirements.

4. Discharge head and motor shall be coupled via a registered fit connection. Mating surfaces between the motor base and the discharge head shall have the tolerance suitable for solid shaft assembly per pump manufacturer's recommendation. Bore shall be line bored and flange faces machined perpendicular to the axis of the shaft. Quality inspection report shall be submitted to the ENGINEER. Discharge head shall provide space for a two-piece headshaft coupling.

5. Pre-lubrication System: Furnish bearing pre-lubrication system to consist of a solenoid valve to be activated before the pump starts, isolation valves, and piping from the water supply to the discharge head connection. Tapped drain and bearing prelube openings shall be provided in the discharge head.

6. Discharge head shall be fabricated with ANSI Class 150 discharge, access, and base flanges. Discharge orientation shall be as shown on the drawings.

7. The discharge head shall be attached to the steel ring pump head flange. CONTRACTOR to match number, size, and spacing of bolts on steel ring pump head flange.

8. All tapped openings and flanges shall be sealed to accommodate a variation in pressure conditions from 150 psi to -29 in. Hg (full vacuum) within the discharge head and casing.

9. The discharge head shall be configured with openings for maintenance.

10. Pump discharge head shall be equipped with lifting lugs.

B. Pump Column

1. Column sections shall be furnished in interchangeable sections and be no greater than 10 feet in length with threaded segments.

2. The pipe shall conform to ASTM A53 Grade A Schedule 40 pipe.

3. Total pump column length from ground surface to bottom of suction pipe shall be as shown on drawings.
4. Column shall be assembled in such a way as to minimize or eliminate any damage to the column coating. Any damage to the coating shall be field-repaired in accordance with Section 09 9000, Painting and Coatings. During column assembly, all locations absent of coating shall be field-coated in full compliance with the coating manufacturer's printed instructions.
5. The pump column pipe shall be coated with an NSF approved fusion bonded epoxy.

C. Pump Shaft and Line Shaft
1. The pump shaft and line shaft shall be of Type 416 stainless steel high grade alloy having a chromium content of not less than 12 percent.
2. All shaft joints shall be designed so that they will not loosen during forward rotation of the shaft.
3. Shaft diameter shall be sized to meet that required for the nameplate horsepower rating and prevent distortion and vibration.
4. Column pipe shaft bearings shall be compatible with the operation conditions and fluid properties provided. Line shaft bearings shall be HZ-Lube Vesconite Bearings

D. Pump Bowl Assembly
1. The pump bowl assembly shall be designed for use with a water lubricated column.
2. The pump bowls shall be coated and lined with a fusion bonded epoxy coating.
3. The bowl castings shall be free from blow holes, sand holes, and all other material defects.
4. Bowl wear rings shall be of nickel aluminum bronze construction and shall be pinned to the bowl so that they remain fixed and do not move or loosen during operation of the pump.
5. The bowls shall be hydrostatically tested at 1.5 times the pressure produced at shut-off head.

E. Stuffing Boxes
1. Stuffing boxes shall be of the best quality, using the manufacturer's suggested materials best-suited for the application. The seals shall be fresh-water flushed, using lantern rings. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.
2. Shaft maximum allowable runout: The pump and motor shall be designed and manufactured so that the shaft runout at the seal journal is not greater than 0.005 inch or as per seal manufacturer's recommendations.

F. Impeller
1. Nickel aluminum bronze impellers shall be provided.
2. The impeller shall be enclosed type.
3. The impeller shall be statically and dynamically balanced.

G. Impeller Wear Ring
1. Nickel aluminum bronze impeller wear rings shall be provided.

H. Vortex Suppressor

1. All new pumps shall have a vortex suppressor/basket strainer installed on the pump's suction. The vortex suppressor/basket strainer shall be constructed to meet the following requirements:
2. Performance requirements:
    a. Approach velocity: 3.0 feet per second, maximum, at rated design flow
    b. Net open area: 65 percent
3. Design requirements:
    a. Configuration: Basket-type with internal straightening vanes.
    b. Screen: 0.120-inch woven wire cloth on 5/8" centers or expanded metal.
    c. Materials: Wire cloth to be 316 stainless steel material. All other materials to be 304 stainless steel with a minimum thickness of 3/16".
    d. Mounting: Bolted to the pump suction bell using 3/8" minimum diameter 18-8 SST bolts.

I. Mechanical Seal
1. Provide split type cartridge seal with Viton O-ring gaskets and carbon stationary face. Approved models are as follows:
    a. Flex-a-Seal Style 85
    b. Chesterson Style 442
    c. John Crane Type 1

J. Discharge Nozzle
1. An ANSI 16.1B 150 lb. flanged discharge nozzle shall be provided as part of the discharge head.

K. Coupling
1. Pump to motor coupling shall be rigid 3-piece construction machined from steel with an adjustable feature for proper impeller setting. Motor coupling shall incorporate a split ring key to transmit pump thrust to the motor and a square key to adequately handle the torque. Pump half coupling shall be keyed to the upper pump shaft. A minimum of six through bolts shall be used to connect the coupling halves. The complete coupling assembly shall be dynamically balanced and match marked prior to shipment.

L. Balance
1. The combined rotating assembly shall be balanced to API 620 G 2.5.
2. All rotating parts shall operate smoothly without excessive vibration.
3. The vibration displacement (peak-to-peak) as measured at the top bearing of the motor shall not exceed that allowed by the Hydraulic Institute.

M. Pump Suction Barrel (Pump Cans) – fabrication
1. Prefabricated steel pipe suction barrels shall be provided as shown on the plan sheets. Suction barrels shall have internal straightening vanes and an inlet pipe splitter plate, as required by Hydraulic Institute's latest standards. Suction barrels shall be constructed of low carbon steel A53Gr B pipe and A36 steel or better. Mill test reports will be furnished, if requested. Suction barrels wall thickness and top flange thickness are shown below. **All suction barrels shall have the top flange shipped loose, with jack bolts to assist in leveling, for field leveling & welding.** Each top flange shall have a drilled and tapped bolt pattern that is equal to a standard 150# flange. These holes shall straddle centerline

of the can inlet. The top surface shall have a minimum surface finish of 125 RMS and include an o-ring groove with o-ring for sealing purposes. A gasket will not be acceptable. The barrel inlet shall be as shown on the plan sheets and shall be flanged with an AWWA C207-94 Class D steel flange. A vertical splitter plate shall be provided in the inlet pipe the entire length of the inlet. The bolting to attach the discharge head to the suction barrel will be 18-8 SST & furnished by the barrel manufacturer. The barrel length shall be as shown on the plan sheet and shall have a bottom cap plate in equal thickness to the top flange. Four (4) evenly spaced, 3" x 3" x 3/8" angles, with a 1" holes in each, shall be welded to the outside diameter on the barrel to assist the installing Contractor in mounting and aligning the suction barrel. The barrel shall be fitted with two (2) ¾" coupling to serve as a vent for the barrel.

The suction barrel shall be blasted and coated as described in the painting section. The coating must meet the requirements of the United States Environmental Protection Agency for potable water applications.

Suction Barrel Outside Diameter	**Top Flange Thickness***	**Barrel Wall Thickness***
16" – 24"	1-1/2"	.375"

***Min Values

2. Pump Suction Barrel (Pump Cans) – Installation

The top flange shall be leveled to within .002 of an inch per foot of diameter of the flange. The top flange shall be seal welded inside and outside to the top of the barrel. The installing Contractor must install the suction barrels so that the barrel pipe is plumb to within .015 inches per foot of length.

Stainless steel anchor bolting shall be provided by the contractor. The minimum

thickness of the concrete foundation which supports the barrel during installation is six (6) inches. The entire suction barrel is to be encased in concrete from the cap

plate to the bottom of the top flange.

Once the top flange is level, seal welded inside and outside, and the coating repaired, the Contractor shall form up and pour a housekeeping foundation around the top of the barrel. The top 2" shall have non-shrink epoxy grout poured to the underside of the top flange. The contractor shall run piping from the couplings out beyond the concrete pad and cap with a pet cock.

The contractor shall provide a millwright and a welder to level and weld the top flanges to the barrels. The Millwright "must" use a machinist level to verify the levelness. A carpenter's level will not be acceptable. The pump manufacturer shall verify the flange levelness prior to grouting and pump installation. After welding the coatings must be repaired per the coating manufacturer's recommendations.

2.05 ELECTRICAL EQUIPMENT

A. Electrical Equipment shall conform to Section 16010 – Basic Electrical Requirements.

B. Electric motors shall conform to Section 43 21 25.

2.06 EQUIPMENT APPURTENANCES

A. Pumping equipment shall be provided with all necessary equipment appurtenances to make the pumping units functional. Pumping appurtenances, fasteners, bolts, nuts, and washers shall be rated for corrosive service.

B. Metal equipment guards shall be provided on all equipment driven by open shafts.

1. Guards shall be designed to enclose the drive mechanism completely and be easily removable.

C. All pumps, motors, and appurtenances shall be factory painted prior to delivery to project site.

1. The interior surfaces of the suction barrel shall be shop-cleaned by grit blasting to near white, SSPC-SP10. The exterior surfaces of the suction barrel, bowl assembly, discharge head, and column pipe shall be shop-cleaned by grit blasting to near white, SSPC-SP10. The interior/exterior of the suction barrel and the exterior of the bowl assembly and column pipe shall receive two coats of TNEMEC Series 140 Pota-Pox Plus Self-Priming Polyamide Epoxy for a total dry thickness of 7-9 mils. Finish color to be Tank White. The exterior of the discharge head shall be shop-primed, only, with one (1) coat of Tnemec 140-1255 Beige Pota-Pox to 4 mils DFT. The Contractor will finish coat the discharge head in the field. Equipment nameplates shall be non-corrosive metal and shall be left unpainted so that the information stamped thereon remains clearly legible.
2. Equipment not painted shall be coated with grease or other suitable rust-resistant coating.

2.07 CONCRETE EQUIPMENT FOUNDATION

A. Concrete as specified in Section 03300 - Cast-In-Place Concrete shall be used for the equipment foundations.

B. Equipment foundations shall have a 28-day compressive strength of at least 4,000 psi.

C. Foundation bolts, as required, shall be furnished for proper positioning during or following the placement of the concrete as applicable.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation of the pump and motor shall be in accordance with American National Standard for Vertical Pumps for Nomenclature, Definitions, Application, and Operation Hydraulic Institute ANSI/HI 2.1-2.5-1994 and manufacturer's printed instructions. An authorized technical representative of the manufacturer shall visit each site to witness the following and to certify in writing that the equipment has been properly installed, aligned, lubricated, adjusted, and readied for operation.

1. Installation of the equipment. Manufacturer’s representatives shall be present at time of pump station skid assembly and installation.
2. Inspection, checking, and adjusting the equipment.
3. Startup and field testing for proper operation. On-site services of 2 days (min).
4. Performing field adjustment to ensure that the equipment installation and operation comply with requirements. On-site service of 1 day.

B. Field Acceptance Tests

1. After the official startup, the CONTRACTOR will be given a period of time in which to make adjustments to the pump equipment under the supervision of the pump manufacturer's technical representative.
2. Once the adjustments are made, the pumps will be operated for 30 calendar days with successive starts and stops.
3. Initial testing of equipment will be paid for by the CONTRACTOR. Subsequent tests will be paid for by the CONTRACTOR, if equipment fails to operate per technical specifications.

4. After the 30 calendar day period of successful pump station operations, the pumps will be accepted after successful performance of Field Testing as indicated in Section 3.2.
5. The Program Manager shall supply the Field Acceptance Test (FAT) forms.

C. The vertical turbine pump and appurtenances shall be disinfected to remove bacteriological contaminants prior to installation. Following installation and start-up, bacteriological clearance will be conducted in accordance with state standards.

3.02 FIELD TEST

A. Each pump and motor system shall be field tested after the 30-day acceptance period to demonstrate.
1. Satisfactory operation without noise and vibration at any operating head, including shutoff.
2. Indicated head, flow, and efficiency at the design point and at least two points above and two points below the design point to satisfactorily demonstrate the range of pump performance.
3. No undue attention is required for operation.

B. The following field testing shall be conducted.
1. Startup, check, and operate the pump system at max rpm. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of four pumping conditions defined by the ENGINEER.
2. Obtain concurrent readings of motor voltage, amperage, storage tank levels, pumping rate, and pump discharge head for at least five pumping conditions at each pump rotational speed, if variable speed, at 100-rpm increment or at max rpm if constant speed. Check each power lead to the motor for proper current balance as defined in MG1 of NEMA.
3. Obtain concurrent readings of pump injection head, storage tank levels, and injection rate for at least five injection conditions.
4. Determine motor bearing temperatures by contact-type thermometer. A run time until bearing temperatures have stabilized shall precede this test, unless insufficient liquid volume is available.
5. Electrical and instrumentation tests shall conform to the requirements of the sections under which that equipment is specified.

C. Field testing will be witnessed by the ENGINEER and OWNER. The CONTRACTOR shall provide 5-days advance notice of field testing.

D. After each pumping system has satisfied the requirements, the CONTRACTOR shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

3.03 FIELD PAINTING

A. Factory painted items requiring touch up work shall be cleaned completely, and shall be primed and top coated in accordance with Section 09 900, Paint and Coatings.

B. Exposed ferrous surfaces shall be painted with two coats of enamel paint conforming to FS TT-E-489, Class A.
1. Factory primed surfaces shall be solvent cleaned prior to painting.
2. Surfaces that have not been factory primed shall be prepared in accordance with the

enamel paint manufacturer's recommendations.

3.04 MANUFACTURER'S SERVICES

A. A manufacturer's qualified representative with experience in the installation, adjustment, and operation of the specified equipment shall supervise the installation, adjustment, and testing of the equipment.

B. Seven working days of supervisory service shall be provided by the manufacturer at no expense to the OWNER. Up to three days shall be provided at startup and calibration. Two days shall be provided at the 30-day test procedure. Two days shall be provided at the one-year anniversary of the approved 30-day test procedure.

3.05 DEMONSTRATION

A. The CONTRACTOR shall provide instructional training for a period of not less than 8 hours on the operation and maintenance of the equipment as specified in this section at each visit.

1. The training shall be provided by one or more competent Manufacturers Representatives.
2. The training shall be received by a representative of the OWNER.

3.06 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are included as part of this Specification.

1. Data Sheets:
   a. Pump
   b. Motor
   c. Controls
   d. Valves, appurtenances
   e. Meters
   f. Electrical components

END OF SECTION

PUMP DATA SHEET **VERTICAL TURBINE PUMPS**		
Project: _____		Pump Mfr.: _____
Owner: San Antonio Water System		Size & Type: _____
Service: _____		No. Stages: _____
Pump Name: _____		Serial No.: _____
Equip. Tag Number(s): _____		Model No.: _____
No. Pumps Required: 4	No. Motor Driven: 4	No. Turbine Driven: 4
Drive Type: ☒ Constant ☐ Adjustable	Pump Item No.: _____	Pump Item No.: _____
LIQUID	OPERATING CONDITIONS	SERVICE CONDITIONS
Name: **Water**	Rated Condition:	Temp (□F): Max **115** Min **10**
Pumping Temperature (□F):	Capacity (U.S. gpm): **1,850**	Rel. Hum (%): Max __ Min ___
Normal **70** Max **80** Min **50**	Total Dynamic Head (ft): **155**	Altitude (ft): +/- _____
Specific Gravity @ **70** □F: **1.0**	Bowl Efficiency (%): **78 (min)**	☐ Indoor ☐ Heated
Vapor Pressure (psia): **0.4**	NPSH Available (ft): **150**	☒ Outdoor ☒ Unheated
Viscosity (CP) @ **70** □F: **0.98**	Operating Range:	Area Classification: Unclassified
pH: **7.0**	Maximum Total Head (ft): **230**	Other: _____
Corrosion/Erosion/Abrasion Caused by: _____	Minimum Total Head (ft): _____	
Remarks: _____	Remarks: _____	Remarks: _____

PERFORMANCE REQUIREMENTS (manufacturer to supply missing data)

Proposal Curve No.: _____

Min. Continuous Flow (gpm): _____

NPSH Required (ft water): _____

Pump Speed (rpm): **1775**

Max. Head, Rated Imp. (ft): _____

3% Head Drop _____

Efficiency (%): _____

Max. Power, Rated Imp (BHP): _____

Suction Specific Speed: _____

Rated Power (BHP): _____

Factory Testing:

☒ Required ☐ Not Required

Remarks: _____

Equipment Tag Number(s): _____

PUMP CONSTRUCTION DETAILS (manufacturer to supply missing data)

Nozzles

	Size	Rating	Facing	Location
Suction				
Discharge				

Miscellaneous Connections

	Size	Location
Drain		
Vent		
Pres. Gauge		
Prelube		

Casing Mount:

☐ Vertical

☒ Vertical Barrel

Impeller Type:

☐ Open ☒ Closed

Impeller Diameter (in):

Rated _____ Max ____

Min _____

Bearings (Type/No.):

Bowl _____

Line Shaft _____

Pump Shaft _____

Max. Allowable Pressure (psig)

At 60 deg. F: _____

At Norm. Pump. Temp: _____

Bowl Size (in) _____

No. of Stages: _____

Mechanical Seal:

Type _____

Intermediate _____

Head Shaft: _____

Lubrication Type:

☐ Grease ☒ Oil

Pump Shaft Dia. (in) _____
Column Size (in): _____
Lineshaft Type: ☐ Open
☐ Closed
Lineshaft Size (in):_____
Hydro Test Pressure (psig): _____
Field Testing: ☐ Not required
☒ Required, functional and performance

Size/No. Rings _____
Manufacturer _____
Model _____
Manufacturer Code _____
Type_____
Size/No. Rings_____
Mechanical Seal:
Type_____
Manufacturer_____
Model_____
Manufacturer Code _____

☐ Pumped Liquid
Coupling:
Manufacturer_____
Type _____
Model _____
Driver Half Coupling Mounted by:
☐ Pump Mfr.
☐ Driver Mfr.
☐ Purchaser
Gland Type/Material: _____
Gland Plate Taps Required:
☐ Quench ☐ Flush
☐ Drain ☐ Vent

Remarks:_____

MATERIALS (manufacturer to supply missing data)

Bowl: Enamel Cast Iron, ASTM A48
Column: ASTM A53 Grade A Schedule 40
Impeller: Nickel Aluminum Bronze,, or 316 Stainless Steel
Impeller Wear Rings: Stainless Steel
Bowl Bearing: _____
Head Shaft Bearing: _____
Lineshaft Bearing:_____
Shaft: 416 Stainless Steel
Shaft Sleeve: 416 Stainless Steel
Discharge Head:
Type:_____
Material: _____

Remarks: _____

ADDITIONAL REQUIREMENTS
Provide Vortex breaking vane as required to assure rated performance and proper operation of pump.

INDUCTION MOTOR DATA SHEET

Project:_____

Owner:_____

Equipment Name:_____

Equipment Tag Number(s):_____

Type: Squirrel-cage induction meeting requirements of NEMA MG 1

Manufacturer: For multiple units of the same type of equipment, furnish motors and accessories of a single manufacturer

Hazardous Location: ☐ Furnish motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark

Motor Horsepower:_____	Guaranteed Minimum Efficiency at Full Load: percent
Voltage:_____	Guaranteed Minimum Power Factor at Full Load: percent
Phase:_____	Service Factor (@ rated max. amb. temp.): ☐ 1.0 ☒ 1.15
Frequency:_____	Enclosure Type: _____
Synchronous Speed:____ rpm	Mounting Type: ☐ Horizontal ☒ Vertical
☐ Multispeed, Two-Speed:	☐ Vertical Shaft: ☒ Solid ☐ Hollow
_____ / _____ rpm	☐ Vertical Thrust Capacity (lb): Up _____ Down _____
☐ Constant Horsepower	☐ Adjustable Speed Drive: See Section 16485, ADJUSTABLE
☐ Variable Torque	FREQUENCY, CONTROLLED SPEED, DRIVE SYSTEMS.
☐ Constant Torque	Operating Speed Range: _____ to _____% of Rated Speed

Winding: ☐ One ☐ Two

☒Thermal Protection: Two replaceable 120-ohm nickel stator RTD's per motor winding

☒Space Heater: 230 volts, single-phase, sized based on 120-volt supply

☒Oversize main terminal (conduit) box for motors

☒Terminal for connection of equipment grounding wire in each terminal box

Additional Motor Requirements: ☒ See Section 16405, AC INDUCTION MOTORS

Special Features:

Provide insertion well type 120-ohm nickel RTD for each motor bearing. RTD's for each bearing and six equally spaced in stator, all wired to a single terminal box.

SECTION 11 2950
PRESSURE RELIEF VALVES

PART 1 - GENERAL

1.01 DESCRIPTION:

The work covered under this item shall consist of furnishing all labor, supervision, tools, materials, equipment and incidentals required to completely install and put into operation a pressure relief valve, as specified herein and shown on the plans. The pressure reducing valve shall be a hydraulically operated, diaphragm actuated control valve that automatically opens to discharge flows and pressures to maintain system pressures within piping to designed limits. The arrangement shown on the plans is based upon the best information available to the Consultant at the time of design and is not intended to show exact dimensions to any specific equipment unless otherwise shown or specified. Therefore, it may be anticipated that the structural supports, foundations, and connected piping shown, in part or in whole, may have to be changed in order to accommodate the equipment furnished. No additional payment will be made for such changes. All necessary calculations and drawings for any related redesign shall be submitted to the Consultant for his approval prior to beginning the work.

1.2 REFERENCES:

1. American Society for Testing and Materials (ASTM).
2. ASTM A48 – Standard Specification for Gray Iron Castings.
3. ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
4. ASTM A436 – Standard Specification for Austenitic Gray Iron Casting.
5. ASTM A536 – Standard Specification for Ductile Iron Castings.
6. American National Standards Institute (ANSI)
7. ANSI B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings
8. NSF 61 – Drinking Water System Components

1.3 QUALITY ASSURANCE:

1. The valves shall be the product of a manufacturer regularly engaged in the manufacture of hydraulic valves having similar service and size and as listed on SAWS approved equipment and manufacturers list. The valves covered by the specifications are intended to be standard equipment that have proven ability.
2. Valves manufactured by others than those specified herein will not be considered for substitution. Any non-approved materials or equipment installed shall be removed by Contractor at no additional expense to Owner.
3. All equipment specified under this section shall be furnished by the pump station manufacturer. The manufacturer shall be responsible for the adequacy and compatibility of all unit components including but not limited to the valve, actuator, and valve control system. Any component of each complete unit not provided by the valve manufacture shall be designed, fabricated, tested, and installed by factory authorized representatives experienced in the design and manufacture of the equipment. This requirement, however, shall not be construed as relieving the Contractor of the overall responsibility for this portion of the work.
4. The main valves shall be certified as a complete drinking water valve according to NSF 61.

1.4 SUBMITTALS

A. The following information/documents shall be submitted to Engineer and Owner. Submittals must be approved by Engineer and Owner prior to ordering of materials or equipment:

1. Technical bulletins and brochures.
2. Certifications of compliance with these specifications.
3. Two printed or one electronic format (PDF) sets of certified drawings showing the principal dimensions, general construction, and material specification for each valve size and/or model.
4. Complete Operation and Maintenance Manual(s) shall be submitted to Engineer and Owner prior to final project walk through inspection.

1.5 REGULATORY AND SAFETY REQUIREMENTS

A. Contractor shall comply with all applicable federal, state, and local regulations.

B. Contractor shall comply with all applicable OSHA safety requirements.

C. Work shall be completed in accordance with the CoSA flood plain development permit and Storm Water Pollution Prevention Plan for the site, as applicable.

1.6 OPERATING INSTRUCTION/TRAINING:

A. A factory representative of all major component manufactures, who has complete knowledge of proper operation and maintenance, shall be provided for one day to instruct representatives of the Owner on proper operation and maintenance of those components. If there are difficulties in operation of the equipment during instruction sessions, additional sessions shall be provided at no cost to the Owner.

B. Prior to scheduling Owner training, Operation and Maintenance manual shall be submitted for review.

1.7 SHIPPING AND STORAGE:

A. All parts shall be properly protected so that no damage or deterioration will occur from time of shipment until installation is completed and the units and equipment are ready for operation.

B. Contractor shall properly store and protect all equipment and parts against any damage prior to installation. If damaged, Contractor shall be responsible for replacement of equipment and parts at Contractor's own expense.

C. The finished surfaces of all exposed flanges shall be protected by wooden flanges, strongly built and securely bolted thereto.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

1.8 WARRANTY:

The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Owner. Warranty shall be for a period of two years and begin on the Date of Final Acceptance.

1.9 PRODUCTS

A. PRESSURE RELIEF VALVES

1. Pressure Relief Valve Manufacturers: Valves furnished under this specification shall be manufactured by one of the following or approved equal:

Cla-Val

Bermad

2. Pressure Relief Valves shall be Model 50G-01 B,P,KC as manufactured by Cla-Val or an equivalent model manufactured by one of the other companies listed above.
3. Main Valve: The main valve shall be a hydraulically operated single diaphragm – actuated, globe or angle pattern. The valve shall consist of three major components: the body, with seat installed; the cover, with bearings installed; and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.
4. Control System: The normally closed pressure relief pilot control shall be a direct acting, adjustable, spring-loaded, normally open, diaphragm valve designed to maintain constant upstream pressure within close limits. An increase in lone pressure to a set point causes the pilot control to open the main valve to maintain steady line pressure and close gradually to prevent surges. A needle valve controls the closing speed of the main valve.
5. Material Specifications

   Valve sizes: 6" Full Port

   Main Valve Body and Cover: Ductile Iron (ASTM A-536)

   Main Valve Trim: 316 Stainless Steel

   Tubing and Fittings: 316 Stainless Steel

   Internal Trim (Closure and Seat): 316 Stainless Steel

   Control Accessories: 316 Stainless Steel

   Bolts and Nuts: 316 Stainless Steel

   Rubber Material: Buna "N"

   End Flange: ANSI B16.42, Class 150

   Min. Working Pressure Rating: 300 PSI

   Temperature Range: -40 to +180 Degrees F

   Coating: Fusion Bonded Epoxy

   Pressure Setting: 155 PSI (HGL = 1291-ft, 6-inch port), but shall be field adjustable as needed.

   Relief Pilot Range 20 to 200 PSI, shall be pre-set to open valve at 155 psi, and be field adjustable as needed.
6. Valve Options
   a) The valve must fail to a closed position.
   b) Valve and fittings shall be configured for exterior installation and freeze protected with heat trace cable and weatherproof insulation.
   c) Valve shall include a 4" diameter pressure gauge on both the suction and discharge sides of the valve.
   d) Limit switch assembly – one limit switch (including indicator rod) with weatherproof enclosure for open and closed position indication to SCADA.
   e) Valve Position Indicator.
   f) Closing and Opening Speed Control.

1.10 INSTALLATION

A. The pressure reducing valve shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings.

B. Installation and adjustment shall be checked and approved by a manufacturer's direct factory representative. After acceptance, the representative shall address a letter to the Owner outlining all installation and start up procedures. The letter shall include a statement that the valves are installed per the manufacturer's recommendations. The manufacturer or his qualified representative shall conduct training session for the Owner's personnel in the operation and maintenance of the valves.

C. The valve manufacturer shall provide a direct factory representative to calibrate the valve and verify operation during start up.

D. All pressure sensing piping, tubing for valve pilot systems shall be fully freeze protected, with heat trace cable and insulation. Insulation shall be properly sealed with tape to preclude exposure to atmosphere.

1.11 MEASUREMENT AND PAYMENT:

This specification will not be measured for payment. Any operations or construction items within this specification shall be considered subsidiary to the Work.

END OF SECTION

SECTION 13 2100
COMPOSITE ELEVATED WATER STORAGE TANK

PART 1 - GENERAL

1.01 SUMMARY

A. Work Included

This section includes the design, construction, testing, and commissioning of a Composite elevated tank and related work including foundations, painting, electrical, mechanical, and appurtenances in accordance with D107-16.

B. Related Documents

Drawings and the general provisions of this document, including General Conditions, Supplemental Conditions, Special Provisions and other Division 1 Sections apply to work in this section.

1.02 REFERENCES

The following Specifications, Codes and Standards are referenced in this section.

A. American Concrete Institute (ACI)

117- 90 Standard Tolerances for Concrete Construction and Materials

304-89 Guide for Measuring, Mixing, Transporting and Placing Concrete

305-91 Hot Weather Concreting

306-88 Cold Weather Concreting

318-95 Building Code Requirements for Structural Concrete

347-94 Guide to Formwork for Concrete

B. American National Standards Institute (ANSI)

B16.5Pipe Flanges and Flanged Fittings

C. American Petroleum Institute (API)

650 Welded Steel Tanks for Oil Storage

D. American Society for Testing Materials (ASTM)

A 123 Zinc Coatings on Iron and Steel Products

A 240 Stainless Steel Plate, Sheet and Strip for Pressure Vessels

A 285 Pressure Vessel Plates, Carbon Steel

A 774 Welded Stainless Steel Fittings

A 778 Welded Stainless Steel Tubular Products

E. American Water Works Association (AWWA)

D100-96 Welded Steel Tanks for Water Storage

D102-97 Coating Steel Water Storage Tanks

C652-92 Disinfection of Water Storage Facilities

F. Federal Aviation Administration (FAA)

70/7460-1H Obstruction Marking and Lighting

G. National Association of Corrosion Engineers (NACE) RP0178

H. National Fire Protection Association (NFPA)

NEC National Electric Code

780 Standard for the Installation of Lightning Protection Systems

I. Occupational Safety and Health Administration (OSHA)

29 CFR Part 1926 Safety and Health Regulations for Construction

1.03 SYSTEM DESCRIPTION

A. Composite Elevated Tank shall consist of the following:

1. Foundation
2. Reinforced concrete support structure
3. Welded steel water tank.
4. Interior piping, valves and fittings
5. Doors and hardware
6. Appurtenances, wiring, lights

B. The support structure shall extend vertically from the foundation as a circular concrete wall. A domed concrete slab shall be provided as structural support for the steel tank within the perimeter of the wall. A reinforced concrete ring beam shall be provided to connect the steel tank, concrete dome and concrete support wall. The elevated tank shall be in accordance with the shape, dimensions and details required by these specifications and drawings.

C. Operating Parameters

Capacity		2,500,000	Gallon (max)
Maximum operating range		45	ft
Minimum operating range		30	ft
Maximum overflow weir rate		9,000	gpm
Air vent capacity		10,000	cfm
Inlet pipe diameter		24	In (min)
Outlet pipe diameter		30	In (max)
Overflow pipe diameter		24	In (min)
Elevation	- overflow/top capacity level	1125.0	ft (MSL)
	- grade slab	935.0	ft (MSL)

D. General Design

1. Design Standards - The structural design of the elevated storage tank shall conform to the following design standards except as modified or clarified by this section.

Foundations and Support Structure	ACI 318
Steel Tank	AWWA D107

E. Design Loads

Design loads shall be in accordance with ASCE 7-02 for Category IV (essential facility) structure.

1. Dead load shall be the estimated weight of all permanent construction.
2. Water load shall be the weight of water when the tank is filled to overflow.

3. Roof live load in addition to snow load: none.

4. Roof snow load shall be the larger of 15 psf. or the snow load determined in accordance with ASCE 7. Ground snow load shall be determined from Figure 7-1 in ASCE 7.

5. Wind loads shall be in accordance with ASCE 7 for wind exposure category C, and basic wind speed of 90 mph. (see Figure 6-1 in ASCE 7)

6. Horizontal and vertical seismic loads shall be in accordance with ASCE 7, the contractor shall provide the following with his submittal:

   Site Class, Spectral response acceleration Ss, Spectral response acceleration S1.

F. Combination of Loads

The effect of combination of loads shall be considered in accordance with the following.

1. Load combinations required for strength design:

   1.4D + 1.6F + 1.6(L+S)

   1.2D + 1.2F + L + 0.5S + 1.6W

   1.2D + 1.2F + L + E

   0.9D + 1.6W

   0.9D + F + E

2. Load combinations required for allowable stress design:

   D + F + L + S

   D + F + L + W

   D + F + 0.7E

   D + W

   D + F + 0.7E

   D = Effect of dead load.

   F = Effect of water load.

   E = Effect of horizontal and vertical seismic load.

   L = Effect of interior or roof live load.

   S = Effect of roof snow load.

   W = Effect of wind load.

G. Foundation Design

The foundations shall be designed by the Contractor to safely support the structure based on the recommendations of the geotechnical report. Foundations shall be sized in accordance with AWWA D-107, Section 7, "Foundations".

1.04 SUBMITTALS

A. Proposal

Submit the following with the proposal:

1. Experience List - A completed contracts summary shall demonstrate minimum ten years' experience and list a minimum of ten Composite elevated tank structures of equal or greater capacity that have been in satisfactory operation for at least 5 years. These tanks shall be of the same design described in paragraph 1.03A. Provide the location, capacity, contact name and year completed.

2. Tank Drawing - A preliminary section view drawing of the tank proposed for this project. The drawing shall include sufficient detail to illustrate tank geometry, materials of construction, primary dimensions, support wall thickness and pour height, domed concrete slab thickness, the elevation of low and high water levels, interior wet, interior dry and exterior paint areas, and other information required to show compliance with the specification. If the proposed design does not comply with the specifications, the bid shall be rejected.

B. Construction Drawings

1. Provide elevation, plan and sectional view drawings of the foundation, support structure, tank and all appurtenant equipment and accessories. Show the location, dimensions, material specifications and finish requirements. The submission shall be sealed by professional engineer registered in the state in which tank construction is planned.
2. Foundation details shall include excavation, soil protection and backfill.
3. Reinforced concrete details shall include construction joints, openings and inserts. Reinforcement shall be clearly indicated on the structural drawings and identified by mark numbers that are used on the fabrication schedule. Location, spacing and splice dimensions shall be shown. Placement and fabrication details shall conform to ACI 318.
4. Steel tank details shall include weld joints and a layout showing all primary and secondary shop and field welds.

C. Construction Procedures

1. Provide design, detail drawings and procedures for the support structure forming system. Details shall include location of form and construction joints, rustications and ties. Procedures shall include form removal criteria and minimum elapsed time for adjacent concrete placement.
2. Provide shop and field weld procedures for all structural joints on the steel tank.

D. Design Data

1. Provide a table showing capacity of the tank in gallons at all levels in one foot increments.
2. Provide a summary of the design for the foundation, support structure, tank and other components. Include the design basis, loads and load combinations and results.

E. Product Data

1. Provide a separate concrete mix design for each specified concrete compressive strength indicated on the drawings.
2. Provide technical data and color samples of all coating products.
3. Provide manufacturers descriptive information for appurtenant equipment and accessories that are not detailed on the construction drawings.

F. Reports/Certification

1. Provide documentation of all tests, inspections and certifications required by this section.
2. Provide qualifications of all welders.

G. Operation/Maintenance

1. Provide operating instructions and maintenance procedures for the elevated tank and applicable appurtenant equipment, mechanical components and accessories.

1.05 QUALITY ASSURANCE

A. Qualification of Manufacturer

1. The work described in this section shall be performed by an experienced Contractor that has a minimum of ten years' experience in composite elevated tank design and construction. The manufacturer shall have designed, constructed and commissioned a minimum of ten composite elevated tanks (with structural concrete domes) of equal or greater capacity, all in satisfactory operation for at least 5 years. These tanks shall be of the same design described in paragraph 1.03A.

2. Acceptable manufacturers are: CB&I Constructors Inc.; Landmark Structures, Inc.; Caldwell Tanks, Inc. Other manufacturers may be considered only if they can demonstrate conformance to the above criteria. Request for qualification with supporting documentation identifying location, size, completion date, and contact names must be received in writing fourteen (14) days prior to bid date. The Owner shall be the sole and final judge as to the acceptability of a manufacturer's qualifications.

3. Elevated tank design, concrete support structure construction and steel tank construction shall not be subcontracted. These items shall be self performed by the Contractor.

4. The Contractor shall directly employ a full time professional engineer with a minimum five years' cumulative experience in the design and construction of Composite elevated tanks as described in paragraph 1.03A. The engineer shall be registered in accordance with 1.04B and shall be in responsible engineering charge of the work.

5. A qualified supervisor directly employed by the Contractor shall be on site at all times during construction of the foundation, support structure and steel tank.

6. Personnel safety equipment shall be provided in accordance with OSHA requirements and the manufacturers' documentation. A certified health and safety technician (CHST) will perform spot inspections of the field activities. The safety supervisor is to be a full-time employee of the tank manufacture

B. Regulatory Requirements

1. The specifications, codes and standards referenced in paragraph 1.02 shall govern the work with regard to materials, design, construction, inspection and testing to the extent specified.

2. The elevated tank shall be designed and constructed in compliance with applicable federal, AWWA, TCEQ, state and local regulations.

3. Personnel safety equipment shall be provided in accordance with OSHA requirements and manufacturers documentation.

1.06 DELIVERY, STORAGE & HANDLING

A. Handling and Shipping

1. The Contractor shall handle materials and fabricated components in a manner that will protect them from damage. Allow painted materials adequate cure time prior to stacking or shipping.

B. Storage and Protection

1. Protect delivered materials and equipment from damage. Store in well drained areas and provide blocking to minimize contact with the ground.

1.07 PROJECT CONDITIONS

A. Permits and Easements

1. Permits, licenses, and easements required for permanent structures, changes in existing facilities or advancement of the construction as specified, shall be secured and paid for by the CONTRACTOR prior to the start of construction. These include building permits, airspace authority approval, site access easements, highway crossing permits, etc.

2. Licenses or permits of a temporary nature required by specific trades shall be the responsibility of the Contractor.

B. Existing Conditions

1. A geotechnical investigation has been carried out at the site and a report has been incorporated within these specifications. The net allowable bearing pressure of shallow foundations and/or the allowable capacity of deep foundation elements have been defined in this report. The Contractor shall be responsible for securing any further geotechnical information required beyond that provided in this report.

C. Access

1. The Contractor shall provide access from public roads to the tank site unless otherwise specified.

D. Working Conditions

1. Safety and Health - The Contractor shall comply with safe working practices and all health and safety regulations of OSHA, state and local health regulatory agencies and Material Safety Data Sheets (MSDS). Provide protective and lifesaving equipment for persons working at the site.

2. Times for Work - Times for work shall comply with local, state and federal regulations and laws.

1.08 SEQUENCING AND SCHEDULING

A. Schedule

1. The Contractor shall provide a bar chart showing the anticipated schedule for design, submittals, site work and the major components of construction including foundation, support structure and steel tank. In addition, show tank painting, electrical installation and other significant activities. Update the schedule as required. Schedule shall be provided to the Owner and Engineer 7 days prior to the Pre-Construction Conference.

B. Notification

1. The Contractor shall provide written notification to Owner and Engineer of the intent to start work at least seven days prior to commencing each major phase of work.

C. Certifications

1. Provide certification from the engineer of record that the elevated tank has been designed in accordance with the requirements of the specification.

2. Provide certification that testing and inspection requirements of 3.07 have been performed and the results comply with the requirements of the specification.

1.09 GUARANTEES

A. The Contractor shall guarantee the structure, appurtenant equipment and accessories provided under this section against defective design, workmanship or materials for a period of two years from the date of substantial completion. If notified within this period, the Contractor shall repair any defects at no cost to the Owner. Defects caused by damaging service conditions are not covered.

B. All guarantees for materials, equipment and accessories provided under this section shall be obtained by the Contractor and submitted.

1.10 INSURANCE

In addition to any requirements specified in the General and/or Supplemental Conditions, the following requirements shall apply.

A General Liability

The Contractor shall maintain General Liability and Umbrella insurance with a minimum combined limit of $5,000,000 each occurrence and aggregate.

B Professional Liability

The Contractor shall maintain Professional Liability insurance with minimum limit of $2,000,000 each occurrence and aggregate.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Reinforced Concrete

1. Concrete materials and reinforcement shall comply with ACI 318, except as modified in this section.

B. Steel Tank

1. Steel tank components, including steel plates, sheets, structural shapes and filler metals shall be in accordance with AWWA D107, Section 5, “Steel Tank".

2.02 CONCRETE FOUNDATION

A. The concrete foundation shall be designed in accordance with ACI 318. Minimum specified compressive strength shall be 4000 psi at 28 days. The service load reinforcement tension stress shall not exceed 30,000 psi under dead plus water load unless flexural cracking is otherwise controlled in accordance with ACI 318.

2.03 CONCRETE SUPPORT STRUCTURE

The concrete support structure shall be designed in accordance with ACI 318. The specified compressive strength of concrete shall be as required by design, but not less than 4000 psi at 28 days. The maximum specified compressive strength of concrete for the wall and dome shall be 6000 and 5000 psi respectively. *Spec Note: Updated Concrete Maximum specified compressive strength per AWWA D107.*

A Support Wall

1. Support wall shall be reinforced concrete with a minimum thickness of 8 inches exclusive of any architectural relief. Wall thickness shall be provided such that the average compressive stress due to the weight of the structure and stored water is limited to 25% of specified compressive strength, but not greater than 1000 psi. A minimum total wall reinforcement of 0.15% vertically and 0.20% horizontally

shall be distributed approximately equally to each face. A minimum of 0.75% vertical reinforcement shall be provided in the top 6 ft. of the wall extending into the concrete ring beam. Minimum concrete cover for interior / exterior faces shall be 1 inch and 1-1/2 inches respectively.

B. Tank Floor

1. Tank floor shall be a reinforced concrete dome not less than 8 inches thick. The average compressive stress due to the weight of the structure and stored water shall not exceed 13% of the specified compressive strength, nor greater than 600 psi. Minimum total reinforcement in orthogonal directions shall be 0.40% distributed approximately equally to each face. Additional reinforcement shall be provided for stress caused by edge restraint effects. *Spec Note: Updated AWWA D107.*

C. Openings

1. The effects of openings in the wall shall be considered in the design. Not less than 60% of the interrupted reinforcement in each direction shall be placed each side of the opening. Reinforcement shall extend past the opening not less than half the transverse opening dimension.

2. Openings wider than 3 ft. 6 in. shall be subjected to a rigorous analysis taking into account the stress concentrations and diminished lateral support that exist in the vicinity of such openings. Each side of the opening shall be designed as a column in accordance with ACI 318.

3. Openings 8 ft. 0 in. or wider used for vehicle access shall be strengthened against vehicle impact and local buckling by means of an internal buttress located on each side of the opening. The buttress shall consist of a thickened, reinforced concrete wall section that is integrally formed and placed with the support wall. The buttress section shall be not less than 3 ft. 0 in. wide and 6 in. thicker than the nominal wall dimension.

2.04 CONCRETE SUPPORT STRUCTURE / STEEL TANK INTERFACE

A. Interface Region

1. The interface region includes those portions of the concrete support structure and steel tank affected by the transfer of forces from the tank cone and the tank floor to the concrete support wall. This includes a ring beam and connection details. The Contractor shall provide evidence that a thorough review of the interface region has been performed. Finite element and finite difference analyses are the required methods for examining such local stresses in detail.

2. The geometry of the interface shall provide for positive drainage and not allow either condensate or precipitation to accumulate at the top of the concrete wall or ring beam.

B. Ring Beam

1. The ring beam shall be reinforced concrete with a nominal width and height of at least two times the support wall thickness. Minimum radial and circumferential reinforcement shall be 0.25%. For direct tension, reinforcement shall be provided such that the average service load stress in tension reinforcement due to the weight of the structure and stored water does not exceed 12,750 psi.

2. Ring beam design shall consider unbalanced forces from the steel tank cone and concrete dome, load conditions varying with water level, eccentricity of loads resulting from design geometry, and allowance for variations due to construction imperfection and tolerance.

2.05 STEEL TANK

A. General

1. The steel tank shall be all welded construction and shall be designed in accordance with applicable sections of AWWA D107, Section 5, "Steel Tank." The required capacity and dimensions of the tank are noted on the drawings and in this section of the specifications. All exposed lap joints shall be fully seal welded on both sides. To ensure an aesthetically pleasing tank and minimize mold growth the design of the cone and shell plate(s) shall minimize the number and total length of visible weld seams (shop and field). A scaled plate layout sketch must be provided with the bid, or be cause for rejection, noting that the use of any cone or shell plate (excluding roof plates) with widths and/or lengths equal to or less than 72" x 20' for the cone and 72" x 30' for the shell is unacceptable.

B. Plate Thickness

1. All members shall be designed to safely withstand the maximum stress to which they may be subjected during erection and operation. The minimum thickness of any steel plate shall be 1/4 in.

C. Roof Support

1. All structural members supporting the roof of the steel tank shall be flat bar or sealed square tubular sections. I-beams or other sections with horizontal projections may be used if the nominal depth is 10 in. or greater. Support beams shall be seal welded to the underside of the roof plate along the entire length of the beam.

2. The roof of the steel tank shall be configured with a Conical shape with a slope ranging from 8:1 to 12:1. Or Domed with a radius between 0.8 and 1.2 times the tank diameter. The intersection of the vertical wall plate and the roof shall be configured with a 2-foot 6-inch high by 1-foot 6-inch wide transition knuckle.

D. Cone

1. For areas of the elevated tank where the water is supported by a steel cone, the Contractor shall submit evidence that the design is based on a finite element shell analysis. The analysis shall include the effects of material and geometric non-linearaties and residual stresses. The modeled imperfection shall not be less than 0.04vRT over a length of 4vRT, where R is the radius normal to the plate surface at the point of consideration, and T is the plate thickness. The design shall have a minimum factor of safety of 2.0 against buckling.

2. If the above analysis is not performed, the design shall be based on AWWA D107, Section 5, "Steel Tank" to determine the allowable compressive stress.

2.06 APPURTENANCES AND ACCESSORIES

A. General

1. Accessories shall comply with the minimum requirements of the Specifications, Codes and Standards listed in 1.02, current applicable safety regulations, and the operating requirements of the structure.

B. Ladder Access

1. Ladders shall be provided from the slab on grade inside the base of the support wall to the upper walkway platform located below the tank floor. The tank floor manhole shall be provided with ladder access from the upper platform. A ladder shall extend from the upper platform, through the access tube interior to the roof.

A ladder mounted on the access tube exterior shall be provided for access to the tank interior, extending from the roof manhole to the tank floor.

2. Ladders that terminate at platforms or landings shall extend a minimum of 48 in. beyond the platform elevations.

3. Ladders located in the concrete support structure and access tube interior shall be galvanized steel. Tank interior ladders shall be coated in accordance with the tank interior coating system.

4. Ladder side rails shall be a minimum 3/8 in. by 2 in. with a 16 in. clear spacing. Rungs shall be minimum 3/4 in. diameter, spaced at 12 in. centers and plug welded into holes drilled in the side rails. Tank interior ladders shall be provided with 1 in. diameter rungs and 1/2 in. x 2 in. side rails and shall be fully seal welded.

5. Ladder shall be secured to the adjacent structure by brackets located at intervals not exceeding 10 ft. Brackets shall be of sufficient length to provide a minimum distance of 7 in. from the center of rung to the nearest permanent object behind the ladder. Ladder brackets located on the access tube exterior shall be reinforced at the access tube shell so that potential ice damage is confined to the ladder and bracket and not the access tube shell.

C. Safe Climbing Device

1. High strength aluminum, rigid rail safe climbing devices shall be provided on all ladders. Rails shall be center mounted and extend from 3 ft. above the ladder bottom to the top of the ladder section. Mounting brackets, fasteners and splice bars shall be provided as required for a rigid installation.

2. Three trolleys with snap hooks shall be provided that are designed to be operated with the aluminum rail. A safety body harness with front and side rings shall be supplied for each trolley.

3. A caution sign shall be provided at the lowest point of access to the ladder requiring safe climbing devices. The sign shall read "CAUTION – Safety Equipment Required When Climbing Ladder ". The sign shall be secured to the wall.

D. Rest Seats

1. Aluminum swing out rest seats shall be provided as required on support wall ladders over 30 ft., at a maximum of 30 ft. intervals. Rest seats shall be operable without removing fall prevention equipment. Platforms may be provided in lieu of rest seats, provided all OSHA requirements and the requirements of 2.06.E., are met.

E. Platforms

1. A 4-ft. wide upper walkway platform shall be located at the top of the support wall to provide access from the support wall ladder to the roof access ladder located on the interior of the access tube. Platforms shall be provided with handrails, midrails and toe plates in accordance with OSHA requirements. Grating shall be used for the walking surface. All components shall be galvanized steel.

2. A fixed lanyard shall be provided at platforms to provide fall prevention.

F. Support Wall Doors

1. Personnel Door - Door frames shall be 16-gauge with concealed reinforcement at hardware locations. Expansion type anchors for existing openings shall be installed near the top, bottom and intermediate point of each jamb to rigidly secure

the frame. Doors shall be 1 3/4 in. thick insulated, reinforced, full, flush type with 18-gauge face sheets and concealed reinforcement at hardware locations. All edges shall be finished flush with watertight seams. Shop applied finish for the frame and door shall be baked on rust inhibitive primer. Field finish shall be compatible with the tank exterior. Standard hardware shall be stainless steel and include three 4 1/2 in. by 4 1/2 in. hinges, industrial duty closer and lockset.

a. Quantity and location of personnel door(s) shall be as shown on the drawings.

2. Overhead Vehicle Door - Door installation shall be on the interior face of the support wall. The door frame shall be a steel plate fabrication suitably detailed, fastened and reinforced to accept the door. Operation shall be manual with a chain hoist. The curtain shall be formed of 22-gauge steel interlocking slats with end locks and wind locks designed for a wind loading of 20 psf. Torsion springs shall be mounted on a solid torsion rod, which is attached to an exterior mounted spring tension adjustment wheel. A 24-gauge steel hood shall be provided with a weather seal to protect the assembly. Steel brackets shall be installed to the interior face of the wall with expansion anchors which enclose and support the counterbalance assembly with sealed bearings. Steel curtain guides are mounted to the brackets. The curtain, bottom bar, brackets, guides, hood, pipe and chain shall be galvanized. Provide with locking device. Roll-up doors with upper protective hood, chain hoist, are acceptable as an alternative to sectional doors.

3. Size, quantity and location of vehicle door(s) shall be as shown on the drawings.

G. Tank Openings

1. Floor - Provide 30 in. diameter manholes through the tank floor. The manhole shall be operable from a ladder located on the upper platform and shall be designed to withstand the pressure of the tank contents without leakage. The manhole assembly shall include a stainless steel handwheel operator and threaded components.

2. Roof - Provide two 30 in. diameter access hatches on the roof of the tank. One hatch shall allow egress from the access tube to the roof. The second hatch, located adjacent to the first, shall allow access to the interior of the tank via the ladder mounted on the exterior of the access tube. The opening shall have a minimum 4 in. curb. Provide aluminum covers with a 2 in. downturned edge, stainless steel hardware, hold open arm and a locking mechanism.

H. Access Tube

1. Provide a minimum 60 in. diameter centrally located access tube through the steel tank to provide access to the tank roof from the upper walkway platform. The access tube shall incorporate a 2 in. channel to collect condensation that may form on the interior surface. Or the area under the access tube shall be provided with a galvanized drip pan to prevent condensation from dripping onto the concrete floor slab below. The drip pan shall extend 3 in. beyond the drip line of the access tube. A 3/4" PVC drain pipe shall be provided. The drain shall exit the support wall 6" above grade.

I. Roof Railing

1. A 42 in. high roof handrail shall be provided to enclose all centrally located roof accessories. The roof railing shall be a minimum of 18 ft. in diameter.

J. Rigging Access

1. Provide a 24 in. x 36 in. opening at the top of the support wall. This opening shall be accessible from a platform and shall provide access to the exterior rigging rail located at the tank/support wall intersection. The access opening shall be provided with a hinged stainless steel cover or a removable vent in accordance with 2.06.M.2.
2. A minimum 24 in. diameter opening shall be provided on the tank roof to provide access to the tank interior rigging rails. This access opening may be combined with a pressure/vacuum relief mechanism.

K. Painters Rails

1. Provide permanently installed painter rails suitable for rolling trolleys at the interior of the tank at the wall/roof and access tube/roof connections. Provide an exterior painters rail at the base of the tank adjacent to the support structure.

L. Piping

1. Inlet/Outlet Pipe - Provide an inlet/outlet pipe that extends from the base of the support structure to the tank floor elevation. See Paragraph 1.03.C. and the drawings for the inlet/outlet pipe size and whether there are separate inlet and outlet pipes (in lieu of a single pipe for both functions) with each pipe's associated size. Provide a minimum of 6 in. high removable silt stop where the inlet/outlet pipe enters the tank. The bottom capacity level of the tank's operating range shall be at or above the elevation of the top of the silt stop. Pipe material within the support structure shall be Type 304L stainless steel.
   a. The inlet/outlet pipe(s) shall be designed to support all related static and dynamic loads. Suitable galvanized steel brackets, guides and hangers shall be provided on the support wall and tank floor at a minimum of 20 ft. intervals.
   b. The inlet/outlet pipe(s) shall be designed and constructed to accommodate any differential movement caused by settlement and by thermal expansion and contraction over the range of extreme temperature differences expected for the support wall and pipe. The required flexibility shall be provided by an expansion joint located near grade in the vertical section of pipe.
2. Overflow Pipe - Provide an overflow pipe of the size as shown in Paragraph 1.03.C. and as shown on the drawings. The top of the overflow shall be located within the tank at the overflow elevation. It shall run vertically beside the central access tube and extend through the tank floor, at which point it shall turn 90° and run under the tank floor to the support wall. This horizontal run shall be sloped to drain. The pipe shall then turn 90° and run vertically beside the support wall to grade. A base elbow shall direct the overflow through the support wall, where the pipe shall be terminated with a flap valve. Pipe material within the support structure shall be Type 304L stainless steel. If the top of overflow is located above top capacity level, the tank shall be designed for the additional capacity provided by the difference.
   a. The entrance to the overflow pipe shall be designed for the maximum inlet flow rate specified in 1.03.C. The design shall be based on the water level cresting within 6 in. above the overflow elevation. A conical weir shall be provided if the entrance capacity of the overflow pipe diameter is not adequate. A vortex prevention device shall be used.
   b. The overflow shall be designed to support all related static and dynamic loads. Suitable galvanized steel brackets, guides and hangers shall be provided on the

support wall and tank floor at intervals not exceeding 20 ft. The overflow and weir section within the tank shall be supported by the central access tube.

c. The overflow pipe shall be designed and constructed to accommodate any differential movement caused by settlement and by thermal expansion and contraction over the range of extreme temperature differences expected for the support wall and pipe. A layout with sufficient upper offset to accommodate differential movement is acceptable. If this method is not applicable, the required flexibility shall be provided by an expansion joint located near grade in the vertical section of pipe.

d. The overflow pipe shall penetrate the support wall approximately 2 ft. above grade and discharge through a flap valve onto a 8 ft. x 8 ft. concrete box with grated surface or of the dimensions as shown on the plans.

3. Stainless Steel Requirements - Pipe and fittings shall be Type 304L stainless steel fabricated from material meeting the requirements of ASTM A-240. Fabrication, inspection, testing, marking and certification of pipe and fittings shall be in accordance with ASTM A-778 and A-774 respectively. Backing flanges shall be in accordance with ASTM A285-C drilled to ANSI B16.5 Class 150. Pipe, fittings and welds shall be cleaned and passivated.

a. Pipe, fittings and flange thickness shall be in accordance with the manufacturers certified pressure rating for the applicable service pressures. For piping located within closed or valve sections, the design pressure rating shall be 150 psi minimum.

4. Tank Drain – A tank drain shall be provided to completely drain the tank contents if the inlet/outlet pipe does not intersect the low point of the tank. A 4-inch (minimum) drain pipe located at the low point of the tank floor shall be fitted with a threaded plug and tee handle or gate valve. (Plug or gate valve must be easily accessible from the tank ladder or platform.) Flexible stainless steel piping shall connect and drain to the overflow pipe.

M. Ventilation

1. Tank Ventilation - A tank vent shall be provided, located centrally on the tank roof above the maximum weir crest elevation. It shall consist of stainless steel or aluminum components, including a support frame, screened area and cap. The support shall be fastened to a flanged opening in the tank roof. The vent cap shall be provided with sufficient overhang to prevent the entrance of wind driven debris and precipitation. A minimum of 4 in. shall be provided between the roof surface and the vent cap.

a. The tank vent shall have an intake and relief capacity sized to prevent excessive pressure differential during the maximum flow rate of water, either entering or leaving the tank. The overflow pipe will not be considered as a vent. The maximum flow rate of water entering the tank is specified in 1.03.C. The maximum flow rate of water exiting the tank shall be calculated assuming a break in the inlet/outlet at grade when the tank is full. The vent shall be provided with an insect screen in accordance with TCEQ and AWWA regulations. Vent capacity shall be determined based on open area provided by the screen.

b. In addition to the tank vent, a pressure/vacuum relief mechanism shall be provided that will operate in the event of vent failure. The mechanism shall be designed to return automatically to its original position after operation. The

pressure/vacuum relief mechanism shall be located on the tank roof above the maximum weir crest elevation, and it may be incorporated in the vent assembly.

2. Support Structure Ventilation - Ventilation within the support structure shall comply with the governing building code requirements, based on occupancy classification. As a minimum, one louvered vent shall be provided at the top of the support wall. This vent shall be accessible from the upper platform and may also be designed to provide access to the exterior rigging rails located at the tank/support wall intersection. Vents shall be accessible from the interior ladders, platforms or floors provided. Vents shall be stainless steel or aluminum and provided with a removable insect screen.

N. Interior Floors

1. Slab on Grade - Provide a 6-inch thick, 3500 psi concrete floor slab in the base of the support structure. The slab shall be supported on compacted granular fill. Slab thickness and reinforcing shall be designed by licensed engineer. Slabs shall have a minimum thickness of 6 inches. Provide 1/2 in. expansion joint between floor slab and support wall and at pipes and supports that extend through the floor. Place cap strip and sealant over the expansion joint. The slab shall be sloped at 0.5% toward the truck door for drainage.

O. Level Monitoring

1. General – Provide four 3/4 in. couplings welded to the inlet/outlet pipe 5 ft. above grade. Each coupling shall be provided with a stainless steel nipple and an isolation gate valve. If separate inlet and outlet pipes are required, install couplings on the outlet pipe.

2. Pressure Gauge - Provide a pressure gauge in accordance with ASME .3B40.1 Grade 2A. The dial shall be 4 1/2 in. diameter with black markings on white background. Pressure range is 0-300 feet.

P. Lightning Protection

1. Provide a lightning protection system for the elevated tank structure and any roof-mounted equipment that may be damaged by lightning. Install the system in accordance with NFPA 780 with materials that meet UL96 and UL96a.

2. Minimum requirements include two 28 strand by 14 gauge copper conductors bonded to the steel tank 180 degrees apart. The conductors shall be fastened to the interior support wall at 3-foot minimum spacing, and shall terminate with buried 5/8-inch diameter by 8-foot long copper clad ground rods.

3. Lightning protection for obstruction lights shall consist of an air terminal mounted on the support and formed to fit around the fixture. The ½-inch diameter copper air terminal shall extend a minimum of 10 inches above the light fixture and shall connect to a copper conductor that terminates in a bonding plate secured to the tank roof.

2.07 ELECTRICAL AND LIGHTING

A. General

1. All work shall be performed and all materials shall be provided in accordance with National Electric Code and the governing electrical, safety and inspection codes, regulations and ordinances.

2. If a conflict exists between this paragraph (2.07) and the requirements shown in Division 16, Division 16 shall govern.

B. Materials

1. Interior Lights - Fixtures shall be enclosed and gasketed, 150-watt incandescent type with aluminum body, clear glass globe and guard. Aluminum mounting hardware and brackets shall be provided to suit the installation.

2. Exterior Door Lights - Fixtures shall be enclosed and gasketed, 100-watt high pressure sodium wall mount type with aluminum base housing, polycarbonate cover, prismatic refractor, internal reflector and low temperature ballast. Fixture shall be vandal resistant and provided with a photo control.

3. Conduit - Exposed interior conduit shall be galvanized rigid steel, supported by galvanized hardware. Exposed exterior conduit shall be PVC coated galvanized rigid steel, supported by PVC coated hardware with stainless steel fasteners. Underground conduit shall be Schedule 40 PVC. Minimum conduit size is 1-inch.

4. Fittings and Boxes - Boxes, fittings and device plates shall be galvanized. Exterior applications shall be waterproof.

5. Enclosures - Load centers, power distribution panels, lighting panels, and enclosed switches shall be in Type 1 or NEMA 1 enclosures for interior applications and Type 3R or NEMA 3R for exterior applications. Exterior enclosures shall be lockable. Finish shall be galvanized or baked on enamel.

6. Receptacles - Standard convenience outlets shall be heavy duty, 3-wire duplex receptacles.

C. Lighting and Receptacles

1. Interior Base - Incandescent light fixtures shall be provided 10 ft. above the slab on grade at equal intervals along the support wall that do not exceed 30 ft. These lights shall be controlled by a single switch located 5 feet±. above the slab on the interior wall, adjacent to the open side of the access door. One convenience outlet shall be provided adjacent to the power distribution panel.

2. Interior Ladder/Landing - Incandescent light fixtures shall be provided adjacent to the access ladder on the support wall at intervals that do not exceed 25 ft. The lower light shall be placed 10 ft. above the floor slab and may be accommodated by a base light if it is located within 5 ft. of the ladder. The upper ladder light shall be placed above the upper platform. A light shall be provided 8 ft. above any intermediate platforms. Lights shall be provided at the top and bottom of the interior access tube. These lights shall be controlled by a single switch located 5 feet ±. above the slab at the base of the ladder.

3. Provide convenience outlets at the upper landing elevation and at the top of the access tube interior.

4. Exterior Door - A high pressure sodium light fixture shall be provided above the personnel access door and on both sides of the vehicle door. These lights shall be controlled by a single switch located 5 feet ±. above the floor slab on the interior wall, adjacent to the open side of the access door.

D. Power Distribution

1. Provide a lighting panel mounted on the support wall interior. The panel shall be a 120/240 volt, single phase, with 12-circuit capacity and a 100A main circuit breaker.

E. Obstruction Lighting

1. Obstruction lighting shall be provided in accordance with FAA standards.

2. The obstruction light shall be centrally located on the roof of the tank above all permanent installations. It shall be a steady burning, dual fixture type with a lamp-out relay switch. The fixture shall be weather sealed, corrosion resistant, with aluminum base and housing. Red globes with 116-watt clear traffic signal lamps rated at 8,000-hour life shall be provided. A pilot light located near the electrical panel shall be provided to indicate when the primary bulb has failed.

F. Miscellaneous

1. Provide two 1 1/2 in. conduits for future exterior lighting that extend from the lighting panel through the slab on grade to a point 6 in. outside the foundation or support wall. Cap the ends.

2.08 STEEL TANK PAINTING

A. General

1. See Division 9 of these Specifications for steel tank painting. Galvanized surfaces are not included.

2.09 SOURCE QUALITY CONTROL

A. Tests

1. Review mill test certifications of all steel plate, structural components and reinforcement to ensure compliance with specification requirements.

B. Inspections

1. Provide inspection of shop fabricated components in accordance with AWWA D107.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Foundation Excavation

1. The foundation bearing surface and excavation shall be inspected by a representative of the geotechnical engineer prior to foundation construction. Verification of the applicable design and construction recommendations is required. The geotechnical engineer shall be retained by the Contractor. After verification of the foundation bearing surface, provide a 2 in. thick concrete working slab within the lower excavation limits. Grade the site to prevent runoff from entering the excavation.

B. Environmental Conditions

1. Prior to performing any work, verify the expected temperature, humidity and weather conditions are within the specified limitations for executing the work.

C. Elevated Tank Components

1. After completion of each major component and prior to proceeding with the next stage of construction, verify that tolerance inspections and material quality control tests conform to the requirements of paragraph 3.07.

D. Prior to tank foundation construction, clear and grub the site to the limits as shown on the drawings. After work is complete, the site shall be uniformly graded to drain away from foundation and site cleared of all materials, debris, dirt and other unsightly materials and leave premises in a good, clean and orderly condition.

3.02 REINFORCED CONCRETE CONSTRUCTION

A. Reinforcement

1. Fabrication, placement, development and splicing of reinforcement shall be in accordance with ACI 318 and ACI 117.

B. Formwork

1. Formwork design, installation and removal shall comply with the minimum requirements of ACI 318 and ACI 117 and with the applicable requirements of ACI 347. The concrete and formwork requirements of this section shall be strictly enforced to ensure concrete of the highest practicable structural and architectural standards.

2. Forming systems shall be designed with the provision of ties and bracing such that concrete components conform to the correct dimensions, shape, alignment and elevation without leakage of mortar. Formwork systems shall be designed to safely support all loading conditions. Embedded items shall be properly positioned and secured. Form surfaces shall be cleaned of foreign materials and coated with a release agent prior to placing reinforcement.

C. Concrete

Concrete proportioning, production, placement, quality control and curing procedures shall comply with ACI 318 and ACI 117. Concrete shall satisfy the specific structural, durability and architectural requirements of the completed components.

1. Proportioning - The proportions of materials for concrete shall be established to provide adequate workability and proper consistency to permit concrete to be worked readily into the forms and around reinforcement without excessive segregation or bleeding. Unless otherwise specified, concrete without high range water reducer shall be proportioned to produce concrete slumps at the point of placement between 2 and 4 in. If high range water reducer is used, concrete slump prior to addition shall be 3 to 4 in. The slump, after addition of high range water reducer, shall be a maximum of 9 in. Air shall be entrained to provide concrete with 4.5% to 7.5% air content.

2. Production - Concrete that arrives at the project with slump below that suitable for placing, may have water added within the limits of the maximum permissible water-cement ratio. Maximum slump shall not be exceeded. The water shall be incorporated by additional mixing equal to at least half of the total mixing time required. For concrete with site-administered high range water reducer, the preplasticized minimum slump requirement shall be attained as permissible by addition of water and mixing prior to the addition of the water reducer.

3. Placement - Prior to concrete placement, all snow, ice, water or other foreign material shall be removed from the spaces that the concrete will occupy. Concrete shall be deposited in its final position in accordance with ACI 318. Drop chutes or tremies shall be used in walls and columns to prevent free-fall of the concrete over 5 ft. and to allow the concrete to be placed through the cage of reinforcing steel. These shall be moved at short intervals to prevent stacking of concrete.

   All concrete shall be consolidated by vibration so that the concrete is thoroughly worked into the corners of forms and around the reinforcement and embedded items to eliminate all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall be the largest practical size that can be used in the work and they shall be operated by competent workmen.

D. Weather

1. Concrete shall not be placed during precipitation or extreme temperatures unless protection is provided.
2. During cold weather the recommendations of ACI 306 shall be followed.
3. During hot weather the recommendations of ACI 305 shall be followed.

3.03 FOUNDATION

A. Excavation

1. After verification of the foundation-bearing surface, provide a 2 in. thick concrete working slab within the lower excavation limits. Grade the site to prevent runoff from entering the excavation.

B. Concrete Construction

1. For shallow foundations, reinforcement placed adjacent to a concrete working slab shall have a 2 in. minimum cover, and shall be supported by precast concrete block, metal or plastic bar supports.
2. The sides of foundations shall be formed using any suitable system conforming to ACI 318. Earth cuts shall not be used as forms for vertical surfaces. Forms shall be provided on top sloping surfaces steeper than 2.5 horizontal to 1 vertical. Straight form panels may be used to form circular foundation shapes. The minimum design radius shall be maintained at all sections.

C. Finish

1. Formed surfaces shall have a smooth form finish when exposed and a rough form finish when not exposed.
2. Unformed surfaces shall have a troweled finish when exposed and floated finish when not exposed.

3.04 CONCRETE SUPPORT STRUCTURE

A. Concrete Construction

1. The concrete and formwork requirements of this section shall be strictly enforced to ensure concrete of the highest practicable structural and architectural standards.
2. Support wall reinforcement shall be installed with plastic supports. Maximum spacing of supports for welded wire fabric shall be 5 ft. centers, horizontal and vertically.

   Support wall concreting shall incorporate segmented placement procedures. Temporary vertical bulkheads shall divide the wall pour into segments corresponding to a single truckload of concrete. The bulkheads shall be located at rustications, braced rigid and tight to maintain vertical alignment under concrete load. Wall segment concrete shall be placed vertically and continuously to full form height from a single truck load of concrete. Vertical pour rate shall be a minimum of 15 feet per hour. Placement from multiple loads is not permitted. Temporary bulkheads shall not be removed until adjacent concrete is placed.
3. The support wall shall be constructed with a jump form process using form segments prefabricated to match the wall curvature. Concrete pour height shall be a minimum of 6 ft. and a maximum of 10 ft. Alternate pour heights are subject to approval by the Engineer. Form panels shall extend the full height of the pour using only vertical panel joints. Form system shall incorporate a positive means of control to maintain dimensional tolerances specified in 3.04.C. Wall forms shall

be adjusted for vertical plumb and circularity and secured using through wall form bolts prior to concrete placement. Panels shall be designed for lateral pressures associated with full height plastic concrete head, and support and bracing shall be provided for construction related impact loads and wind loads. Working platforms that allow safe access for inspection and concrete placement shall be provided. Form facing material shall be metal, or plywood faced with plastic or fiberglass.

4. The form system shall incorporate a uniform pattern of vertical and horizontal rustications to provide architectural relief to the exterior wall surface. All construction joints and panel joints shall be located in rustications. Vertical panel joints shall be sealed using closures which combine with the form pattern to prevent grout leakage and panel joint lines. The vertical and horizontal rustications shall be proportioned and combined to impart a symmetrical architectural pattern to the completed structure. Form ties shall be located in a uniform pattern. No architectural form treatment is required on the interior surface.

5. Wall forms shall not be disturbed or removed until the concrete has attained sufficient strength to prevent forming operations or environmental loads from causing surface damage or excessive stress. The minimum concrete strength shall be established by the Contractor, based on an analysis of stress at critical stages throughout the forming and concrete operations. Early age concrete testing shall be in accordance with ACI 228.1R-89. Pull Out testing in accordance with ASTM C 900-99, Maturity Method testing in accordance with ASTM C 1074-93, or field cured cylinders compressive strength tested in accordance with ASTM C 172 are the acceptable methods to determine early concrete strength. Support wall concreting operations shall occur a maximum of once per day. Multiple form movements and concrete placements within a day are not permitted.

6. The formwork system for the domed structural floor shall be designed to support all construction loads. Adequate shoring and bracing shall be provided to transfer loads without appreciable movements. Form surfaces shall be steel, plastic or fiberglass coated material. Shoring and forms for the structural dome slab shall remain in place until the concrete has gained sufficient strength to carry the floor weight without damaging deflections.

7. Concrete surfaces shall be protected in accordance with the recommendations of ACI 306 until the component attains 35% of the specified compressive strength. At this time, protection may be removed subject to the allowable temperature differential. A reasonable temperature differential shall be defined, based on component thickness and restraint conditions.

B. Finish

1. Provide a smooth form finish without rub for the interior and exterior support wall. Tie holes shall be plugged using grout on the interior and manufactured plugs on the exterior which match the color of the cured concrete as closely as possible. Provide a light sandblast to the exposed exterior concrete support wall surface.

2. Provide a smooth form finish without rub for the interior dome slab. The unformed surface shall have a floated finish.

C. Dimensional Tolerances

1. Support structure concrete construction shall conform to the following:

Variation in thickness:

wall -3.0% to +5.0%

dome -6.0% to +10%

Support wall variation from plumb:

in any 10 feet of height 1 inch

in any 50 feet of height 2 inch

maximum in total height 3 inches

Support wall diameter variation 0.4%

not to exceed 3 inches

Dome floor radius variation 1.0%

Level alignment variation:

from specified elevation 1 inch

from horizontal plane 1/2 inch

D. Mock-Up Panel

A mock up panel shall be constructed using the proposed form work, concrete and placement methods. Minimum size will be 4 ft wide by 6 ft high. This panel shall be agreed upon by the Contractor and Engineer as the reference standard with which to judge surface quality, appearance and uniformity of texture and color.

Review and acceptance of formed concrete surface must be made immediately upon form removal. The Contractor shall be responsible to inform the Engineer as to pour schedule. The Engineer shall not delay the Contractor by lack of attendance.

Concrete with surface defects exceeding limitations specified herein or not meeting the standard represented by the mock-up panel shall be repaired to meet that standard, or removed.

3.05 STEEL TANK

A. Welding

1. Welding procedures and general welding requirements shall be in accordance with AWWA D107, Section 9.5, "Welding".
2. No structural welding is permitted to any steel embedded in hardened concrete, unless the weld is at least 2 ft. from the embedment interface.
3. Grinding of weld contour shall approximate Condition "D" of NACE Standard RP0178.
4. Provide shop and field weld procedures for all structural joints on the steel tank and the name of the certified welding inspector (CWI) that will perform spot inspections of the shop and field welding process. The CWI is to be a full-time employee of the tank manufacturer.

B Fabrication

Layout, cutting, forming, edge preparation and workmanship for steel tank components and fabrications shall be in accordance with AWWA D107, Section 5.4, "Fabrication and Construction Requirements".

C. Tank Erection

Steel tank erection procedures and general requirements shall be in accordance with AWWA D107, Section 5.4, "Fabrication and Construction Requirements".

D. Tolerances

1. Steel tank tolerances shall be in accordance with the requirements of API 650, Section 5.5.
2. Steel cone shall be constructed to the following tolerance. The deviation from the theoretical conical surface shall not exceed 0.032 vRT, when measured in the radial direction over length 4vRT, where R is the radius normal to the plate surface at the point of consideration, and T is the plate thickness.

E. Grouting

1. The interface between the steel tank floor plate and the supporting structural concrete slab shall be constructed with a minimum 1 in. void. Subsequent to testing, the void shall be filled with a flowable grout mix.

3.06 TANK PAINTING

A. Surface Preparation

1. Surfaces to be painted shall be clean and free of harmful scale, rust, dirt, oil, grease, moisture or other foreign matter which might affect the coating. Surfaces shall be free from blisters, rough welds, sharp edges, pits, or other detrimental imperfections prior to painting. Slag, weld metal accumulation and splatters shall be removed by chipping and grinding.
2. Blast cleaning for all surfaces shall be by dry methods. Particle size of abrasive used in blast cleaning shall be selected to produce a surface profile in accordance with recommendations of the paint system manufacturer. Abrasive shall be new, washed, graded and free of contaminants that will interfere with adhesion of paint.
3. Caution shall be exercised so that existing coatings are not exposed to excessive abrasion from blast cleaning. Blast cleaned surfaces shall be clean prior to application of specified coatings.
4. The Contractor shall keep the area of the work in a clean condition and shall not permit blasting materials to accumulate to the degree that would constitute a nuisance or hazard.
5. See also Specification Section 09 900 for surface preparation.

B. Paint Application

1. Paint materials shall be delivered in original containers with seals unbroken and labels intact. The Contractor shall coordinate prime coat materials and finish coat materials so that they are from the same manufacturer.
2. All paint shall be thoroughly agitated prior to use and shall be kept agitated while using. All ready-mixed paint shall be applied as received from the manufacturer, without addition of any kind of a drier or thinner except as permitted by the manufacturer. Paint shall be applied according to manufacturer's recommendations.
3. Each coating shall be applied at the rate specified and in the manner specified by the manufacturer. Deficiencies in tested dry film thickness shall be corrected by application of additional coat(s) of paint.
4. Paint application shall not proceed when the temperature is below 50° F., during precipitation or fog, or if there is moisture on the surfaces to be painted. Exceptions to the temperature limit will be allowed in accordance with the manufacturer's printed literature.
6. Each coat of paint shall dry thoroughly as specified by the manufacturer prior to application of successive coats. Do not immerse coating until appropriate dry film

thickness has been obtained and finished coating system has been allowed to cure as recommended by the paint manufacturer.

7. All paint materials shall be evenly spread without runs, sags, skips or other faults. Finished surfaces shall be uniform in gloss, finish and color and shall be free from brush marks. All lines of demarcation between paints of different colors or shades shall be carefully drawn so as to be true and free from blurred edges.

8. See also Specification Section 09 900 for paint application.

3.07 FIELD QUALITY CONTROL

A. Concrete Testing and Inspection

1. The evaluation and acceptance of concrete shall be in accordance with Section 5.6 of ACI 318 and ACI 117, except as modified in this section.

2. Three cylinders shall be made from each sample required. A 7-day compressive strength test shall be used to supplement the 28 day tests.

3. Slump, air and compressive cylinder testing shall be performed by an independent laboratory. The Owner shall retain the independent laboratory and provide the Contractor with copies of all test results.

4. The support wall radius, plumb and thickness shall be verified for each concrete lift at 45 degree intervals. An inspection report certified by the tank designer shall be provided to the Owner at project completion.

B. Steel Tank Testing & Inspection

1. Inspection procedures for the steel tank shall be as required by AWWA D107, Section 9, "Inspection and Testing". Radiographic inspection of full penetration butt-welded joints shall be made by an independent inspection company retained by the Contractor.

2. Erection tolerance of the steel cone in the radial direction shall be measured. Provide field measurements at 30 degree intervals.

3. Weld joints of plate over the structural concrete floor shall be tested for leaks by vacuum box / soap solution testing, or equivalent method prior to grouting.

4. Provide the name of the certified welding inspector (CWI) that will perform spot inspections of the shop and field welding process. The CWI is to be a full-time employee of the tank manufacturer.

C. Tank Painting Inspection and Testing

1. Adequate illumination shall be provided while work is in progress, including explosion proof lights and electrical equipment. Temporary ladders and scaffolding shall conform to applicable safety requirements. They shall be erected to facilitate inspection and moved by the Contractor as required.

2. Inspection and testing shall generally be in accordance with AWWA D102 and in accordance with Section 09 9000 of these Specifications. The Contractor shall furnish to the Owner inspection devices in good working condition for measurement of dry film thickness of coatings. Contractor shall also furnish U.S. Department of Commerce, National Bureau of Standards certified thickness calibration plates to test the accuracy of dry film thickness measurement device.

3. The Contractor shall deliver to the Owner a nondestructive holiday detector to be used for inspecting the interior and exterior coatings. All holidays shall be marked,

repaired in accordance with the manufacturer's printed recommendations and retested. No holidays or other irregularities shall be permitted in the final coating.

4. A warranty inspection shall be conducted one year after acceptance of the tank. Defective work shall be repaired in accordance with AWWA D102.

3.08 CLEANING

A. Site

1. The project site shall be kept in a clean and safe condition at all times. The Contractor shall remove all construction equipment and debris at project completion.

B. Tank Disinfection

Water and sufficient pressure for flushing, cleaning, initial testing and disinfection shall be supplied by the Owner and paid for by the Owner. Disinfection shall be in accordance with AWWA C652. Contractor shall pay for all chemicals used in the disinfection process. The Owner shall pay for all bacteriological testing that proves the disinfection process was successful. The Contractor shall pay for all failed testing.

END OF SECTION

SECTION 13 4460
VALVE AND GATE OPERATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Item Includes:

1. Valve and Gate Operators.
2. Handwheel Operators.
3. Key Operated Valves.
4. Bench Stands.
5. Floor Stands.
6. Accessory Equipment and Floor Boxes.

1.02 REFERENCES

A. Aluminum Association (AA):

1. DAF-45 - Designation System for Aluminum Finishes.

1.03 SUBMITTALS

A. Shop Drawings: Include shop drawings for hydraulic gate lifts with shop drawings for gates as integrated units.

1.04 QUALITY ASSURANCE

A. Provide valve operators integral with valve or gate, except for valve operators utilizing T-wrenches or keys, and portable operators intended to operate more than 1 valve.

B. Provide similar operators by one manufacturer.

C. Provide gates and hand operating lifts by one manufacturer.

D. Provide hydraulic gate lifts by one manufacturer.

E. Provide hydraulic valve operators and motorized operators by one manufacture.

1.05 MAINTENANCE

A. Extra Materials:

1. Key Operated Valve Keys or Wrenches: Furnish a minimum 4 keys with 6-foot shafts and 3-foot pipe handles or wrenches with 6-foot shafts and 3-foot handles for operating key operated valves.

PART 2 - PRODUCTS

2.01 VALVE AND GATE OPERATORS

A. Stem Covers:

1. Aluminum pipe; threaded cap on top; bolted aluminum flange on bottom; 1 by 12 inch slots cut at 18 inches on center in front and back of pipe; capable of covering threaded portion of greased stems that project above operators when gates or valves are opened or closed.

B. Stem Cover Flanges, Pipes and Caps:

1. Etched and anodized to produce chemical finishes in accordance with AA C 22, medium matte finish, and AA A 41 clear anodic coating, or described in AA publication 45, after fabrication.

C. Gate Stem Covers: Concentric with stem.

D. Position Indicators:

1. 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.

E. Manual or Power Operator 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.

F. Operator Size: Capable of supporting weight of suspended shafting unless carried by bottom thrust bearings; shaft guides with wall mounting brackets.

G. Provisions for Alternate Operation: Where specified or indicated on Drawings, position and equip crank or handwheel operated geared valve operators or lifts for alternate operation with tripod mounted portable gate operators.

H. 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.

I. Open Direction Indicator: Cast arrow and legend indicating direction to rotate operator on handwheel, chain wheel rim, crank, or other prominent place.

J. Buried Operator Housing: Oil and watertight, specifically designed for buried service, factory packed with suitable grease, completely enclosed space between operator housing and valve body so that no moving parts are exposed to soil; provide operators with 2-inch square AWWA operating nut.

K. Worm Gear Operators: Provide gearing on worm gear operators 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.

L. Traveling Nut Operators: Capable of requiring maximum 100 foot-pounds of torque when operating valve under most adverse condition; limit stops on input shaft of manual operators for fully open and closed positions; non-moving vertical axis of operating nut when opening or closing valve.

2.02 HANDWHEEL OPERATORS

A. Manufacturers: One of the following:

1. Rodney Hunt Company.
2. Waterman Industries, Incorporated.

B. Mounting: Floor stand or bench stand. Unless otherwise indicated on the Drawings position operator 36 inches (nominal) above top of walkway surface.

C. Bearings above and below Finished Threaded Bronze Operating Nut: Ball or roller.

D. Wheel Diameter: Minimum 24-inch.

E. Indicator: Counterclockwise opening with arrow, and word OPEN cast on top of handwheel indicating direction for opening.

F. Pull to Operate: Maximum 40-pounds pull at most adverse design condition.

G. Stem Travel Limiting Device: Setscrew locked stop nuts above and below lift nut.

H. Grease Fittings: Suitable for lubrication of bearings.

2.03 HAND-CRANKED GEARED OPERATORS

A. Type: Single removable crank; fully enclosed.

B. Mounting: Floor and Bench Stand. Unless otherwise indicated on the Drawings position operator 36 inches (nominal) above top of walkway surface.

C. Operating Nut: When scheduled for portable operators.

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.
5. Indicator: Dial position type mounted on gear operator; 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:

1. Waterman industries, Inc.
2. Rodney Hunt Company, or approved equal.

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:

1. Rodney Hunt Company.
2. Waterman industries, Inc., or approved equal

B. Floor Stand Assemblies: Heavy-duty cast iron, suitable for mounting specified operator.

2.06 BENCH STANDS

A. Manufacturers: One of the following:

1. Rodney Hunt Company.
2. Waterman industries, Inc., or approved equal

B. Bench Stands: Handwheel operators or hand crank, geared operators conforming to hand-cranked geared operator 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 operator; 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 operator, adjustable in 2 directions.

F. Stem Stuffing Boxes: Cast iron, with adjustable gland and packing.

G. Fasteners and Anchor Bolts: 316 stainless steel.

H. Geared Valve Operators: 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.

I. Geared Valve Traveling Nut Operators: Acceptable only where specified or indicated on the Drawings.

J. Accessory Equipment for Valves and Gates Requiring Remote Operators:

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 or concrete pavement, or final grades 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 stainless steel anchor bolts

D. Install stem stuffing boxes where operating stems pass through intermediate concrete floor slabs.

3.02 SCHEDULES

A. Geared Operators: Provide geared operators for following valves:

1. Valves larger than 6 inches, nominal size, on liquid service.
2. Valves larger than 10 inches, nominal size, on gas and air service.
3. Plug valves 6 inches, nominal size, and larger.

B. Handwheel Operators: Provide hand wheel operators for valves mounted 6 feet or less above floors.

C. Chain Wheel Operators: Provide chain wheel operators for valves mounted more than 6 feet to centerline above floors.

D. Gate Operators: Provide geared operators with floor stand for all gates.

END OF SECTION

SECTION 15 0500
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

Item Includes: Basic design and performance requirements for mechanical equipment.

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA) Standards:

1. AGMA 2001-B88 - Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
2. AGMA 6000-A88 - Specification for Measurement of Linear Vibration on Gear Units.
3. AGMA 6010-E88 - Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives.
4. AGMA 6019-E89 - Standard for Gear motors using Spur, Helical, Herringbone, Straight Bevel or Spiral Bevel Gears.
5. AGMA 6025-C90 - Sound for enclosed Helical, Herringbone and Spiral Bevel Gear Drives.

B. American Society of Mechanical Engineers (ASME):

1. ASME PTC 8.2 - Performance Test Code for Centrifugal Pumps.
2. ANSI/ASME PTC 10 - Performance Test Code - Compressors and Exhausters.
3. ANSI/ASME PTC 17 - Performance Test Code – Reciprocating Internal-Combustion Engines.
4. ANSI/ASME PTC 11 - Performance Test Code - Measurement of Shaft Horsepower - Instruments and Apparatus.

C. American Bearing Manufacturers Association (ABMA) Standards:

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings**.**
2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. American Society for Testing and Materials (ASTM):

1. A 36 - Standard Specification for Structural Steel.
2. A 48 - Standard Specification for Gray Iron Castings.
3. A 526 - Standard Specification for Steel Sheet, Zinc Coated by the Hot Dip Process, Commercial Quality.
4. B-61 - Standard Specification for Steam or Valve Bronze Castings.
5. B 62 - Standard specification for Composition Bronze or Ounce Metal Castings.
6. E 527 - Standard Practice for Numbering Alloys and Metals (UNS).

E. American National Standards Institute/Hydraulic Institute Standards (ANSI/HI):

1. ANSI/HI 2.1-2.5 - Vertical Pumps - Nomenclature, Definitions, Application and Operation.
2. ANSI/HI 2.6 - Vertical Pump Tests.

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.

1.04 SYSTEM DESCRIPTION

A. General:

1. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions as specified in this Item.
2. Provide equipment and parts that are suitable for stresses which may occur during fabrication, transportation, erection, and operation.
3. Provide equipment that has not been in service prior to delivery, except as required by tests.
4. Like parts of duplicate units are to be interchangeable.
5. When two or more units of equipment for the same purpose are required, provide products of same manufacturer.
6. 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.
7. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings and contained in Laws and Regulations.

B. Material Requirements:

1. Materials: Suitable for superior corrosion resistance and for services under conditions normally encountered in similar installations.
2. Dissimilar Metals: Separate contacting surfaces with dielectric material.

C. Power Transmission Systems:

1. Power Transmission Equipment: 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 minimum service factor of 1.5.

D. Apply 1.5 service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.

E. Apply service factors higher than 1.5 when recommended for continuous 24 hour-per-day operation and shock loadings specified in AGMA 6010-E88, other applicable AGMA standards, or other applicable referenced standards.

F. When manufacturer recommends service factor greater than 1.5, manufacturer's recommendation takes precedence.

G. Vibration:

1. Resonant Frequency: Ensure there are no natural resonant torsional, radial, or axial 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.
2. Design, balance, and align equipment to meet the vibration criteria specified by manufacturer.

H. Equipment Mounting and Anchoring:

1. Mount equipment on cast iron or welded steel bases with structural steel support frames. Utilize continuous welds to seal seams and contact edges between steel members. Grind welds smooth.
2. Provide bases and supports with machined support pads, dowels for alignment or 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. Anchor equipment base to concrete pad. Determine number, size, type, and location of bolts, anchor bolts, or other connections.

I. Provide bolt sleeves for anchor bolts for heavy equipment. Adjust bolts to final location and fill sleeve with non-shrink grout.

J. Structural Design:

1. For equipment with operating weight of 400 pounds or more provide calculations for:
   a. Determination of operating weight and centroid of equipment.
   b. Operating weight is to be weight of unit plus weight of fluids or solids normally contained in unit during operation.
   c. Determination of seismic forces and overturning moments.
   d. Determination of shear and tension forces in connections.
   e. Design of connection details based on calculated shear and tension forces.

K. 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.
   d. 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.

B. Gear Reduction Units:

1. Engineering information per applicable AGMA standards.
2. Gear mesh frequencies.

C. Shop Drawings:

1. Drawings for Equipment:
   a. Drawings that include outline drawings, cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
      i. 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, baseplate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
      ii. Installation and check-out instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial start-up procedures.
      iii. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer based controls.
      iv. Recommended or normal operating parameters such as temperatures and pressures.
      v. Alarm and shutdown setpoints for all controls furnished.

D. Calculations:

1. Calculations and other information to substantiate base plates, supports, and anchor bolts meet minimum design strength requirements.
2. Bearing L10 life calculations in accordance with ABMA 9 or ABMA 11 calculation methods for drivers, pumps, gears, shafts, motors, and other drive line components with bearings.
3. Calculations and other information to substantiate operating rotational frequencies meet the requirements of this Item.
4. Torsional Analysis of Power Transmission Systems: When torsional analysis specified in the equipment Items, 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.
   c. Calculations for connection details demonstrating compliance with specified structural design requirements.
   d. Require Professional Engineer registered in state where Project is located to stamp and sign calculations.

E. Quality Control Submittals:

1. Source quality control reports and certified test data as specified in Item 15958.

2. Submit factory test reports before shipment.
3. Certified static and dynamic balancing reports for rotating equipment.
4. Field quality control reports and test data as specified in Item 15958.
5. Start-up Plan: Proposed plan for field testing equipment as specified in Item 01756.
6. Certificate of Proper Installation: As specified in Item 01756. Submit material test reports a specified in the equipment Items.

F. Operation and Maintenance Manuals:

1. As specified in Special Provisions.
2. Submit prior to training of OWNER's personnel.
3. Make available at project site complete copy of manuals for use by field personnel and ENGINEER during start-up and testing of equipment.
4. Include manufacturer and model number of every bearing; include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.
5. Include motor rotor bar pass frequencies.
6. Project Closeout Documents: As specified in Special Provisions.

1.06 QUALITY ASSURANCE

A. Qualifications: Equipment manufacturer and system component manufacturers to have a minimum of 5 years' experience in the design, manufacture, and assembly of the specified equipment and components with an established record of successful operation of such equipment and components.

B. References: Provide references from a minimum of three (3) installations currently operating the same model equipment in continuous service for a minimum of 2 years under similar operating conditions. Reference information shall include location, service, contact person, and contact telephone number.

C. Manufacturer's Field Service:

1. Furnish services of authorized representative specially trained in installation of equipment.

D. Visit project site and perform tasks necessary to certify installation.

E. Furnish Certificate of Proper Installation as specified in Item 01756.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. Equipment: Pack in boxes, crates, or otherwise protect from damage and moisture, dust, or dirt during shipment, handling, and storage.
2. Bearings: Separately pack or otherwise suitably protect during transport.
3. Spare Parts: Deliver in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

B. Storage:

1. Equipment Having Bearings: Store in enclosed facilities. Rotate units at least once per month or more often as recommended by the manufacture to protect rotating elements and bearings.
2. Gear Boxes: Oil filled or sprayed with rust preventive protective coating.
3. Protection:

C. Equipment: Protect equipment from deleterious exposure.

D. Painted Surfaces: Protect against impact, abrasion, discoloration, and other damage.

1.08 PROJECT CONDITIONS

A. Environmental Requirements:

1. Equipment for project is to be suitable for performance in domestic water treatment plant and water pump station environment and under following conditions:

B. Ambient Temperatures: 20 to 120 degrees Fahrenheit.

C. Relative Humidity: zero to 100 percent.

D. Site Elevation: About 935 feet above mean sea level.

1.09 SEQUENCING AND SCHEDULING

A. Equipment Anchoring: Obtain from equipment manufacturers' anchoring material and templates or setting drawings in time for anchors to be cast-inplace when concrete is placed.

B. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. General Start-up and Testing of Equipment:

1. Perform general start-up and testing procedures after operation and maintenance manuals for equipment have been received.

2. Conduct functional testing of mechanical or electrical systems when each system is substantially complete and after general start-up and testing procedures have been successfully completed.

3. Functional testing requirements as specified in technical specifications.

1.10 WARRANTY

A. Warranty: Warrant equipment free of defects in material and workmanship for 2 years from the date of acceptance or date of first beneficial use of the equipment by the OWNER; cover parts and labor.

B. Where warranty exceeds 2-years, manufacturer's warranty shall be issued in the OWNER's name.

1.11 MAINTENANCE

A. Special Tools:

B. When specified, provide special tools required for operation and maintenance. Mark or tag and list such tools in maintenance and operations instructions. Describe use of each tool.

C. Spare Belts:

1. When spare belts are specified, furnish one spare belt for every different type and size of belt-driven unit.

D. Where 2 or more belts are involved, furnish matched sets.

E. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.

F. Package in boxes labeled with identification of contents.

G. Spare Parts:

1. Assume responsibility until turned over to OWNER.

2. Store in enclosed facilities.

3. Furnish itemized list and match identification tag attached to every part.

4. List parts by generic title and identification number.
5. Furnish name, address, and telephone number of supplier and spare parts warehouse.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ferrous Materials:
   1. Steel for Members used in Fabrication of Assemblies: ASTM A 36.
   2. Iron Castings: ASTM A 48, tough, close-grained gray iron, free from blow-holes, flaws, and other imperfections.
   3. Galvanized Steel Sheet: ASTM A 526, minimum 0.0635-inch (16 gauge).
   4. Expanded Metal: ASTM A 36, 13 gauge, 1/2-inch flat pattern expanded metal.

B. Nonferrous Materials:
   1. Stainless Steel: Type 304 or 316 as specified; provide L grade where welding required.
   2. Bronze in Contact with Liquid: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C92200 or C92700 in accordance with ASTM B 62, B-61, B-505, or B-584, when not specified otherwise.
   3. Dielectric Materials for Separation of Dissimilar Metals:

C. EPDM, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators, washers, or other materials.
   1. Anchors Bolts: As specified in Item 05120; minimum 0.5-inch diameter.
   2. Non-Shrink Grout: As specified in Item 03600.

2.02 SHAFT COUPLINGS

A. General:
   1. Type and Ratings: Provide non-lubricated 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 Item 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 Item.

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:

C. T.B. Woods, Dura-Flex, L-Jaw C-Jaw or G-Jaw.

D. Lovejoy, S-Flex.
   1. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
   2. Manufacture flexible component of coupling from synthetic rubber, or urethane.
   3. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
   4. Do not allow metal-to-metal contact between driver and driven equipment.
   5. Examples of Loads Where Sudden Torque Reversals may be Expected:
      a. Reciprocating pumps, blowers, and compressors.

b. Conveyor belts.

c. Reversing equipment.

d. 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:

6. Manufacturers: One of the following:

a. Falk, WA Torus.

b. T.B. Woods, Dura-Flex, Sure-Flex or Form-Flex.

7. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.

8. Provide flexible connecting element of rubber and reinforcement fibers.

9 Connect stub shafts through collars or round flanges, firmly keyed to their shafts with EPDM cylinders held to individual flanges by through pins.

E. 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 mountings unless noted otherwise in the individual equipment specifications.

1. Specialized Couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer.

2.03 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:

1. Unless otherwise noted in the equipment Item, 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. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.

5. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open packing box.

B. Packing: When specified in the equipment Item of the specifications, provide the following type of packing:

1. Wastewater, Water, and Sludge Applications:

2. Asbestos free.

3. PTFE (Teflon) free.

4. Braided graphite.

C. Manufacturers: One of the following:

1. Chesterton, 1400.

2. John Crane Inc., equivalent product.

D. Drinking Water Service:

1. Approved by the Food and Drug Administration (FDA) or National Sanitation Foundation (NSF).
2. Asbestos free.
3. Material: Braided PTFE (Teflon).

E. Manufacturers: One of the following:
1. Chesterton, 1725.
2. John Crane, Inc., equivalent product.

F. Mechanical Seals: Provide seal types specified in the equipment Items and as specified herein.
1. Provide seal types meeting the following requirements:
2. Balanced hydraulically.
3. Spring: Stationary, out of pumping fluid, Hastelloy C; Type 316 stainless steel for split seals.
4. O-Ring: Viton 747.
5. Gland: Type 316L stainless steel.
6. Set Screws: Type 316L stainless steel.
7. Hard Face: Reaction bonded, Silicon Carbide.
8. Soft Face: Carbon, Union Carbide 658 RC.
9. Seal designed to withstand 125 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.

G. Cartridge Type Single Mechanical: Manufacturers: One of the following:
1. Chesterton, 155.
2. John Crane, 88 SRS Series.
3. Flex-A-Seal.

H. Cartridge Type Double Mechanical: Manufacturers: One of the following:
1. Chesterton, 225.
2. John Crane, 88 RS Series.
3. Flex-A-Seal

I. Split Face Single Mechanical: Manufacturers: One of the following:
1. Chesterton, 442 (single).
2. John Crane, 37 (single).
3. Flex-A-Seal.

2.04 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.

C. Use more severe service condition when such is recommended by unit's manufacturer.
1. Cast iron housing with gears running in oil.

2. Anti-friction bearings.
3. Thermal horsepower rating based on maximum horsepower rating of prime mover not actual load.

D. Manufactured in accordance with applicable AGMA standards.

E. Planetary gear units are not to be used.

2.05 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. Oil Lubrication Systems: Sized to safely absorb heat energy normally generated in bearings under maximum ambient temperature of 15 degree Fahrenheit above the specified maximum ambient temperature specified under article, Project Conditions; provide external cooler when required, air cooled if water cooling source not indicated on the Drawings. Equip with filler pipe and external level gauge.
2. Grease Lubricated Bearings, Except Those Specified to Be Factory Sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.

C. Lubrication Lines and Fittings:

1. Lines: Minimum 1/4-inch diameter stainless steel tubing.
2. Multiple Fitting Assemblies: Mount fittings together in easily accessible location.
3. Use standard hydraulic type grease supply fittings.

D. Manufacturers: One of the following:

1. Alenite
2. Zurk.

E. Ratings: Rated in accordance with ABMA 9 or ABMA 11 for L10 rating life of not less than 50,000 hours.

F. Higher ratings, when specified in other Items, supersede preceding requirement.

2.06 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; cover Type 3 insulation with moisture-proof protective jacket; and cover Type 5.

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.

5. Materials:
6. Sheet Metal: Carbon steel, 12-gauge minimum thickness, hot-dip galvanized after fabrication.
7. Fasteners: Type 304 stainless steel.

2.07 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.
B. Performance Requirements: Minimum spring deflection of 1 inch under static load and capable of limiting transmissibility to 10 percent maximum at design operating load.
C. Manufacturers: One of the following:
   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 A 536 Grade CS-45-12.
   2. Spring Steel: ASTM A 125.

2.08 WARNING SIGNS

Provide for equipment that starts automatically or remotely.

2.09 FABRICATION

A. Structural Steel Members: As specified in Item 05120.
B. Nameplates:
   1. Engraved or stamped on Type 304 stainless steel and fastened to equipment at factory in an accessible and visible location.
C. Indicate Following Information as Applicable:
   1. Manufacturer's name.
   2. Equipment model number and serial number.
   3. Maximum and Normal rotating speed.
   4. Horsepower.
   5. Rated capacity.
   6. Service class per applicable standards.
D. Nameplates for Pumps: Include:
   1. Rated total dynamic head in feet of fluid.
   2. Rated flow in gallons per minute.
   3. Impeller, gear, screw, diaphragm, or piston size.
E. Gear Reduction Units: Include:
   1. AGMA Class of service.
   2. Service factor.
   3. Input and output speeds.

4. Bolt Holes in Equipment Support Frames: Do not exceed bolt diameter by more than 25 percent, up to limiting maximum diameter oversize of 1/4 inch.

F. Shop Finishing:

1. Provide factory and field coating as specified in Item 09960. If not specified in Item 09960, provide coating as follows:

a. Bases and Support Frames in Contact with Concrete or Other Material: Paint contacting surfaces with minimum of 2 coats of zinc chromate primer before installation or grouting.

b. Shop Primer for Steel and Iron Surfaces, Unless Specified Otherwise:

G. Manufacturers: One of the following:

1. Ameron, Amercoat 185 Universal Primer.
2. Cook, 391-N-167 Barrier Coat.
3. Kop-Coat, Pug Primer.
4. Tnemec, 37-77 Chem-Prime.
5. Valspar, 13-R-28 Chromox Primer.

3. Coat machined, polished, and nonferrous surfaces that are not to be painted with rust-preventive compounds.

H. Manufacturers: One of the following:

1. Houghton, Rust Veto 344.
2. Rust-Oleum, R-9.

4. Coating for Ferrous Metal Surfaces, Except Stainless Steel: High solids polyamine epoxy.

5. Finish Painting of Motors: Shop finish paint with manufacturer's standard coating.

PART 3 - EXECUTION

3.01 EXAMINATION

Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners.

3.02 PREPARATION

A. 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.

B. Concrete Surfaces Designated to Receive Grout:

1. Give surfaces heavy sandblasting treatment.
2. Clean surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bonding of grout.

C. Concrete Saturation: Saturate concrete with water. Concrete surface shall be damp concrete at time grout is placed.

D. Field Measurements:

1. Prior to fabrication of equipment, take measurements for installation of equipment and verify dimensions indicated on the Drawings. Ensure equipment and ancillary appurtenances fit within available space.

3.03 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions and recommendations.

B. 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.

C. 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 Hydraulic Institute Standards, 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 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 Items.
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 to be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
4. Alignment and calculations to 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, tighten anchor bolts and grout between base and foundation. Allow minimum 48 hours for grout to harden. After grout hardens, remove jacking screws, fully tighten anchor bolts, and recheck alignment. Correct alignment as required.
6. After operational testing is complete, dowel motor or drivers and driven equipment. Comply with manufacturer's instructions.

D. Grouting Equipment Bases:

1. Comply with manufacturer's installation instructions for grouting spaces, type of grout, and tolerances for level and alignments, both vertical and horizontal.
2. Grout base when piping connections are complete and in alignment with no strain transmitted to equipment.
3. Grout base when equipment is leveled and in alignment.

4. Place grout, filling voids under equipment bases including recesses between anchor bolts and sleeves.
    a. Extend grout to edge of bases or bedplates and bevel at 45 degrees around units.
    b. Finish surfaces with slope that prevents ponding water within grouted areas.
5. Grout: As specified in Section 04 0511.

E. Special Techniques: Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

F. Tolerances:

1. Completed Equipment Installations: Comply with requirements for intended use and specified vibration and noise tolerances.

G. Warning Signs: Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.04 FIELD QUALITY CONTROL

A. Test equipment as specified and the individual equipment Section of the Specifications.

B. Perform operational testing as required.

3.05 MANUFACTURER'S REPRESENTATIVE

A. Field Check-out: Before field testing and start-up, provide services of factory trained field service representative to certify the equipment has been installed, aligned and checked in accordance with the manufacturer’s instructions and the Specifications.

B. Testing: Provide services of factory trained representative to observe and advise the CONTRACTOR during field quality control testing.

C. Training: When training is specified, provide services of factory trained representative to perform training as specified.

END OF SECTION

SECTION 15 0610
PIPE SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY

Item Includes: Supports for pipe, fittings, valves, and appurtenances.

1.02 REFERENCES

A. American National Standard Institute or Manufacturer's Standardization Society (ANSI/MSS):
   1. SP-58 - Standard for Pipe Hangers and Supports - Materials, Design, and Manufacture.
   2. SP-69 - Standard for Pipe Hangers and Supports - Selection and Application.

1.03 SUBMITTALS

Shop Drawings: Include schedule, indicating where supports will be installed, and drawings of pipe support system components.

PART 2 - PRODUCTS

2.01 PIPE SUPPORTS

A. Concrete Inserts for Pipes under 30 Inch Diameter: ANSI/MSS SP-69 Type 18. Minimum 1,140-pounds capacity with 5/8-inch diameter rod.
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 282.
      b. Carpenter and Paterson, Figure CP-109.
   2. Concrete Inserts for Pipe 30 Inch Diameter and Larger: Hot-dip galvanized steel body with ¾-inch diameter National Coarse zinc plated square nut, anchor insert to steel concrete reinforcement.
      a. Manufacturers: One of the following:
         i. Connection Specialties, Inc., Model 6MD350.

B. Hanger Rods: Sized to match suspended pipe hanger, or as indicated on the Drawings.
   1. Manufacturers: One of following:
      a. Grinnell, Figure 140.
      b. Bergen-Paterson, Part 5000.
      c. B-Line Systems, Inc., Figure B3205.

C. Hanger Rods, Continuously Threaded: Sized to match suspended pipe hanger, or as indicated on the Drawings.
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 146.
      b. Bergen-Paterson, Part BP-5006.

D. Eye Bolts: Welded and rated equal to full load capacity of rod.

E. Welded Eyebolt Rod:
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 278.
      b. Bergen-Paterson, Part 5004.

c. B-Line Systems, Inc., Figure B3210.

F. Adjustable Ring Hangers: ANSI/MSS SP 69 Type 7.
   1. Manufacturers: One of the following:
      a. Grinnell.
      b. B-Line Systems, Inc., Figure B3172.

G. Adjustable Clevis Hangers: ANSI/MSS PS 69, Type 1.
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 260.
      b. Bergen-Paterson, Part 6750.
      c. B-Line systems, Inc., Figure B3100 or B3105.

H. Brackets: ANSI/MSS SP-69 Type 32 with back plate; rated for 1,500 pounds.
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 195.
      b. B-Line Systems, Inc., Figure B3066.

I. Standard U-bolt: ANSI/MSS SP-69 Type 24.
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 137.
      b. Bergen-Paterson, Part 6502.

J. Riser Clamps: ANSI/MSS SP-69 Type 8.
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 261.
      b. Bergen-Paterson, Part 6302.
      c. B-Line Systems, Inc., Figure B3373.

K. Pipe Clamps: ANSI/MSS SP 69 Type 4.
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 212.
      b. Bergen-Paterson, Part 6100.
      c. B-Line Systems, Inc., Figure B3140.

L. Adjustable Offset Pipe Clamp:
   1 Manufacturers: One of the following:
      a. Grinnell, Figure 100.
      b. B-Line Systems, Inc., Figure B3149.

M. Offset Pipe Clamp:
   1. Manufacturers: One of the following:
      a. Grinnell, Figure 103.
      b. B-Line Systems, Inc., Figure B3148.

N. Floor Stand or Stanchion Saddles: ANSI/MSS SP-69 Type 37. Provided with U-bolt hold down yokes.
   1. Manufacturers: One of the following:

a. Grinnell, Figure 259.
b. Bergen-Paterson, Part 6652.
c. Piping Technology and Products, Figure 48.

O. Adjustable Pipe Saddle Supports
1. Manufacturers: One of the following:
a. Grinnell, Figure 264
b. Piping Technology and Products, Figure 46
c. Bergen Paterson, Part 6651.

P. Spring Supports:
1. Manufacturers: One of the following:
a. Bergen-Paterson, Part 3200.
b. Grinnell, Figure B-268.

Q. One Hole Pipe Clamps:
1. Manufacturers: One of the following:
a. Grinnell, Figure 126.
b. Carpenter and Paterson, Figure 237.

R. Welded Beam Attachment:
1. Manufacturers: One of the following:
a. Grinnell, Figure 66.
b. Bergen-Paterson, Part 1047.
c. B-Line Systems, Inc., Figure B3083.

S. Heavy Pipe Clamp:
1. Manufacturers: One of the following:
a. Grinnell, Figure 216.
b. Bergen-Paterson, Part 6101.

T. Anchor Bolts, Flush Shells, Powder Actuated Fasteners, and Concrete Anchors: As specified in Item 05120.

2.02 MATERIALS

A. Pipe Supports:
1. Stainless Steel (type 304 or 316): Use in all submerged locations, above water level but below top of wall inside water bearing structures and where specifically indicated on the Drawings.
2. Hot-dip Galvanized Steel: Use in areas other than above and where specifically indicated on the Drawings. Hot-dip galvanize pipe support after fabrication.
3. Plastic, Aluminum, FRP and Other Miscellaneous Materials: Use where specifically indicated on the Drawings.

B. Fasteners:
1. As specified in Item 05120.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Properly 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. Carefully determine locations of inserts. Anchor to formwork prior to placing concrete.

C. Use flush shells only where indicated on the Drawings.

D. Do not use anchors relying on deformation of lead alloy.

E. Do not use stud type powder actuated fasteners for securing metallic conduit or steel pipe larger than 1 inch to concrete, masonry, or wood.

F. Suspend pipe hangers from hanger rods. Secured with double nuts.

G. Install continuously threaded hanger rods only where indicated on the Drawings.

H. Use adjustable ring hangers; or adjustable clevis hangers, for 6 inch and smaller diameter pipe.

I. Use adjustable clevis hangers for pipe larger than 6 inches in diameter.

J. Secure pipes with galvanized double-nutted U-bolts or suspend pipes from hanger rods and hangers.

K. 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, 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.

L. Install Supports at:

1. Horizontal bends.
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.

M. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

N. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

O. Provide ductile iron elbows or tees supported from floors with base fittings where indicated on the Drawings.

P. Support base fittings with metal supports or where indicated on the Drawings, concrete piers.

Q. Size hanger rods, supports, clamps, anchors, brackets, and guides in accordance with ANSI/MSS SP 58 and SP 69.

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 Uniform Plumbing Code.

T. Supports, Clamps, Brackets, and Portions of Support System Bearing Against Copper Pipe: Copper plated, copper throughout, or isolated with EPDM or polyvinyl chloride tape.

U. Where pipe is insulated, install over-sized supports and hangers.

V. Install insulation shield in accordance with ANSI/MSS SP 69, Type 40. Shield shall be galvanized steel unless specified elsewhere.

W. Install riser clamps at floor penetrations and where indicated on the Drawings.

X. Paint or Coat support system components as specified in Item 09960.

END OF SECTION

SECTION 15 0750
MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Item Includes: Mechanical Identification including the following:

1. Pipe identification by color and legend.
2. Special Items.
3. Identification of equipment and components of systems with paint, brands, tags, and signboards.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit Following:

1. Product Data.
2. Samples.
3. Manufacturer's Installation Instructions.
4. Submit following as specified in Special Provisions:
   a. Operation and Maintenance Data.
   b. Warranty.

1.04 QUALITY ASSURANCE

Not used.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. One of the following:

1. Seton, Opti Code Pipe Markers. B.

   Lab Safety Supply.

2.02 MATERIALS

A. Pipe Markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; meet ANSI A13.1 requirements.

1. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5	½ inch
1.5 inches to 2 inches	¾ 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

2. Marker Colors:

Service	Lettering	Background
Flammables, chemicals, toxics	Black	Yellow
Water, nontocix solutions or low hazard liquids	White	Green
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO2 Halon)	White	Red

B. Paint: As specified in Section 09 9000.

C. Pipe Identification Tags: Aluminum or stainless steel with stamped-in 1/4 inch high identifying lettering.

D. Pipe Identification Tag Chains: Aluminum or stainless steel.

E. 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:

1. Brady Bradysnap-On B-915.
2. Seton Setmark.

2.03 SPECIAL ITEMS

A. In addition, special painting 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 that are identified on 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.

3.02 PREPARATION

A. Prepare and paint surfaces as specified in Section 09 9000.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 PIPING IDENTIFICATION

A. Identify exposed piping, 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 piping scheduled to be color coded completely with specified colors.
2. Paint segments of pipe specified to be unpainted with specified coding color long enough to accommodate required lettering and arrows.

C. Paint piping specified to be painted to match adjacent surfaces, unless otherwise directed.

D. 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.
3. Where scheduled, space 6-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.
4. Metal Tags:
    a. Where outside diameter of pipe or pipe covering is 5/8-inch or smaller, provide metal pipe identification tags instead of lettering.
    b. Fasten pipe identification tags to pipe with chain.
    c. Where tags are used, color code pipe as scheduled.

3.04 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 5-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.

3.05 PIPING COLOR CODE AND MARKER SCHEDULE

Service Fluid	Pipe Color	Maker Legend
Drain	Dark Grey	DRAIN
Process Water	Dark Blue	PROCESS WATER
Recycle Water	Silver/Grey	RECYCLE WATER
Sample	Green	FLUID BEING SAMPLED

Letters	Color of Pipe	Color of Bands	Color of Letters
Finished or Potable (cold)	Light Blue	None	Black
Service Water (lines downstream from backflow prevention unit	Dark Blue	White	Red
Sample	Dark Blue	Black	White
Drain	Dark Gray	None	White

END OF SECTION

SECTION 15 0900
BALL VALVES AND ELECTRIC ACTUATORS

PART 1 – GENERAL

1.01 SCOPE OF WORK:

A. The Contractor shall furnish all labor, materials, equipment and incidentals required to completely install and put into operation, ball valves and electric actuators as specified herein and shown on the plans.

B. The Contractor shall coordinate the ball valve installation with the electric actuators to insure a complete functional operation.

C. Unit Responsibility and Coordination:

The Contractor shall cause all equipment specified under this section to be furnished by the valve and actuator manufacturers who shall be responsible for the adequacy and compatibility of their respective components. Any component of each complete unit not provided by the manufacturers shall be designed, fabricated, testing, and installed by factory-authorized representatives experienced in the design and manufacture of the valve and actuator equipment. This requirement, however, shall not be construed as relieving the Contractor of the overall responsibility for this portion of the work.

1.02 REFERENCES:

A. San Antonio Water System (SAWS) latest specifications.

B. American Water Works Association (AWWA)

AWWA C507 – Ball Valves, 6 in. Through 48 in.

AWWA C542 – Electric Motor Actuators for Valves and Slide Gates

C. American Society for Testing and Materials (ASTM)

ASTM A126 – Gray Iron Castings for Valves, Flanges, and Pipe Fittings

ASTM A536 – Ductile Iron Castings.

D. American National Standards Institute (ANSI) ANSI C50.41 – Polyphase Induction Motors for Power Generating Stations

E. National Electrical Manufacturer's Association (NEMA) NEMA MG1 – Motors and Generators.

1.03 SUBMITTALS:

A. Required Submittals

Drawings & Data	Complete Assembly
	Materials List
	Foundation
	Installation
	Equipment
	Drawings
Valve	Name of the Manufacturer
	Type, Model, and Serial Number
	Design Pressure
	Shutoff pressure

	Weight
	Complete Performance Curves
	Shop Coatings
Motor	Name of Manufacturer
	Type and Model
	Type, Size, and Rating of Bearing & Lubrication
	Rated Size of Motor in Hp
	Temperature Rating
	Full Load Rotative Speed
	Weight
	Current at Full, ¾, and ½ Load
	Efficiency at Full, ¾, and ½ Load
	Power Factor of Full, ¾, and ½ Load
	Full Load Torque
	Operation and Maintenance Manuals with Connection Diagrams
	Motor Capabilities Curve
	Starting Current Curve
Product Data Section	Manufacturer's Technical Data
	Performance Charts and Curves
	Catalog Cuts
	Installation Instructions
	List of Parts with Price and Source
	List of Supplies with Price and Source
Drawings Section	Complete List of Equipment and Materials
	Writing and Schematic Diagrams
	System Layout
	Anchorage of Equipment and Appurtenances
	Curve plotting: "Area of Opening in Percent of Full Opening" vs "Plus Rotation in Degrees" and "Area of Opening in Percent of Full Opening" vs "Percent of Total Crosshead Travel"
Instruction Section	Operating Instructions
	Maintenance Procedures
	System Checking Methods
	Staff Training

Certification	Specify and Describe the Names and Qualifications of the Factory Trained Personnel
Operation and Maintenance Manuals	Specify and Describe the Six Complete Sets of the Manufacturer's Instructions
	System Layout Showing Piping, Valves, and Control, Approved Wiring and Control Diagrams
	Control Sequence Describing Startup, Operation, and Shutdown
	Operating and Maintenance Instructions for each piece of equipment, including lubrication instructions and troubleshooting guide

B. Shop Drawings:

1. Product data sheets for make and model.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Separate detailed point-to-point internal wiring diagram for each pump control valve.
4. Power and control wiring diagrams, including terminals and numbers.
5. Complete motor nameplate data.
6. Electric operator sizing calculations.

C. Quality Control Submittals:

1. The manufacturer shall submit product data and manufacturer's installation instruction under provisions of Section 01 3050.10 - Submittals.
2. Three complete sets of certified assembly drawings showing the principal dimensions, construction details, and material used for all parts of the valve.
3. The Drawings shall include a specific comprehensive elementary control schematic.
4. The Drawings shall include a separate detailed point-to-point internal wiring diagram for each electrically operated or controlled valve and the associated electrical control equipment to include all external device connections.
5. Five certified copies of the test record report including the Affidavit of Compliance.
6. Manufacturer's Certificate of Proper Installation.
7. Six copies of the Operation and Maintenance Manual.

1.04 QUALITY ASSURANCE

A. Acceptable ball valve manufacturers (no approved equals):

1. Henry Pratt Company
2. Val-Matic Valve & Manufacturing Corporation
3. DeZurik, Inc.
4. GA Industries, LLC
5. No approved equals

B. Acceptable actuator manufacturers (no approved equals):

1. EIM (Model 2000 MG)
2. Limitorque Flowserve

3. No approved equals

C. Ball Valves shall be built and tested in accordance with the latest version of AWWA C507 and Institute of Electrical and Electronics Engineers, Inc. Standard Test Procedures for Polyphase Induction Motors and Generators (IEEE 112) or latest standard. The following tests are required:

1. Hydrostatic Test
2. Shop seat-leakage Test
3. Performance Test
4. Proof-of-Design Test
5. Motor test per IEEE 112

1.05 SPARE PARTS AND TOOLS:

A. Furnish one set of special tools required for the proper servicing of all equipment supplied under these Specifications, packed in a suitable steel tool chest with a lock.

1.06 SHIPPING INSTRUCTIONS:

A. Comply with recommendations of AWWA C507.

B. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

C. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

D. The finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.

E. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

F. Storage and Protection: Take special care to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, preventing any deformation.

1.07 WARRANTY:

A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Owner. Warranty shall be for a period of two years and begin on the Date of Final Acceptance.

PART 2 – PRODUCTS

2.01 BALL VALVES:

A. The main valve shall have a full, circular, unobstructed waterway and be shaft in complete conformance with the latest requirements of AWWA C507.

B. Components

Body	Gray Iron - ASTM A126, class B, or ASTM A48, class 35 Ductile Iron - ASTM A395 or ASTM A536, grade 65-45-12 Cast Steel - ASTM A27, grade 65-35, or ASTM A216, grade WCB
Valve Ball	Gray Iron - A126, class B, or ASTM A48, class 35 Ductile Iron - ASTM A536, grade 65-45-12 Cast Steel - ASTM A27, grade 65-35, or ASTM A216, grade WCB

Valve Seats-Metal Body and Ball Seats	Metal Body and Ball Seats: Stainless Steel, Nickel- Chromium Alloy, Monel, or formed, molded, or extruded rubber materials Mating Seat Surfaces: Stainless Steel - 18-8 Stainless Steel (Castings conforming to ASTM A351, grade CF8 or grade CF8M; ASTM A743; or Wrought materials conforming to ASTM A276, type 304 or type 316 Nickel-Chromium Alloy - Nickel-chromium alloy; or weld overlay having a minimum total thickness of at least 1/4 in. including 1/8 in. thickness of base weld material of weld rod or wire having greater than 50% nickel overlaid with stainless steel rod or wire conforming to AWS A5.4, E308L, or AWS A5.9, ER308L, for gray-iron or ductile iron valves; or weld overlay with a minimum thickness of 1/8" Monel Rod conforming to AWS A5.11, ENicu-1, ENicu-2, or AWS A5.14, ERNicu-5 for use with gray-iron, ductile
Bearings	Bearings exposed to potable water shall be bronze, stainless steel, Monel, or nonmetallic materials
Shaft	Austenitic Stainless Steel - ASTM A276 Ferritic Stainless Steel - ASTM A276 Type 410 with metal sleeve of bronze, stainless steel, or Monel through support- bearing areas Chrome Molybdenum Steel - ASTM A322 Grade 4140 or ASTM A331 Grade 4140 with metal sleeve of bronze, stainless steel, or Monel through support-bearing areas Monel
Shaft Seals	V-type packing O-ring or nongraphited - lubricated compression packing
Manual Actuators	Gray Iron - ASTM A126, Class B or ASTM A48, Class 35 Ductile Iron - ASTM A536, Grade 65-45-12 Cast Steel - ASTM A27 or better
Power Actuators	Designed and manufactured in accordance with all applicable requirements of ANSI/AWWA C540

D. Valve bodies shall be marked with the size, design pressure, and manufacturer's name. Single-seated valves shall also be marked with an arrow showing the direction of flow.

E. Accessories

1. Equipment Identification Plate: 16 – gauge stainless steel with ¼-inch die stamped equipment tag securely mounted in a readily visible location with manufacturer name, model number, serial number, size of valve, design pressure, shutoff pressure, operational data, and date of manufacture.
2. Lifting Lugs: Equipment weighing over 100 pounds.
3. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, ½-inch minimum diameter.

F. Ball valves shall be rated for a design pressure of 250 psi.

G. Flanges shall conform to ANSI/ASME B16.1, Class 125.

H. All ball valves shall be coated with a fusion bonded epoxy coating, 25 mils minimum dry film thickness.

2.02 VALVE ACTUATOR

A. Design: Valve actuators shall conform to the latest requirements of AWWA C507 and C542. The valve actuator shall be designed to hold the valve in any intermediate position between full open without creeping or fluttering. Valve actuators shall be of the worm gear design.

B. Position Indicator: Valve actuators shall be equipped with a travel indicator for valve position between full open and full close. The indicator shall be raised, clearly showing the legends "Open" and "Closed" at the end of a 90-degree arc with a pointer to show the disc position (Closed at 0 degrees and Open at 90 degrees) and the arc graduated in increments of ten degrees.

C. Direction of Operation: Clockwise direction shall close the valve and counter-clockwise direction shall open the valve. The valve actuator shall be located on the side of the valve, suitable for vault service or above ground service.

2.03 ELECTRIC MOTOR ACTUATOR (AC REVERSING CONTROL TYPE)

A. General:

1. Comply with AWWA C542.
2. Size to 1-1/2 times required operating torque starting with valve wide open at maximum port velocity and ending with a differential equal to the specified maximum shutoff pressure. Motor stall torque not to exceed torque capacity of valve.
3. Stem protection for rising stem valves.
4. Complete with motor, gearing, handwheel, limit and torque switches, lubricants, space heaters, wiring, and terminals.
5. Self-contained unit with cast iron weatherproof housing.
6. Integrally assembled on valve by valve manufacturer.

B. Open-Close Service:

1. Size motors for two complete OPEN-CLOSE-OPEN cycles that occur in immediate succession without overheating at full differential pressure.

C. Actuator Power Supply:

1. 208-volt, three-phase unless otherwise indicated.
2. Control power transformer, 120-volt secondary.
3. Remotely located, externally operable power disconnect switch.

D. Motors:

1. Totally enclosed, high torque.
2. In accordance with NEMA standards.
3. Operate at any voltage within 10 percent above or below rated voltage.
4. Permanently lubricated motor bearing.

E. Gearing:

1. Hardened steel spur or helical gears.
2. Alloy bronze or hardened steel worm gear.
3. Designed for 100 percent overload.

4. Hardened steel gears not less than 350 Brinell.
5. Sealed against entrance of foreign matter.
6. Self-locking so that actuation of a torque switch by a torque overload condition will not allow the operator to restart until the torque overload is eliminated.
7. Planetary or cycloidal gearing; aluminum, mild steel, or nonmetallic gearing will not be acceptable.
8. Contain continually energized space heaters rated for 230 volts and connected to 120 volts.

F. Handwheel Mechanism:
1. Prevent handwheel rotation during motor operation and prevent effect of motor rotation during handwheel operation.
2. Geared so that force required to operate does not exceed 80 pounds.

G. Torque Switches:
1. Provide for torque and thrust loads in both opening and closing directions.
2. Provide with micrometer adjustment and reference setting indicator.
3. Adjustment with approximately 40 percent torque setting variation.
4. Rated for not less than 6 amperes at 120 volts ac.

H. Limit Switches:
1. The design of each multi-turn electric operator shall be such that it is readily field adaptable for four limit switch assemblies.
2. Each switch assembly shall consist of two tandem 2-pole switches.
3. Each switch assembly shall be operated by the driving mechanism and shall be independently adjustable to trip at any point between the fully open and fully closed valve position.
4. All switches shall have silver contacts with an inductive contact rating of not less than 6 amperes at 120 volts ac, and 3 amperes at 240 volts ac.
5. Limit switches shall be furnished as indicated in valve and pump control schematics in the Plans.
6. Housed in actuator control enclosure.

I. Control Features: As specified in Division 17.

J. Valve Control Cabinet:
1. Remote to valve actuator.
2. Provide complete with open and close three-phase reversing motor starter contactors, open and closed indicating lights, open and close pushbutton switches, “HAND-OFFAUTO” selector switch, three-phase circuit breaker, motor overload protector, control power transformer, wiring and terminals, as indicated on the Contract Drawings.
3. Enclosure:
   a. As defined in NEMA 250, Type 4.
   b. Contain continually energized space heaters rated for 230-volts and connected to 120 volts.
   c. Oversized to permit adequate and convenient clearance to all internally mounted devices.

4. Selector Switch, Pushbuttons, and Indicator Lights:

a. Heavy duty, oiltight/watertight construction for outdoor use with NEMA A600 modular contact blocks.

b. Four-stage, three-position maintenance contact selector switch.

c. Momentary spring return, nonilluminated, recessed type, pushbuttons.

d. Push-to-test indicating lights, both lamps shall illuminate in intermediate valve position.

e. Mount devices on interior swing panel.

5. Terminals:

a. Provided in motor starter enclosure for all external control connections.

b. Provide sufficient terminals so that no more than two conductors are connected to a single terminal.

c. Provide permanent designations which agree with wiring diagrams.

d. Heavy duty, phenolic strap-screw type, 300-volt, 30-amp rating.

6. Wiring:

a. Flame retardant switchboard type.

b. Minimum No. 14 AWG.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Valves and actuators shall be installed in accordance with instructions of the manufacturer and as shown on the plans.

B. Installation and adjustment shall be checked and approved by a manufacturer's direct factory representative. After acceptance, the representative shall address a letter to the Consultant outlining all installation and start up procedures. The letter shall include a statement that the valves are installed per the manufacturer's recommendations. The manufacturer or his qualified representative shall conduct training session for the Owner's personnel in the operation and maintenance of the valves.

C. Ball valves and actuators shall be field tested and all deficiencies shall be corrected.

END OF SECTION

SECTION 15 1140
CHECK VALVES

PART 1 - GENERAL

1.01 SUMMARY

Section Includes: Check valves.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. A-48 - Specification for Gray Iron Castings.
2. A 126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. A 276 - Specification for Stainless Steel Bars and Shapes.
4. B 582 - Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet and Strip.
5. B 584 - Specification for Copper Alloy Sand Castings for General Applications.

B. American Water Works Association (AWWA):

1. C 508 - Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch NPS.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Check Valves: When not otherwise specified or indicated on the Drawings, provide check valves suitable for service as follows:
   a. In either horizontal or vertical position.
   b. Under pressures equal and less than 250 pounds per square inch gauge.
   c. Certified to NSF/ANSI 61.

PART 2 - PRODUCTS

2.01 PUMP STATION CHECK VALVES

A. Manufacturers: One of the following:

1. Val-Matic Valve and Manufacturing Corp., Surgebuster, Series 7200.
2. Henry Pratt Company, RD-Series.
3. GA Industries, LLC., Slaminator, Figure SB200D.

B. Valve Design: 2-piece construction, bolted at the center, with disc at an angle of 55 angular degrees, metal seated, full body type.

1. Minimum Cross-sectional Area Throughout Valve Body: Equal to cross sectional area of the pipe connected to the valve at the inlet and outlet, and gradually increasing to an area 40 percent greater at the valve seat.
2. A position indicator shall be supplied to indicate disc position. C.

   Ends: Flanged, ANSI B 16.1 Class 125 drilling pattern.
3. Flanged inspection ports shall be provided upstream and downstream of the valve disc for inspection or use with optional dashpots.
4. The leakage rate shall not exceed one-half of the rate allowed by AWWA Standard C508 or 15 milliliters per hour per inch of valve diameter.

C. Materials:

1. Body: ASTM A536 Grade 65-45-12 ductile iron, or ASTM A 48, Class 30 Cast Iron.
2. Disc: Viton ASTM D2000-HK
3. Seat Ring and Disc Ring: Bronze, ASTM B 584, Alloy C 92200, Alloy C 83600, Alloy C 94700, or Alloy C 93700.
4. Pivot Pins: ASTM B505 aluminum bronze.
5. Bushings: ASTM B505 Alloy C95400 aluminum bronze.

PART 3 - EXECUTION

3.01 INSTALLATION

Per Manufacturer's Instructions.

3.02 ADJUSTING

Per Manufacturer's Instructions.

END OF SECTION

SECTION 15 1520

ALTITUDE CONTROL VALVE

PART I – GENERAL

1.01 SCOPE OF WORK:

A. Provide a high capacity, three-way control, bi-directional capable, solenoid shut-off valve. Furnish all materials, equipment, and labor and incidentals necessary to provide, install and put into operation one solenoid control valve as specified herein and shown on the plans.

1.02 REFERENCES:

A. American Society for Testing and Materials (ASTM).

B. ASTM A48 Gray Iron Castings.

C. ASTM A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings

D. ASTM A436 Austenitic Gray Iron Casting.

E. ASTM A536 Ductile Iron Casings.

1.03 SYSTEM DESCRIPTION:

A. The arrangement shown on the plans is based upon the best information available to the Consultant at the time of design and is not intended to show exact dimensions to any specific equipment unless otherwise shown or specified. Therefore, it may be anticipated that the structural supports, foundations, and connected piping shown, in part or in whole, may have to be changed in order to accommodate the equipment furnished. No additional payment will be made for such changes. All necessary calculations and drawings for any related redesign shall be submitted to the Consultant for his approval prior to beginning the work.

1.04 QUALITY ASSURANCE:

A. The valve shall be the product of a manufacturer regularly engaged in the manufacture of hydraulic valves having similar service and size. The valves covered by the specifications are intended to be standard equipment that has proven ability and shall be new, free from defects or contamination.

B. All other valves will be considered a substitution, and will be required to submit a substitution form. The Consultant shall be the sole judge of the acceptability of any substitution requested. If the substitution request is found to be unacceptable by the Consultant then the CONTRACTOR shall provide the listed equipment at no additional expense to the Owner. The CONTRACTOR shall be responsible for any delays as a result of a substitution request. The listing above does not imply that the manufacturer's standard product is acceptable. The successful manufacturer will be required to conform to all specifications.

C. Unit Responsibility and Coordination:

The CONTRACTOR shall cause all equipment specified under this section to be furnished by the valve manufacturer who shall be responsible for the adequacy and compatibility of all unit components including but not limited to the valve, actuator and extension stems. Any component of each complete unit not provide by the valve manufacturer shall be designed, fabricated, tested, and installed by factory authorized representatives experienced in the design and manufacture of the equipment. This requirement, however, shall not be construed as relieving the CONTRACTOR of the overall responsibility for this portion of the work.

1.05 SUBMITTALS:

A. Provide the following in conformance with applicable requirements contained in Section 01 3050.10 – Submittals. Shop drawings shall be complete with bill-of-materials showing kind and class of materials and catalog and engineering data showing compliance with the specified requirements.

B. Submittals required after award of contract and prior to shipping:

1. Technical bulletins and brochures.
2. Certification of compliance with specifications.

C. Submittals required prior to final walk through:

1. Operation and Maintenance Manual.

1.06 SPARE PARTS AND TOOLS:

A. A spare speed controller and a spare transmitter shall be furnished and delivered to the Owner as spare parts.

1.07 OPERATING INSTRUCTIONS:

A. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided for one day to instruct representatives of the Owner on proper operation and maintenance. If there are difficulties in operation of the equipment during instruction sessions, additional sessions shall be provided at no cost to the Owner.

B. Prior to scheduling instructions, submit outline of instructions to Consultant and Owner for approval.

C. Operating and maintenance manual shall be explained during these instructions.

1.08 EQUIPMENT STORAGE AND HANDLING:

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

C. The finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted thereto.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

E. Storage and Protection: Take special care to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, preventing any deformation.

1.09 WARRANTY:

A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Owner. Warranty shall be for a period of two (2) years and begin from the date of Final Acceptance.

PART 2 - PRODUCTS

2.01 MANUFACTURER:

A. Altitude valve shall be 16-inch Model 136-03 B-C-H-P-S-Y-KC Solenoid Control Valve as manufactured by Cla-Val Co., or approved equal.

2.02 MAIN VALVE:

A. The valve shall be hydraulically operated, single diaphragm actuated, globe pattern. The valve shall consist of three major components: the body with seat installed, the cover with bearing installed, and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls. Valve body and cover shall be of cast material manufactured and machined in North America. No fabrication or welding shall be used in the manufacturing process. Valve shall have NSF 61 approval. The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

B. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.

C. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm must withstand a Mullins burst test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully open or fully closed position.

D. Valve seat in eight inch and larger size valves shall be retained by flat head machine screws for ease of maintenance. The seat shall be of the solid, one-piece design and shall have a minimum of a five degree taper on the seating surface for positive drip tight shut- off. Pressed-in bearings and/or multi-piece seats shall not be permitted. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline.

E. The valve manufacturer shall be able to supply a complete line of equipment from 1-1/4 inch through 24-inch sizes and a complete selection of complimentary equipment. The valve manufacturer shall also provide a computerized cavitation chart which shows flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitation damage. An orifice plate shall be provided upon determination of system characteristics and evaluation of system requirements and analysis.

2.03 MATERIAL SPECIFICATION:

A. Valve size: 16-inch Full Port

B. Main Valve Body and Cover: Ductile Iron / ASTM A-536

C. Main Valve Trim: 316L Stainless Steel

D. Stem: 303 Stainless Steel

E. End Detail: ANSI B16.42 150 LB. FLG.

F. Pressure Rating: 200 PSI

G. Temperature Range: -40 to +180 Degrees F

H. Rubber Material: Buna "N"

I. Coating: Epoxy coated by baked on resin fusion method process 10 mils thick internal & external, with 3 mil polyurethane coating as identified in Technical Specification 09900.

J. Limit Switch – X105L2W limit switches.

K. Valve and fittings shall be configured for exterior installation and freeze protected with heat trace cable and weatherproof insulation.

L. Valve shall have brass isolation cocks.

M. Valve must vent to atmosphere

N. Altitude valve shall be normally open and shall fail in the open position during a power outage.

O. Valve shall include a pressure gauge on both the suction and discharge side of the valve. Pressure gauge must be stainless steel, liquid filled, reading pressure and feet of water. 0-200 psi inlet and 0-200 psi outlet.

P. Opening and closing speed control.

2.04 SOLENOID:

J. The electric solenoid shall initiate hydraulic closing of the valve based upon being energized. Solenoid shall be stainless steel with NEMA 4 enclosure. The valve pilot system shall consist of a single solenoid (120-volt AC with Nema type 4 enclosure), which upon being powered shall hydraulically close the main valve. A direct factory representative shall be made available for start-up service, inspection and necessary adjustments.

K. MATERIAL SPECIFICATION FOR PILOT CONTROL:

1. Body & Cover: Cast Bronze ASTM B62
2. Pressure Rating: 150 PSI
3. Trim: 303 Stainless Steel
4. Rubber Material: Buna "N"
5. Tubing and Fittings: Stainless Steel
6. Operating Fluids: Potable Water
7. Voltage: 120 Volt AC 60 Hz
8. Adjustment Range: 0-100 PSI
9. Enclosure Type: Nema 4 Watertight

PART 3 - EXECUTION

3.01 INSTALLATION:

A. The valve shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings.

B. Installation and adjustment shall be field-checked and approved by a manufacturer's direct factory representative. After acceptance, the representative shall address a letter to the Consultant outlining all installation and start up procedures. The letter shall include a statement that the valves are installed per the manufacturer's recommendations. The manufacturer or his qualified representative shall conduct training session for the Owner's personnel in the

operation and maintenance of the valves.

C. The valve manufacturer shall provide a direct factory representative to calibrate the valve and verify operation during start up.

3.02 PROTECTIVE COATINGS:

A. All interior non-working ferrous surfaces other than stainless steel shall be given fusion bonded epoxy coatings. The interior waterway passages of all valves shall be given a shop applied coating system unless provided with a shop applied epoxy coating. The exterior surfaces shall have a coating system equal to the steel pipe exterior coating system.

3.03 COORDINATION WITH INSTRUMENTATION:

A. The CONTRACTOR is responsible to coordinate with Division 16 regarding the requirements of control valves.

END OF SECTION

SECTION 15 9560
PUMP STATION PIPING TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Test requirements for pump station piping systems.

1.02 REFERENCES

A. Uniform Plumbing Code (UPC)

B. National Fuel Gas Code: ANSI Z 223.1 or NFPA 54

C. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):

1. B31.8 - Gas Transmission and Distribution Piping Systems.
2. B31.1 - Power Piping.
3. B31.3 - Process Piping.

D. Uniform Mechanical Code (UMC).

1.03 TESTING REQUIREMENTS

A. General Requirements:

1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 43 2125; are specified in the specifications covering the various types of piping; and are specified herein.
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 Uniform Plumbing Code, and UL requirements.
4. When testing with water, the specified test pressure is considered to be the pressure at the highest point of the piping section under test. Lower test pressure as necessary to prevent testing the lowest point above a safe test pressure.

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.

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 in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

PART 2 - SUBMITTALS

A. 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. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

2.01 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 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.

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 driers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 15052.

1. Provide temporary pressure relief valve for piping under test. 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 ANSI/ASME B31.1, ANSI/ASME B31.3, ANSI/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 one-half 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 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. 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. 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:

$$L = S \times D \times P^{1/2} \times 133{,}200^{-1}$$

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

3.04 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 appropriate specification sections.
    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 potable water while venting air.
    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.

END OF SECTION

SECTION 15 9580
MECHANICAL EQUIPMENT TESTING

PART 1 - GENERAL

1.01 SUMMARY

This section includes testing of mechanical equipment and systems.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

ANSI S1.4 Specification for Sound Level Meters.

B. American National Standards Institute/Hydraulic Institute (ANSI/HI):

1. ANSI/HI 1.1-1.5 Standard for Centrifugal Pumps for Nomenclature, Definitions, Application and Operation.
2. ANSI/HI 2.1-2.5 Standard for Vertical Pumps for Nomenclature, Definitions, Application and Operation.
3. ANSI/HI 2.6 Standard for Vertical Pump Tests.
4. ANSI/HI 9.1-9.5 Standard for Pumps - General Guidelines for Types, Definitions, Application and Sound Measurement.

1.03 SUBMITTALS

A. Schedule of factory tests and field tests as specified in Section 11 2120 and this Section.

B. Test instrumentation calibration data.

C. Start-up plan as specified in Section 46 0103.

D. Test result reports.

PART 2 - EXECUTION

2.01 QUALITY CONTROL TESTING AND REPORTING

A. Scheduling and Notification:

1. Witnessed Source Quality Control Tests: Schedule test date and notify ENGINEER at least 30 days prior to start of test.
2. Field Quality Control Tests: Schedule test date and notify ENGINEER at least 7 days prior to start of test.

B. Testing Levels:

1. Test equipment based on test levels specified in the equipment section of the specifications.
2. Requirements for Test Levels 1 to 4 are defined below.
3. Test levels apply for both Source (Factory) Quality Control Tests and Field Quality Control Tests as specified in the individual equipment Sections of the specifications.
4. If testing is not specified in the equipment section, provide Level 1 testing.

C. Witnessing: Source Quality Control Tests not witnessed unless specified otherwise in the equipment specifications shall be witnessed.

D. Instrumentation: Provide necessary test instrumentation which has been calibrated within one year from date of test to recognized test standards traceable to the National Institute of Standards and Technology, Washington, D.C. or approved source. Properly calibrated field

instrumentation permanently installed as a part of the Work may be utilized for Field Quality Control Tests.

E. Temporary Facilities and Labor: 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. With OWNER's permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

F. Test Fluids:

1. Factory Tests: Use water or air as appropriate at ambient conditions unless specified otherwise in the equipment Section.
2. Field Tests: Use specified process fluid at available conditions.

G. Pressure Testing: Hydrostatically pressure test pressure containing parts in the factory at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher. Submit pressure test reports before shipping.

H. 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. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
2. Do not adjust results of tests for instrumentation accuracy. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

I. Field Testing:

1. Submit test plan as specified in Section 01756. 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. Perform general start-up and testing procedures as specified in Section 46 0103.
3. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.

J. Reports: Submit reports for Source and Field testing. Submit Source Quality Control Test result reports before shipping equipment to the field. 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.

2.02 EQUIPMENT TESTING, GENERAL

A. Tests for Pumps, All Levels of Testing:

1. Test in accordance with applicable Hydraulic Institute Standards in addition to the requirements in this and other Sections.
2. Test Tolerances: In accordance with appropriate Hydraulic Institute Standards, except the following modified tolerances apply:
    a. From zero to plus 5 percent of head at the rated design point flow.
    b. Zero to plus 5 percent of flow at the rated design point head.
    c. No negative tolerance for the efficiency at the rated design point.
    d. No positive tolerance for vibration limits. Vibration limits and test methods in Hydraulic Institute Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

B. Tests for Drivers: Test motors as specified in Section 15 95 60. Test other drivers as specified in the driver equipment Section.

2.03 REQUIREMENTS FOR VIBRATION TESTING

A. Definitions:

1. Peak to Peak Displacement: The root mean squared average of the peak to peak displacement multiplied by the square root of 2.
2. Peak Velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
3. Peak Acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
4. 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 spectra of acceleration versus frequency. Manufacturers: One of the following:
    a. Rockwell Automation, Entek Group, "Spike Energy" analysis.
    b. CSI, "PeakVue."
5. Low Speed Equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
6. High Speed Equipment: Equipment and equipment components operating at or above 600 revolutions per minute.

B. Vibration Instrumentation Requirements:

1. 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 6400 lines, storage for up to one hundred 3200 line frequency spectra, RS232C data output port, circuitry for integration of acceleration data to velocity or double integration to displacement. Manufacturers: One of the following:
    a. Entek-IRD, Division of Rockwell Automation, Enpac 1200 with applicable data analysis software or Entek Model 838 analyzer with built in printer.
    b. Computational Systems Inc., (CSI) Division of Emerson Electric, Model 2120A, Data Collector/analyzer with applicable analysis software.

2. Analyzer Settings:
    a. Units: English, inches/second, mils and g's.
    b. Fast Fourier Transform Lines: Most equipment 1600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3200 lines for motors with a nominal speed of 3600 rpm; 3200 lines minimum for High Frequency Enveloping; 1600 lines minimum for low speed equipment.
    c. Sample Averages: 4 minimum
    d. Maximum Frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
    e. Amplitude Range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
    f. Fast Fourier Transform Windowing: Hanning Window.
    g. 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.
3. Accelerometers:
    a. For Low Speed Equipment: Low frequency, shear mode accelerometer, 500 millivolts per g sensitivity, 10 g range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount. Manufacturers: One of the following:
        1) Wilcoxon Research, Model 797L.
        2) PCB, Model 393C.
    b. For High Speed Equipment: General purpose accelerometer, 100 millivolts per g sensitivity, 50 g range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder. Manufacturers: One of the following:
        1) Wilcoxon Research, Model 793.
        2) Entek-IRD Model 943.
4. 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.

C. Vibration Testing Results Presentation:
1. Provide equipment drawing with location and orientation of measurement points indicated.
2. 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.
3. When Vibration Spectra Data Required:
    a. Plot peak vibration velocity versus frequency in cycles per minute.
    b. 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.

c. Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower and point of vibration measurement.

d. Plot motor spectra on a log amplitude scale versus frequency.

4. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.

5. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

2.04 TESTING LEVELS

A. Level 1 Quality Control Tests:

1. Level 1 General Equipment Performance Test:

a. For equipment, operate, rotate or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.

b. Operate at rated design load conditions.

c. 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.

2. Level 1 Pump Performance Test:

a. 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.

b. 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.

c. Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.

3. Level 1 Vibration Test:

a. Test Requirement: Measure filtered vibration spectra for peak velocity and peak to peak displacement versus frequency in three perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; one plane of measurement to be parallel to the axis of rotation of the component.

b. Equipment Operating Condition: Test at specified maximum speed.

4. Level 1 Noise Test:

a. 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.

B. Level 2 Quality Control Tests:

1. Level 2 General Performance Test:

a. For equipment, operate, rotate or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.

b. Operate at rated design load conditions.

c. 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.

2. Level 2 Pump Performance Test:
   a. 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.
   b. 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.
   c. Test for flow and head at two additional conditions; one at 25 percent below the rated flow and one at 10 percent above the rated flow.
   d. Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.
3. Level 2 Vibration Test:
   a. Test Requirement: Measure filtered vibration spectra for peak velocity, peak to peak displacement versus frequency and measure vibration phase in three perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; one 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. Equipment Operating Condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
   c. Natural Frequency Test of Field Installed Equipment:
      1) 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.
      2) Perform test at each bearing housing and at each support pedestal and for pumps on the suction and discharge piping.
      3) Perform with equipment and attached piping full of intended service or process fluid.
4. Level 2 Noise Test:
   a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at three feet horizontally from the surface of the equipment at mid-point height of the noise source.

C. Level 3 Quality Control Tests:
1. Level 3 General Equipment Performance Tests:
   a. For equipment, operate, rotate or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
   b. Operate at rated design load conditions for one half the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.

c. 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.

d. 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.

e. Bearing Temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 3 Pump Performance Test:

a. Test four 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.

b. 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.

c. 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.

d. 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 specification) and record observations on noise levels.

3. Level 3 Vibration Test:

a. Requirements: Same as Level 3 vibration test except data taken at each operating condition tested and with additional requirements below.

b. Perform High Frequency Enveloping Analysis for gears and bearings.

1) 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.

2) Report results in units of acceleration versus frequency in cycles per minute.

c. 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).

d. Plot vibration spectra on three different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.

4. 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 midpoint height and at four locations approximately 90 degrees apart in plan view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Quality Control Tests:

1. Level 4 General Equipment Performance Test:

a. For equipment, operate, rotate or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.

b. Operate at rated design load conditions for one half the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.

c. 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.

d. 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.

e. Bearing Temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 4 Pump Performance Test.

a. 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.

b. 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.

c. 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 specification) and record observations on noise levels.

d. Bearing Temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

e. 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 ANSI/HI standard and as follows:

1) 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.

2) Perform efficiency testing with test fluids at maximum rated speed.

3) Perform priming time testing with test fluids at maximum rated speed.

3. Level 4 Vibration Test: Same as Level 3 vibration test.

4. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

2.05 SOURCE QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in individual equipment sections. Prepare and submit test reports as specified.

B. Inspection and Balancing:

1. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.

2. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

C. Critical Speed of Rotating Equipment: Satisfy the following:

1. First critical speed of the constant, variable, and 2-speed driven equipment is to be at least 25 percent above the maximum operating speed or 25 percent below the minimum operating speed.

2. Second critical speed of any 2-speed or the variable speed equipment is to be at least 25 percent above or below the maximum operating speed or 25 percent below the minimum operating speed.

2.06 FIELD QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in individual equipment Sections. Prepare and submit test reports as specified. Comply with latest version of applicable standards.

B. For variable speed equipment, conduct test to establish performance over the entire speed range and at the average operating condition. Establish performance curves for:

1. The speed corresponding to the rated maximum capacity.

2. The speed corresponding to the minimum capacity.

3. The speed corresponding to the average operating conditions.

2.07 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 is not to exhibit unfiltered readings in excess of following:

	Unfiltered (overall) Peak-to-Peak Amplitude (mils	
Operating Speed (revolutions per minute)	**Other Rotating Equipment**	**Clean Fluid Pumps**
0 – 300	5.0	6.0
301 – 600	4.0	5.0
601 – 900	3.0	3.0
901 – 1,200	2.0	2.0
1,201 – 1,500	1.8	1.8
1,501 – 1,900	1.5	1.5
1,801 – 2,400	1.0	1.0
2,401 – 3,000	0.8	0.8
3,001 – 3,600	0.7	0.7
Note: For all equipment, axial shaft displacements not to exceed 50 percent of the maximum radial shaft displacements relative to the casing.		

C. Vibration Velocity Limits: Unless otherwise specified, equipment is not to exceed the following peak velocity limits:

Item	Unfiltered Overall Limit (inches per second)	Any Filtered Peak Limit (inches per second)
Non-Clog or Mixed Flow Pumps	0.35	0.25
Clean Fluid Pumps	0.25	0.20
Motors and Steady Bearings	0.25	0.20
Gear Reducers, Radial	Not to exceed AGMA 6000-A88 limits	

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 subrotational, 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 two times the rotor bar pass frequency.
    d. Phasing problems evidenced by one third 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.

2.08 NOISE REQUIREMENTS AND CONTROL

A. Make measurements in relation to reference pressure of 0.0002 microbar.

B. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

C. Set sound level meter to slow response.

D. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

2.09 FUNCTIONAL AND OPERATIONAL TESTING OF EQUIPMENT

A. Functional testing as specified in this Section.

B. General Check-out: Prior to operating equipment, inspect, test, and check supporting systems, including but not limited to power systems, control systems, piping systems, lubrication systems, and safety systems.
   1. Test and calibrate instrumentation and electrical devices as specified in Division 16.
   2. Test and prepare piping as specified in SAWS standards.
   3. As a minimum for control systems associated with the equipment, perform the following:
      a. Individual Loop Tests: Test from field device to intermediate terminations to controller and back to controlled element.
      b. End to End Test: Simulate input at field device and observe control system response at the final field control element.
   4. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

C. Operation of Related Existing Equipment: OWNER will operate related existing equipment or facilities necessary to accomplish the testing.

D. Acceptable Tests: Demonstrate the equipment performance meets the requirements of this Section and the equipment Section; when the equipment 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.

E. Operational Testing: As specified in Section 46 0103.

END OF SECTION

SECTION 31 1000
SITE CLEARING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Clearing and protection of vegetation.

B. Removal of existing debris.

1.02 RELATED REQUIREMENTS

A. Section 101 (SAWS) – Preparation of Right-of-Way

B. Section 01 5000 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.

C. Section 01 5713 - Temporary Erosion and Sediment Control.

D. Section 01 7800 - Closeout Submittals.

E. Section 31 2200 - Grading: Topsoil removal.

F. Section 31 2200 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

G. Section 32 9300 - Plants: Relocation of existing trees, shrubs, and other plants.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS

A. See Section 01 3050.10 – Shop Drawings, Product Data.

B. Site Plan: Showing:
   1. Vegetation removal limits.
   2. Areas for temporary construction and field offices.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill Material: As specified in Section 31 2200 - Grading

PART 3 EXECUTION

3.01 SITE CLEARING

A. Comply with other requirements specified in Section 03 1000.

B. Minimize production of dust due to clearing operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.02 VEGETATION

A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, storage areas, work areas.

B. Do not begin clearing until vegetation to be relocated has been removed.

C. Do not remove or damage vegetation beyond the limits: Shown on the drawings

D. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
   1. At vegetation removal limits.
   2. Around trees to remain within vegetation removal limits; locate no closer to tree than at the drip line.
   3. Around other vegetation to remain within vegetation removal limits.

4. See Section 01 5000 for fence construction requirements.

E. In areas where vegetation must be removed but no construction will occur other than pervious paving, remove vegetation with minimum disturbance of the subsoil.

F. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
   1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
   2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
   3. Existing Stumps: Treat as specified for other vegetation removed; remove stumps and roots to depth of 18 inches.
   4. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
   5. Fill holes left by removal of stumps and roots, using suitable fill material, with top surface neat in appearance and smooth enough not to constitute a hazard to pedestrians.

G. Dead Wood: Remove all dead trees (standing or down), limbs, and dry brush on entire site; treat as specified for vegetation removed.

H. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.03 DEBRIS

A. Remove debris, junk, and trash from site.

B. Leave site in clean condition, ready for subsequent work.

C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 31 1000.10
TREE PROTECTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Protection of Existing Trees.

1.02 RELATED REQUIREMENTS

A. Section 02 4100.10 - Site Demolition.

B. Section 31 1000 - Site Clearing.

C. Section 31 2200 - Grading.

1.03 PRICE AND PAYMENT PROCEDURES

A. Tree Protection Fence: No separate pay item. Includes chain link or plastic mesh fence, posts, tie wire, and installation.

1.04 REFERENCE STANDARDS

A. ANSI A300-2008 Pruning.

B. Local Municipal Code.

1.05 SUBMITTALS -- NOT USED

1.06 QUALITY ASSURANCE

A. Employ certified arborist or landscape architect to supervise or perform tree protection work as required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Tree Protection Fence: 4 feet high galvanized chain link.
   1. Metal “T” Posts: 1-1/2 inch at 10 feet on center, 2 feet deep.
   2. Tension Wire: No. 6 gauge at top and 6 inches above existing grade.

B. Tree Protection Fence: 4 feet high heavy gauge orange plastic mesh.
   1. Posts: "T" posts at 10 feet on center, 2 feet deep.

PART 3 EXECUTION

3.01 TREE PROTECTION FENCE

A. Install at Root Protection Zone of all existing trees to be protected as shown on drawing.

B. Root Protection Zone shall be located 1 foot radius from trunk for every 1 inch diameter of trunk at 4.5 feet from ground. The diameter of a multi-trunk tree is calculated as the sum of the largest trunk plus half of the sum of additional trunks at 4.5 feet from ground.

C. Fence may be located a minimum of half of the root protection radius if approved by the regulatory authority, Engineer, or Owner.

D. Provide 3 foot wide gap in fencing for watering, fertilization, or trash removal.

E. Fence Location Detail: See detail as shown on drawings.

3.02 TREE PROTECTION REQUIREMENTS

A. Install tree protection fence prior to any clearing, excavation, or grading and maintain in good repair for the duration of all construction work unless otherwise directed**.**

B. No construction operations are allowed within the Root Protection Zone.

C. Root Protection Zone shall be sustained in a natural state and shall be free from vehicular or mechanical traffic; no fill, equipment, liquids, or construction debris shall be placed inside the protective barrier.

D. Root Protection Zone shall be covered with mulch to reduce moisture stress.

E. The proposed finished grade and elevation of land within the Root Protection Zone of any trees to be preserved shall not be raised or lowered more than 3 inches. Welling and retaining methods are allowed outside the Root Protection Zone.

F. Root Protection Zone shall remain pervious, i.e. ground cover or turf at completion of landscape design.

G. No roots may be cut closer than 6 feet from the base of any tree. Roots cut within the Root Protection Zone will only be allowed on one side of the tree. Any roots that need to be cut within the Root Protection Zone will be cut using a saw-type trencher, and all cut roots will be painted.

H. All trees impacted by construction shall be fertilized with an organic tree fertilizer prior to construction and again at the end of construction. The area within the protective fencing shall be mulched with about 4 inches of mulch. Water barrels shall be placed within the Root Protection Zone to irrigate these trees if necessary.

I. No trash or warming fires shall be allowed for this project.

J. No pedestrian traffic shall occur within dripline of any tree.

3.03 DAMAGE TO PROTECTED TREES

A. Trim trees and shrubs when doing so will prevent removal or damage. Trimmed or damaged trees shall be treated or repaired under supervision of a certified arborist or landscape architect.

B. Any damage done to existing tree crowns or root systems shall be repaired immediately under supervision of a certified arborist. All wounds to oaks shall be painted with pruning paint within 20 minutes after damage. Roots exposed during construction operations will be cut cleanly. Cut surfaces shall be painted and topsoil and mulch placed over exposed root area immediately.

C. Branch Pruning Detail: See detail as shown on drawings.

D. Contractor shall compensate owner for damage to existing trees designated to remain in the amount of $200 per caliper inch measured 4.5 feet from ground. This amount will be deducted from final payment.

END OF SECTION

SECTION 31 2200
GRADING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Removal of topsoil.

B. Rough grading the site.

C. Topsoil and finish grading .

1.02 RELATED REQUIREMENTS

A. Section 31 1000 - Site Clearing.

B. Section 31 1000.10 - Tree Protection.

C. Section 31 2316 - Excavation.

D. Section 31 2323 - Fill.

E. Project Geotechnical Report.

1.03 PRICE AND PAYMENT PROCEDURES

A. Topsoil:
   1. Measurement Method: Lump Sum.
   2. Includes: scarifying substrate surface, placing where required, and compacting.

1.04 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with available geotechnical engineering and landscape specifications.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: Topsoil excavated on-site; friable loam, imported borrow; local borrow.
   1. Graded.
   2. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.

B. Other Fill Materials: See Section 31 2323.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect from damage above- and below-grade utilities to remain.

D. Notify utility company to remove and relocate utilities.

E. Protect site features to remain, including but not limited to bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs, from damage by grading equipment and vehicular traffic.

F. Protect trees to remain. Reference Section 31 1000.10.

G. Protect features to remain as a portion of final landscaping.

3.03 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, without mixing with foreign materials.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated.

D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. See Section 31 2323 for filling procedures.

G. Benching Slopes: Horizontally bench slopes greater than 4:1 to key fill material to slope for firm bearing.

H. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.04 SOIL REMOVAL

A. Stockpile topsoil to be re-used on site; remove remainder from site.

B. Stockpile subsoil to be re-used on site; remove remainder from site.

C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.05 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of 1-1/2 inch in size. Remove soil contaminated with petroleum products.

C. Where topsoil is to be placed, scarify surface to depth of 3 inches.

D. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

E. Place topsoil in areas indicated on drawings.

F. If not otherwise indicated, place topsoil to the following compacted thicknesses:
   1. Areas to be Seeded with Grass: 4 inches.
   2. Areas to be Sodded: 4 inches.

G. Place topsoil during dry weather.

H. Remove roots, weeds, rocks, and foreign material while spreading.

I. Near plants, buildings, and curbs spread topsoil manually to prevent damage.

J. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

K. Lightly compact placed topsoil.

3.06 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 0.10 foot (1-3/16 inches) from required elevation.

B. Top Surface of Finish Grade: Plus or minus 0.04 foot (1/2 inch).

3.07 REPAIR AND RESTORATION

A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.

B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Engineer as to remedy.

C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.08 FIELD QUALITY CONTROL

A. See Section 31 2323 for compaction density testing.

3.09 CLEANING

A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 2316
EXCAVATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Excavating for site grading, paving, structures.

B. Trenching for utilities from 5 feet outside the building to utility main connections.

1.02 RELATED REQUIREMENTS

A. Section 01 5713 - Temporary Erosion and Sediment Control.

B. Section 31 2200 - Grading.

C. Section 31 2323 - Fill.

D. Section 804 (SAWS) -Excavation, Trenching and Backfill.

E. Section 550 (SAWS) - Trench Excavation Safety Protection.

F. Project Geotechnical Report.

1.03 PRICE AND PAYMENT PROCEDURES

A. Excavating Soil Materials:
   1. Measurement method: By the cubic yard measured before removal.
   2. Includes: Excavating to required elevations, loading and placing materials in stockpile or removing from site.
   3. Does Not Include Over-Excavation: Payment will not be made for over-excavated work nor for replacement materials.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench mark and intended elevations for the work are as indicated.

B. Verify that existing topography is as shown in the plans. Coordinate with the engineer for any discrepancies prior to start of excavation.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum locations.

B. Excavate and backfill, in advance of construction, test pits to determine conditions or location of existing utilities.

C. Locate, identify, and protect utilities that remain and protect from damage.

D. Notify utility company to remove and relocate utilities.

E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, curbs, and existing utilities from excavating equipment and vehicular traffic. Repair damage at no additional charge to Owner, including utility company charges.

F. Protect plants, lawns, rock outcroppings, and other features to remain.

3.03 EXCAVATING

A. Underpin adjacent structures that could be damaged by excavating work.

B. Excavate to accommodate construction operations and to lines and grades indicated on the drawings.

C. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.

D. Excavate to provide adequate work space and clearance for concrete forms. Do not undercut excavation face for extended footings.

E. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

F. Steep slope and trench excavations shall conform with OHSA standards for shoring and safety protection.

G. Do not interfere with 45 degree bearing splay of foundations.

H. Cut utility trenches wide enough to allow inspection of installed utilities. Reference SAWS Standards Section 804.

I. Hand trim excavations. Remove loose matter.

J. Remove lumped subsoil, boulders, and rock up to 1/5 cu yd measured by volume.

K. Grade top perimeter of excavation to prevent surface water from draining into excavation.

L. Remove excavated material that is unsuitable for re-use from site.

M. Stockpile excavated material to be re-used in area designated on site.

N. Remove excess excavated material from site. Transport and place in accordance with all applicable regulations. Do not dispose of excess material in any stream or watercourse. Do not dump excess material on public property. Do not dispose of excess material on private property unless authorized by Owner.

O. Structure and Roadway Excavations:
   1. Subgrade shall be firm, dense, and compacted to 95 percent maximum density at a moisture content between optimum and optimum plus or minus 4 percent unless otherwise indicated in the Project Geotechnical Report.
   2. Bottom of excavations for footings and slabs shall be level, clean, dry, and clear of loose material.
   3. Remove unsuitable material and replace with suitable material as required or directed by Testing Laboratory.
   4. Refill over-excavated areas with properly compacted select backfill material.
   5. Extend excavation 5 feet minimum on each side of structure or footing unless otherwise indicated on drawings.
   6. Proof roll exposed design subgrade using a 25 ton pneumatic tire roller, maintaining a minimum tire pressure of 75 psi. Proof rolling operation shall be inspected by Testing Laboratory. Any soft or unconsolidated zones or areas detected by proof rolling operations shall be undercut as directed by the Engineer or the Testing Laboratory. Undercut subgrade shall be scarified to a minimum depth of six inches and compacted to a minimum of 95 percent maximum density at a moisture content between optimum and optimum plus 4 percent unless otherwise indicated in the Project Geotechnical Report. After the undercut subgrade has been scarified and compacted, the undercut shall be backfilled with select backfill to the design subgrade elevation. The final subgrade shall be reviewed by the Engineer or the Testing Laboratory.
   7. The surface of the subgrade for street excavations shall be finished to the lines and grades as established, and be in conformity with the typical sections shown on the plans. Any deviation in excess of one-half inch in cross section, and in a length of sixteen feet, measured longitudinally, shall be corrected by loosening, adding, or removing material, reshaping and compacting by sprinkling and rolling.

3.04 FIELD QUALITY CONTROL

A. Provide for visual inspection of load-bearing excavated surfaces before placement of foundations.

3.05 PROTECTION

A. Prevent displacement of banks and keep loose soil from falling into excavation; maintain soil stability.

B. Protect bottom of excavations and exposed soil against physical disturbance, rain, and freeze.

C. Protect footing excavations; construct concrete footings same day excavation is made wherever possible.

END OF SECTION

SECTION 31 2323
FILL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Filling, backfilling, and compacting for paving and site grading, paving , and site structures.

B. Filling holes, pits, and excavations.

1.02 RELATED REQUIREMENTS

A. Section 31 2200 - Grading.

B. Section 31 2316 - Excavation.

C. Section 804 (SAWS) - Excavation, Trenching and Backfill.

D. Project Geotechnical Report.

1.03 PRICE AND PAYMENT PROCEDURES

A. General Fill:
   1. Measurement Method: By the cubic yard.
   2. Includes: Supplying fill, placing where required, and compacting.

B. Structural Fill:
   1. Measurement Method: By the cubic yard.
   2. Includes: Supplying fill, placing where required, and compacting.

C. Granular Fill:
   1. Measurement Method: By the cubic yard.
   2. Includes: Supplying fill, placing where required, and compacting.

D. Aggregates:
   1. Measurement Method: By the cubic yard.
   2. Includes: Supplying fill, placing where required, and compacting.

1.04 DEFINITIONS

A. Finish Grade Elevations: Indicated on drawings.

B. Subgrade Elevations: Indicated on drawings.

1.05 REFERENCE STANDARDS

A. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; 2010.

B. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2014.

C. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

D. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.

E. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.

F. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.

G. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

H. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

I. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

J. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.

K. TxDOT TEX-113-E, Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials, using 5.5 lb rammer and 12-inch drop.

1.06 SUBMITTALS

A. Samples: sample of each type of fill; submit each material sample in three 5-gallon air-tight containers to testing laboratory.

B. Materials Sources: Submit name of imported materials source.

C. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

D. Compaction Density Test Reports.

1.07 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. When fill materials need to be stored on site, locate stockpiles where designated.
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 FILL MATERIALS

A. General Fill: Subsoil excavated onsite, imported borrow.
   1. For imported borrow, gradation less than 15 percent passing No. 200 sieve as determined by ASTM D 1140.
   2. For imported borrow, plasticity index less than 20 percent as determined by ASTM D 4318.
   3. No vegetative matter or debris.
   4. No rocks larger than half of the lift thickness.

B. Structural Fill:
   1. Refer to Geotechnical Engineering Report.
   2. If a Geotechnical Engineering Report is not available then comply with TxDOT Item 247 Type A Grade 2 Base.
   3. Graded in accordance with the following limits unless otherwise indicated:
      a. 1-3/4 inch sieve: 90-100 percent passing.
      b. No. 4 sieve: 25-55 percent passing.
      c. No. 40 sieve: 15-40 percent passing.
   4. Mixture shall be crushed stone and contain no clay lumps or organic matter.
   5. Fraction passing No. 40 sieve shall have a liquid limit less than 40 and a plasticity index less than 12 as determined by ASTM D 4318.

C. Granular Fill : Crushed limestone or pea gravel ; free of shale, clay, friable material and debris.
   1. Graded in accordance with ASTM C136, within the following limits:
      a. 1/2 inch sieve: 95 percent passing.
      b. No. 4 sieve: 5 percent passing.

D. Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.
   1. Graded in accordance with ASTM C136; within the following limits:
      a. No. 4 sieve: 100 percent passing.
      b. No. 200 sieve: 0 to 10 percent passing.

E. Drain Gravel: Washed gravel.
   1. Material shall have an LA abrasion number of 35 or less.
   2. Graded within the following limits:
      a. 2 inch sieve: 100 percent passing.
      b. 1-1/2 inch sieve: 90-100 percent passing.
      c. 1 inch sieve: 25-55 percent passing.
      d. 1/2 inch sieve: 0-10 percent passing.
      e. 1/4 inch sieve: 0-5 percent passing.

F. Topsoil: See Section 31 2200.

2.02 SOURCE QUALITY CONTROL

A. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.

B. If tests indicate materials do not meet specified requirements, change material and retest.

C. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the Work are as indicated.

B. Verify that existing topography is as shown in the plans. Coordinate with the engineer for any discrepancies prior to start of excavation.

C. Identify required lines, levels, contours, and datum locations.

D. See Section 31 2200 for additional requirements.

E. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.

F. Verify structural ability of unsupported walls to support imposed loads by the fill.

3.02 PREPARATION

A. Scarify and proof roll subgrade surface to a depth of 6 inches to identify soft spots.

B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.

E. Record locations of underground utilities.

F. If required, remove concrete formwork.

G. Remove trash and debris.

3.03 FILLING

A. Fill to contours and elevations indicated using suitable materials.

B. All select backfill, backfill and fill required for structures and trenches and required to provide the finished grades shown and as described herein shall be furnished, placed and compacted by the Contractor.

C. Employ a placement method that does not disturb or damage other work.

D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Slope grade away from building minimum 2 percent, unless noted otherwise. Make gradual grade changes. Blend slope to transition at grade changes.

G. Correct areas that are over-excavated.

H. All material shall be placed in horizontal loose lifts not exceeding eight inches (8") in thickness and shall be mixed and spread in a manner assuring uniform lift thickness after placing. Each lift shall be compacted by not less than two complete coverages of the specified compactor. Select backfill shall be placed to the underside of all concrete slabs or paved areas. The fill material shall extend a minimum of five feet (5') outside the face of each structure and be twelve inches (12") below finished grade. The maximum slope of select backfill to the subgrade shall be one vertical to one and one half horizontal.

I. Backfill around and outside of structures and over select backfill shall be deposited in layers not to exceed eight inches (8") in uncompacted thickness and mechanically compacted, using platform type tampers. Compaction of structural backfill, by rolling will be permitted provided the desired compaction is obtained and damage to the structure is prevented. Compaction of select backfill and/or backfill by inundation with water will not be permitted. All materials shall be deposited as specified herein and as shown on the drawings.

J. Unless otherwise indicated in the Geotechnical Report, all material shall be placed at a moisture content that falls in the range of laboratory optimum moisture content and laboratory optimum +4%. It shall be compacted to a density of 95 percent (95%) of the maximum laboratory dry density for that material as determined by TxDOT TEX-113-E. The Contractor shall provide equipment capable of adding measured amounts of water to the material to bring it to a condition within the range of the required moisture content. The Contractor shall provide equipment capable of discing, aerating, and mixing the soil to insure reasonable uniformity of moisture content throughout the material and to reduce the moisture content of the material by air drying if necessary. If the subgrade material must be moisture conditioned before compaction, the material shall be sufficiently mixed or worked on the subgrade to insure a uniform moisture content throughout the lift of material to be compacted. Materials at moisture content in excess of the specified limit shall be dried by aeration or stockpiled for drying.

K. No material shall be placed when free water is standing on the surface of the area where the material is to be placed. No compaction of material will be permitted with free water on any portion of the material to be compacted. No material shall be placed or compacted in a frozen condition or on top of frozen material. Any material containing organic materials or other unacceptable material previously described shall be removed and replaced with acceptable material prior to compaction.

L. Each lift of compacted material shall be compacted by the designated number of coverages of all portions of the surface of each lift by a smooth drum vibratory roller for granular material having a static weight not less than 5,500 pounds, a sheepsfoot roller for cohesive material exerting a pressure of 250 psi on the surface of the feet, or equivalent equipment, prior to commencement of the work. One coverage is defined as the condition obtained when all portions of the surface of the backfill material have been subjected to the direct contact of the compactor. The compactor shall be operated at a forward speed not exceeding 40 feet per minute.

M. Compaction shall be performed with equipment suitable for the type of material being placed. The contractor shall select equipment which is capable of providing the minimum density required by these Specifications. The gross weight of compacting equipment shall not exceed

7,000 pounds within a distance of ten feet (10') from the wall of any existing structure or completed structure under this contract. Equipment shall be provided that is capable of compacting in restricted areas next to structures and around piping. The effectiveness of the equipment selected by the Contractor shall be tested at the commencement of compacted material work by construction of a small section of material within the area where material is to be placed. If tests on this section of backfill show that the specified compaction is not obtained, the Contractor shall increase the amount of coverages, decrease the lift thicknesses or obtain a different type of compactor.

N. Particular care shall be taken to compact structure backfill which will be beneath pipes, roads, or other surface construction or structures. In addition, wherever a trench passes through structure backfill, the structure backfill shall be placed and compacted to an elevation twelve inches (12") above the top of the pipe before the trench is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

O. The compaction requirements specified are predicated on the use of normal materials and compaction equipment. In order to establish criteria for the placement of a controlled fill so that it will have compressibility and strength characteristics compatible with the proposed structural loadings, a series of laboratory compaction and/or compressive strength tests will be performed on the samples of materials submitted by the Contractor. From the results of the laboratory tests, the final values of the required percent compaction, the allowable compaction moisture content range, and the maximum permissible lift thickness will be established for the fill material and construction equipment proposed.

P. Compaction Density, unless otherwise specified or indicated:
   1. Standard: TxDOT TEX-113-E.
   2. Required Density: 95 percent of the maximum dry density.
   3. Lift Thickness: 8 inches.
   4. Moisture Content: Between optimum and optimum +4 percent.
   5. Testing laboratory will perform density tests at completion of each lift.
   6. If the tests indicate unsatisfactory compaction, the Contractor shall provide the additional compaction necessary to obtain the specified degree of compaction. All additional compaction work shall be performed by the Contractor at no additional cost to the Owner until the specified compaction is obtained. This work shall include complete removal of unacceptable (as determined by the Testing Laboratory) fill areas and replacement and recompaction until acceptable fill is provided.
   7. Pit Run Sand Placement: Pit run sand shall be placed and compacted to the limits shown on the drawings.
   8. Drainage Gravel: Drain gravel shall be compacted in maximum 8-inch lifts with a minimum of two passes of a hand operated vibratory plate compactor weighing between 150 and 500 pounds.

Q. Reshape and re-compact fills subjected to vehicular traffic.

3.04 TOLERANCES

A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.

3.05 FIELD QUALITY CONTROL

A. Refer to the Geotechnical Engineer for general requirements for field inspections and testing.

3.06 CLEANING

A. See Section 01 7419 - Construction Waste Management and Disposal, for additional requirements.

B. Leave unused materials in a neat, compact stockpile.

C. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

D. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 32 1123
AGGREGATE BASE COURSES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aggregate base course.

B. Paving aggregates.

1.02 RELATED REQUIREMENTS

A. Section 31 2200 - Grading.

B. Section 31 2323 - Fill.

C. Section 209 (CoSA) - Concrete Pavement.

D. Project Geotechnical Report.

1.03 PRICE AND PAYMENT PROCEDURES

A. Coarse Aggregate Type A: By the cubic yard. Includes supplying aggregate material, stockpiling, scarifying substrate surface, placing, and compacting.

B. Fine Aggregate Type A: By the cubic yard. Includes supplying aggregate material, stockpiling, scarifying substrate surface, placing where required, and compacting.

1.04 REFERENCE STANDARDS

A. AASHTO M 147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses; 1965 (2004).

B. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18 in.) Drop; 2010.

C. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2014.

D. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)); 2012.

E. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method; 2007.

F. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN m/m3)); 2012.

G. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2008.

H. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2011.

I. ASTM D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.

J. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

K. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2010.

L. TxDOT TEX-113-E - Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials.

1.05 SUBMITTALS

A. Samples: 10 lb sample of each type of aggregate; submit in air-tight containers to testing laboratory.

B. Materials Sources: Submit name of imported materials source.

C. Aggregate Composition Test Reports: Results of laboratory tests on proposed and actual materials used.

D. Compaction Density Test Reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. When necessary, store materials on site in advance of need.

B. Aggregate Storage, General:
   1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
   2. Prevent contamination.
   3. Protect stockpiles from erosion and deterioration of materials.

PART 2 PRODUCTS

2.01 MATERIALS

A. Limestone, coarse, crushed rock meeting the requirements of 2004 TxDOT Item 247, Type A, Grade 1 or 2.

2.02 SOURCE QUALITY CONTROL

A. Where aggregate materials are specified using ASTM D2487 classification, test and analyze samples for compliance before delivery to site.

B. If tests indicate materials do not meet specified requirements, change material and retest.

C. Provide materials of each type from same source throughout the Work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that survey bench marks and intended elevations for the work are as indicated.

B. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.02 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place aggregate on soft, muddy, or frozen surfaces.

3.03 INSTALLATION

A. Spread aggregate over prepared substrate to a total compacted minimum thickness of 6 inches or as indicated on the drawings.

B. Under Bituminous Concrete Paving:
   1. Place coarse aggregate to a total compacted minimum thickness of 6 inches or as indicated on the drawings.
   2. Compact to 95 percent of maximum dry density as determined by ASTM D 1557 at a moisture content ranging from -2 to +3 percent of the optimum moisture content unless otherwise indicated on the geotechnical report.

C. Under Portland Cement Concrete Paving:
   1. Place coarse aggregate to a total compacted minimum thickness of 6 inches or as indicated on the drawings.

2. Compact to 95 percent of maximum dry density as determined by ASTM D 1557 at a moisture content ranging from -2 to +3 percent of the optimum moisture content unless otherwise indicated on the geotechnical report.

D. Roller compact to specified density.

E. Level and contour surfaces to elevations and gradients indicated.

F. Add small quantities of fine aggregate to coarse aggregate as appropriate to assist compaction.

G. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

H. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.04 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation From Design Elevation: Within 1/4 inch.

3.05 FIELD QUALITY CONTROL

A. Compaction density testing will be performed on compacted aggregate base course in accordance with ASTM D1556.

B. Results will be evaluated in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D 698 ("standard Proctor").

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

D. Frequency of Tests: To be determined by the Owner's Construction Materials Testing Contractors.

E. Proof roll compacted aggregate at surfaces that will be under slabs-on-grade, pavers, and paving.

3.06 CLEANING

A. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.

B. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 32 3113
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 DEFINITIONS

A. Terms as defined in ASTM F552-88b.

1.02 SUBMITTALS

A. Shop Drawings: Detailed information and specifications for materials, finishes, and dimensions.
B. Quality Control Submittals:
C. Manufacturer's recommended installation instructions.
D. Evidence of Supplier and installer qualifications.

1.03 SCHEDULING AND SEQUENCING

A. Complete necessary site preparation and grading before installing chain link fence and gates.

PART 2 - PRODUCTS

2.00 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components.

2.01 CHAIN LINK FENCE FABRIC

A. Galvanized fabric conforming to ASTM A392-89, Class 1; hot-dipped galvanized after weaving.
B. Height: 96 inches, unless otherwise shown.
C. Wire Gauge: No. 9, Bare Wire.
D. Pattern: 1-inch diamond woven mesh.
E. Diamond Count: Manufacturer's standard and consistent for fabric furnished of same height.
F. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.
G. Wires of Twisted Selvages:
   1. Twisted in a closed helix three full turns.
   2. Cut at an angle to provide sharp barbs that extend minimum 1/4-inch beyond twist.

2.03 POSTS

A. General:
   1. Strength and Stiffness Requirements: ASTM F669-90a, Heavy Industrial Fence, except as modified in this section. Steel Pipe: ASTM F1083-90.
   2. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 36 inches.
   3. Protective Coatings:
      a. Zinc Coating: ASTM F1234-90a, Type A external and internal coating.

B. Line Posts:
   1. Steel Pipe:
      a. Outside Diameter: 2-3/8-inch.
      b. Weight: 3.65 pounds per foot.

C. End, Corner, Angle, and Pull Posts:
   1. Steel Pipe:
      a. Outside Diameter: 4.00-inch.
      b. Weight: 9.11 pounds per foot.

D. Posts for Swing Gates: 1. ASTM F900-84.
      a. Outside Diameter: 4.00-inch.
      b. Weight: 9.11 pounds per foot.

2.04 TOP RAILS AND BRACE RAILS

A. Galvanized steel pipe.
B. Protective Coatings: As specified for posts.
C. Strength and Stiffness Requirements: ASTM F669-90a, Top Rail, Heavy Industrial Fence.
D. Steel Pipe:
1. ASTM F1083-90.
2. Outside Diameter: 1-5/8-inch.
3. Weight: 2.27 pounds per foot.

2.05 FENCE FITTINGS

A. General: In conformance with ASTM F626-90, except as modified by this article.
B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.
C. Tension and Brace Bands: No exceptions to ASTM F626-90.
D. Tension Bars:
E. One-piece.
F. Equal in length to full height of fabric.
G. Truss Rod Assembly: 3/8-inch diameter. Barb Arms: 45-degree arms facing into the site for supporting three strands of barbed wire.
H. Tie Wires, Clips and Fasteners shall be in accordance to ASTM F626 and ASTM F 1916. For attaching chain link fabric to posts, rails and frames, all tie wires, clips and fasteners shall be metallic coated steel, 0.192-in diameter (min) wire with galvanized coating thickness matching coating thickness of chain-link fence fabric.

2.06 TENSION WIRE

A. Zinc-coated steel marcelled tension wire conforming to ASTM A824-86, Type II, Class 2.

2.07 BARBED WIRE

A. Zinc-Coated Barbed Wire: ASTM A121-86, Chain Link Fence Grade:
1. Line Wire: Three (3) strands of No. 12-1/2 gauge.
2. Barbs:
a. Number of Points: Four.
b. Length: 3/8-inch minimum.
c. Shape: Round.
d. Diameter: No. 14-gauge.
e. Spacing: 5 inches.

2.08 GATES (UNLESS OTHERWISE SPECIFIED ELSEWHERE)

A. General:
1. Gate Operation: Opened and closed easily by one person.
2. Welded Steel Joints: Paint with zinc-based paint.
3. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 24 inches.
B. Swing Gates: ASTM F900-84.
1. Hinges:
2. Furnished with large bearing surfaces for clamping in position.
3. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.
4. Latches: Plunger bar arranged to engage stop, except single gates of openings less than 10 feet wide may each have forked latch.
5. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.
6. Locking Device and Padlock Eyes: Integral part of latch, requiring production lock carousel for locking both gate leaves of double gates.
7. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in

open position until manually released.

C. Chain Link Cantilever Slide Gate: ASTM F-1184.
   1. Obtain chain link fences and gates, including accessories, fittings, and fastenings from a single source.
   2. Gate frames: Fabricate chain link cantilever slide gates in accordance with ASTM F-1184, Type II, Class 2, using aluminum members conforming to ASTM B 221, alloy and temper 6061- T6.
   3. Chain Link Fabric: To match specification of existing fence. Provide barbed wire along top of gate.
   4. Gate Posts to be 4" OD galvanized steel, SCH 40, ASTM F 1083
   5. UL 325 and ASTM F-2200 compliant
   6. Provide Gate Operator model HySecurity SlideDriver 50VF2/3.

D. Provide as specified in Section 03300 Cast-In-Place Concrete.

PART 3 - EXECUTION

3.00 GENERAL

A. Install chain link fences and gates in accordance with ASTM F567-84 and San Antonio Water System Standard Drawing DD-45-01, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by OWNER. Erect fencing in straight lines between angle points.

B. Provide all necessary hardware for a complete fence and gate installation.

3.01 PREPARATION

A. Establish locations of fence lines, gates, and terminal posts.

3.02 FENCE LOCATION

A. All fence posts shall be placed a minimum of one-foot (1') inside all property lines. All locations shall be confirmed by contractor's surveyor prior to beginning installation of new fence.

3.03 POST SETTING

A. Driven posts are not acceptable.

B. Post Hole Depth:
   1. Minimum 38 inches below finished grade.
   2. 2 inches deeper than post embedment depth below finish grade.

C. Backfill post holes with concrete to 2 inches above finished grade.

D. Before concrete sets, crown and finish top of concrete to readily shed water.

3.04 BRACING

A. Brace gate and corner posts diagonally to adjacent line posts to ensure stability.

3.05 TOP RAILS

A. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 CHAIN LINK FABRIC

A. Do not install fabric until concrete has cured minimum 7 *calendar* days.

B. Install fabric with twisted and barbed selvage at top.

C. Tie Wires: Power-fastened or manually fastened ties configured to wrap a full 360-degrees around rail or post, and a minimum of 1 complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists, and cut-off protruding ends to preclude untwisting by hand.

D. Maximum Spacing: Tie fabric to line posts at 12-inches on center (max) and to braces at 24 inches on center (max).

3.07 BARBED WIRE

A. Install three strands of barbed wire on brackets, tighten, and secure at each bracket. Brackets to be vertical.

3.08 GATES

A. Hang gates and adjust hardware so gates operate satisfactorily from open or closed position.
B. Set gate stops in concrete to engage center drop rod or plunger bar.
C. Install Cantilever Slide Gate fence per in accordance with manufactures' instructions and specifications. Install plumb, level, and secure for full opening without interference.

3.09 FIELD QUALITY CONTROL

A. Gate Tests: Prior to acceptance of installed gates and gate operator systems, demonstrate proper operation of gates under each possible open and close condition specified.

END OF SECTION

SECTION 32 9219
SEEDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil.

B. Placing topsoil.

C. Hydroseeding, mulching and fertilizer.

D. Maintenance.

1.02 RELATED REQUIREMENTS

A. Section 31 2200 - Grading.

1.03 PRICE AND PAYMENT PROCEDURES

A. Topsoil:
   1. Basis of Measurement: By the cubic yard.
   2. Basis of Payment: Includes topsoil, placing topsoil.

B. Grassed Areas:
   1. Basis of Measurement: By the square yard.
   2. Basis of Payment: Includes preparation of subsoil, preparation of topsoil, placing topsoil, seeding, watering and maintenance for 90 days or until established.

1.04 DEFINITIONS

A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nuts Hedge, Nimble Will, Bindweed, Wild Garlic, Perennial Sorrel, and Brome Grass.

1.05 SUBMITTALS

A. Topsoil samples.

B. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

C. Maintenance Contract.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.01 SEED MIXTURE

A. Seed Mixture: Common Bermuda grass.

2.02 SOIL MATERIALS

A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

2.03 ACCESSORIES

A. Mulching Material: Hay, oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry.

B. Fertilizer: Recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.

C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

D. Erosion Fabric: Jute matting, open weave.

E. Herbicide.

F. Stakes: Softwood lumber, chisel pointed.

G. String: Inorganic fiber.

H. Edging: Galvanized steel.

2.04 TESTS

A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.

B. Submit minimum 10 oz sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.

C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this Section.

3.02 PREPARATION

A. Prepare subgrade in accordance with Section 31 2200.

B. Place topsoil in accordance with Section 31 2200.

C. Install edging at periphery of seeded areas in straight lines to consistent depth.

3.03 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to roller compaction.

C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.

D. Mix thoroughly into upper 2 inches of topsoil.

E. Lightly water to aid the dissipation of fertilizer.

3.04 SEEDING

A. Apply seed per seed providers recommendation.

B. Do not seed areas in excess of that which can be mulched on same day.

C. Planting Season: Dependent upon seed species.

D. Do not sow immediately following rain, when ground is too dry, or during windy periods.

E. Roll seeded area with roller not exceeding 112 lbs.

F. Immediately following seeding , apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.

G. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

H. Following germination, immediately re-seed areas without germinated seeds that are larger than 24 by 24 inches.

3.05 HYDROSEEDING

A. Apply seeded slurry per seed providers recommendations.

B. Do not hydroseed area in excess of that which can be mulched on same day.

C. Immediately following seeding, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.

D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

E. Following germination, immediately re-seed areas without germinated seeds that are larger than 24 by 24 inches.

3.06 PROTECTION

A. Cover seeded slopes where grade is 4 inches per foot or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.

B. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

C. Secure outside edges and overlaps at 36 inch intervals with stakes.

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.07 MAINTENANCE

A. Provide maintenance at no extra cost to Owner; Owner will pay for water.

B. Provide a separate maintenance contract for specified maintenance service.

C. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.

D. Mow grass at regular intervals to maintain at a maximum height of 3 inches. Do not cut more than 1/3 of grass blade at any one mowing.

E. Neatly trim edges and hand clip where necessary.

F. Immediately remove clippings after mowing and trimming.

G. Water to prevent grass and soil from drying out.

H. Roll surface to remove minor depressions or irregularities.

I. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

J. Immediately reseed areas that show bare spots.

K. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

SECTION 32 9223
SODDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil.

B. Placing topsoil.

C. Fertilizing.

D. Sod installation.

E. Maintenance.

1.02 RELATED REQUIREMENTS

A. Section 31 2200 - Grading.

B. Section 31 2323 - Fill.

1.03 PRICE AND PAYMENT PROCEDURES

A. Topsoil:
   1. Basis of Measurement: By the cubic yard.
   2. Basis of Payment: Includes topsoil, placing topsoil.

B. Sodded Areas:
   1. Basis of Measurement: By the square yard.
   2. Basis of Payment: Includes preparation of subsoil, preparation of topsoil, placing topsoil, sodding, watering and maintenance.

1.04 DEFINITIONS

A. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nuts Hedge, Nimble Will, Bindweed, Wild Garlic, Perennial Sorrel, and Brome Grass.

B. Grass: Bermuda, Buffalo; other acceptable grasses suitable for the region and climate.

1.05 REFERENCE STANDARDS

A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding; 2006.

1.06 SUBMITTALS

A. Certification: Submit certification of grass species and location of sod source.

B. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.07 QUALITY ASSURANCE

A. Sod Producer: Company specializing in sod production and harvesting, and certified by the State of Texas.

B. Installer Qualifications: Company approved by the sod producer.

1.08 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver sod on pallets or in rolls. Protect exposed roots from dehydration.

B. Do not deliver more sod than can be laid within 24 hours.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sod: TPI, Certified Turfgrass Sod quality; cultivated grass sod; type indicated in plant schedule on Drawings; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft. Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
   1. Thickness: "Thick" sod, minimum 1 inch and maximum 1-3/8 inch topsoil base.
   2. Machine cut sod in accordance with TPI Guidelines.

B. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay, or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

C. Fertilizer: Recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, to the following proportions unless otherwise indicated:
   1. Nitrogen: 16 percent.
   2. Phosphoric Acid: 8 percent.
   3. Soluble Potash: 8 percent.

D. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

2.02 ACCESSORIES

A. Wood Pegs: Softwood, sufficient size and length to ensure anchorage of sod on slope.

B. Wire Mesh: Interwoven hexagonal plastic mesh of 2 inch size.

C. Edging: Galvanized steel, painted steel.

D. Herbicide.

2.03 SOURCE QUALITY CONTROL

A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.

B. Submit minimum 10 oz sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.

C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared soil base is ready to receive the work of this section.

3.02 PREPARATION

A. Prepare subgrade in accordance with Section 31 2200.

B. Place topsoil in accordance with Section 31 2200.

C. Install edging at periphery of seeded areas in straight lines to consistent depth.

3.03 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after smooth raking of topsoil and prior to installation of sod.

C. Apply fertilizer no more than 48 hours before laying sod.

D. Mix thoroughly into upper 2 inches of topsoil.

E. Lightly water to aid the dissipation of fertilizer.

3.04 LAYING SOD

A. Moisten prepared surface immediately prior to laying sod.

B. Lay sod immediately after delivery to site to prevent deterioration.

C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.

D. Where new sod adjoins existing grass areas, align top surfaces.

E. Where sod is placed adjacent to hard surfaces, such as curbs, pavements, etc., place top elevation of sod 1/2 inch below top of hard surface.

F. On all slopes lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.

G. Prior to placing sod, on slopes exceeding 4 inches per foot or where indicated, place wire mesh over topsoil. Securely anchor in place with wood pegs sunk firmly into the ground.

H. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.

I. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

3.05 MAINTENANCE

A. Provide maintenance until final acceptance at no extra cost to Owner; Owner will pay for water.

B. Provide a separate maintenance contract for specified maintenance service.

C. Provide maintenance of sodded areas for one month from Date of Substantial Completion.

D. Maintain sodded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.

E. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.

F. Neatly trim edges and hand clip where necessary.

G. Immediately remove clippings after mowing and trimming.

H. Water to prevent grass and soil from drying out.

I. Roll surface to remove irregularities.

J. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

K. Immediately replace sod to areas that show deterioration or bare spots.

L. Protect sodded areas with warning signs during maintenance period.

END OF SECTION

SECTION 32 9300
PLANTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Preparation of subsoil and topsoil.

B. Topsoil bedding.

C. New trees, plants, and ground cover.

D. Relocated trees, plants, and ground cover.

E. Mulch and Fertilizer.

F. Maintenance.

G. Tree Pruning.

1.02 RELATED REQUIREMENTS

A. Section 31 2200 - Grading.

B. Section 31 2323 - Fill.

1.03 PRICE AND PAYMENT PROCEDURES

A. Allowances:

1. Allowance includes purchase and delivery of trees, plants, and ground cover. Installation is included in this section and is part of the Contract Sum.

B. Unit Prices:

1. Topsoil: By the cubic yard. Includes topsoil, placing topsoil.
2. Plants: By the unit. Includes preparation of subsoil, preparation of topsoil, placing topsoil, planting, watering and maintenance to specified time period.

1.04 DEFINITIONS

A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Wild Garlic, Perennial Sorrel, and Brome Grass.

B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

1.05 REFERENCE STANDARDS

A. ANSI/ANLA Z60.1 - American National Standard for Nursery Stock; 2004.

B. ANSI A300 Part 1 - American National Standard for Tree Care Operations -- Tree, Shrub and Other Woody Plant Maintenance -- Standard Practices; 2008.

1.06 SUBMITTALS

A. Maintenance Data: Include cutting and trimming method; types, application frequency, and recommended coverage of fertilizer.

B. Submit list of plant life sources.

1.07 QUALITY ASSURANCE

A. Nursery Qualifications: Company specializing in growing and cultivating the plants.

B. Installer Qualifications: Company specializing in installing and planting the plants.

C. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.

D. Tree Pruning: NAA - Pruning Standards for Shade Trees.

1.08 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

B. Plant Materials: Certified by federal department of agriculture; free of disease or hazardous insects.

1.09 DELIVERY, STORAGE, AND HANDLING

A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

B. Protect and maintain plant life until planted.

C. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.10 FIELD CONDITIONS

A. Do not install plant life when ambient temperatures may drop below 40 degrees F or rise above 95 degrees F.

B. Do not install plant life when wind velocity exceeds 20 mph.

1.11 WARRANTY

A. Provide one year warranty; replace dead or unhealthy plants.

B. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.01 PLANTS

A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

B. Trees, Plants, and Ground Cover: Species and size identifiable in plant schedule, grown in climatic conditions similar to those in locality of the Work.

2.02 SOIL MATERIALS

A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0.

2.03 SOIL AMENDMENT MATERIALS

A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, unless otherwise indicated.
   1. Nitrogen: 13 percent.
   2. Phosphoric Acid: 13 percent.
   3. Soluble Potash: 13 percent.

B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.

C. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

D. Herbicide: As directed by Landscape Architect or Owner.

E. Pesticide: As directed by Landscape Architect or Owner.

2.04 MULCH MATERIALS

A. Mulching Material: Cedar or Oak shavings, ground bark, free of growth or germination inhibiting ingredients.

B. Mulching Material: Hay, oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry.

2.05 ACCESSORIES

A. Wrapping Materials: Burlap.

B. Stakes: Softwood lumber, pointed end; Mild steel angle, galvanized, pointed end.

C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.

D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.

E. Plant Pot: Plastic.

F. Grates: Cast iron finish, sized to resist pedestrian or vehicular loads.

G. Decorative Cover: Bark chips, crushed gravel, smooth gravel, or mulch, 1 inch minimum and 3 inch maximum size.

H. Membrane: 20 mil thick, black polyethylene.

I. Wrapping: Waterproof fabric.

J. Tree Protectors: Plastic.

2.06 SOURCE QUALITY CONTROL

A. Provide testing and analysis of imported or existing topsoil.

B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt and organic matter; and pH value.

C. Submit minimum 10 oz sample of topsoil proposed. Forward sample to testing laboratory in sealed containers to prevent contamination.

D. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that prepared subsoil or planters are ready to receive work.

B. Saturate soil with water to test drainage.

C. Verify that required underground utilities are available, in proper location, and ready for use.

3.02 PREPARATION OF SUBSOIL

A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.

B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.

C. Scarify subsoil to a depth of 3 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.

D. Dig pits and beds 6 inches larger than plant root system.

3.03 PLACING TOPSOIL

A. Spread topsoil to a minimum depth of 4 inches over area to be planted. Rake smooth.

B. Place topsoil during dry weather and on dry unfrozen subgrade.

C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.

D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.

E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches.

3.04 FERTILIZING

A. Apply fertilizer in accordance with manufacturer's instructions.

B. Apply after initial raking of topsoil.

C. Mix thoroughly into upper 2 inches of topsoil.

D. Lightly water to aid the dissipation of fertilizer.

3.05 PLANTING

A. Place plants for best appearance.

B. Place plants for best appearance for review and final orientation by Landscape Engineer.

C. Set plants vertical.

D. Remove non-biodegradable root containers.

E. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches under each plant. Remove burlap, ropes, and wires, from the root ball.

F. Place bare root plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch layers. Maintain plant life in vertical position.

G. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.06 PLANT RELOCATION AND RE-PLANTING

A. Relocate plants as indicated by Landscape Engineer.

B. Replant plants in pits or beds, partly filled with prepared topsoil mixture, at a minimum depth of 6 inches or as indicated on drawings under each plant. Remove burlap, ropes, and wires, from the root ball.

C. Place bare root plant materials so roots lie in a natural position. Backfill soil mixture in 6 inch layers. Maintain plant materials in vertical position.

D. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.07 INSTALLATION OF ACCESSORIES

A. Place decorative cover and membrane, stone, or mulch where indicated on drawings.

B. Place grates at base of trees where indicated on drawings.

C. Wrap deciduous shade and flowering tree trunks and place tree protectors.

3.08 PLANT SUPPORT

A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:
   1. Tree Caliper: 1 inch; Tree Support Method: 2 stake with two ties
   2. Tree Caliper: 1 to 2 inches; Tree Support Method: 3 stakes with two ties
   3. Tree Caliper: 2 to 4 inches; Tree Support Method: 3 stakes with two ties
   4. Tree Caliper: Over 4 inches; Tree Support Method: 3 guy wires with eye bolts and turn buckles

3.09 TREE PRUNING

A. Perform pruning of trees as recommended in ANSI A300.

B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.10 FIELD QUALITY CONTROL

A. Plants will be rejected if a ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

3.11 MAINTENANCE

A. Provide maintenance at no extra cost to Owner; Owner will pay for water.

B. Maintain plant life immediately after placement and until plants are well established and exhibit a vigorous growing condition. Continue maintenance until termination of warranty period.

C. Irrigate sufficiently to saturate root system and prevent soil from drying out.

D. Cultivate and weed plant beds and tree pits.

E. Remove dead or broken branches and treat pruned areas or other wounds.

F. Neatly trim plants where necessary.

G. Immediately remove clippings after trimming.

H. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions.

I. Control insect damage and disease. Apply pesticides in accordance with manufacturers instructions.

J. Remedy damage from use of herbicides and pesticides.

K. Replace mulch when deteriorated.

L. Maintain wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

END OF SECTION

SECTION 43 21 25
PACKAGED PUMP STATION

PART 1 - GENERAL

1.01 WORK INCLUDED

A. The CONTRACTOR shall furnish and install all tools, equipment, materials, and supplies and shall perform all labor necessary for the installation, testing, and placing into operation of a pre-fabricated water pumping station. The pump station shall be a complete unit with pumps, drives, controls, piping, and appurtenances, all mounted on a steel single base.

1.02 RELATED SECTIONS

A. Division 15, as applicable MECHANICAL.

B. Section 09 90 00 – PAINTS and COATINGS.

C. Division 16 - ELECTRICAL

1.03 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

B. ANSI/ASME B31.1 - Power Piping.

C. ASTM A 48 - Specification for Gray Iron Castings.

D. Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps.

1.04 CONTRACTOR SUBMITTALS

A. Submittals shall be made in accordance with Section 01 30 50.10.

B. Submittals shall include copies of all materials required to establish compliance with these specifications. At a minimum, they shall include the following:

1. Shop drawings showing important details of construction and dimensions.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. A detailed description of the system operation, including pressure and flow ranges, pump sequencing, and controller functionality.
4. Guaranteed performance curves and data sheets on the pumps showing head, capacity, efficiency, $NPSH_R$, and design and maximum horsepower.
5. Total weight of the equipment.
6. Complete Bill of Materials for the system.
7. Electrical information, including control schematic and panel layout to scale.
8. Manufacturer's UL 508A / NITW certificate for Industrial Control Panels.
9. Manufacturer's UL 698A / NRBX certificate for Industrial Control Panels Relating to Hazardous Locations (if applicable).
10. Manufacturer's UL QCZJ certificate for Packaged Pumping Systems.
11. AWS D1.1 welding certificates for those employees working on the project.
12. A complete list of all field service offices, complete with phone numbers and contact information, having the fields service office closest to the site clearly indicated

C. Operation and Maintenance Manuals: Provide in accordance with Sections 01 78 00, 11 21 12, 11 29 50 and Division 15. At a minimum, the manuals shall include:

1. Shop drawings showing important details of construction and dimensions.
2. Descriptive literature, bulletins, and/or catalogs of the equipment.
3. A detailed description of the system operation, including pressure and flow ranges, pump staging, and controller functionality.
4. Guaranteed performance curves and data sheets on the pumps showing head, capacity, efficiency, $NPSH_R$, and design and maximum horsepower.
5. Total weight of the equipment.
6. Complete Bill of Materials for the system.
7. Electrical information, including control schematic and panel layout.
8. Manufacturer's Operation and Maintenance Manuals with parts cross-sections.
9. Recommended spare parts.
10. Contact phone numbers for troubleshooting and service.

D. Tools: Special tools necessary for maintenance and repair of the pumps shall be furnished as a part of the work hereunder; such tools shall be suitably motors and all related components stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

E. Spare Parts: The CONTRACTOR shall obtain and submit from the manufacturer a list of recommended spare parts for each piece of equipment according to the provisions of SPARE PARTS of the General Requirements. After approval, CONTRACTOR shall furnish such spare parts suitably packaged, identified with the equipment number, and labeled. CONTRACTOR shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment. All spare parts are intended for use by the OWNER, only, after expiration of the guaranty period. Any spare parts which the ENGINEER permits the CONTRACTOR to use for startup activities shall be replaced by the CONTRACTOR prior to the OWNER's acceptance of beneficial use of the equipment.

1. During the term of this Contract the CONTRACTOR shall notify the ENGINEER in writing about any manufacturer's modification of the approved spare parts, such as part number, interchangeability, model change or others. If the ENGINEER determines that the modified parts are no longer applicable to the supplied equipment, the CONTRACTOR at its expense shall provide applicable spare parts.

F. Field Procedures: Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the pumps.

1.05 QUALITY ASSURANCE

A. Bidding manufacturers shall have the necessary organization, experience, capital, and equipment to carry out the manufacturing and start-up of the equipment. Each bidder shall have produced similar packaged pumping systems for similar applications and capacity a minimum of five (5) times over the past five (5) years. The Owner and/or Engineer reserve the right to reject any bid that cannot satisfactorily demonstrate successful experience and competence with similar packaged pumping systems.

B. Equipment Testing: The CONTRACTOR shall be responsible for the coordination of the following tests of each pump, drive, and motor.

C. The pump station shall be a pre-fabricated assembly, with all components on a platform assembly. All materials incorporated in the pump station shall be new and of the best

quality, meeting the technical requirements for the purpose intended. The equipment specified herein is to set forth a standard of quality and operation. The pump station shall be fully assembled, completely wired, piped hydraulically and electrically tested at the manufacturer's facility prior to shipment to the project site. The pump station manufacturer shall be responsible for fully assembling the package pump station assembly at its facility prior to shipment of the pump station assembly to the Project Site. This assembly shall include all gaskets, valves, appurtenances, spacers, fittings, etc. as necessary to fully assemble the following components:

1. Intake piping manifold piping
2. Individual steel piping from intake manifold to the vertical turbine pump can piping (4 sets)
3. Assembly of vertical turbine pumps and motors with vertical turbine pump can piping to ensure proper fit, minimum clearances, spacings, elevations.
4. Pump discharge piping, valves, appurtenances, etc. to the pump station discharge manifold pipe.
5. Verification that all components will be assembled properly with minimal field adjustments for level tests, alignment tests per SAWS specifications and vibration testing.
6. Full and complete assembly of electrical and control components, including conduits, conductors, wiring, junctions, splices, etc. to enable full system testing per technical specifications.

All piping, valves, fittings and appurtenances included in the pump station fabrication and assembly shall be provided through the pump station manufacturer for assembly and testing as noted in paragraph 1.05 C above. Photographs of fully assembled piping components shall be provided to Engineer prior to pump testing.

D. The pumps, motors, control equipment, and all appurtenant equipment included under pumps, motors and controls shall be furnished by a single pump systems manufacturer. The manufacturer shall be responsible for all other equipment furnished. All components provided under this section shall be shipped, delivered and received as a single lot from the pump station manufacturer's plant. Separate shipments of components from their individual manufacturer's facility shall not be permitted. The manufacturer shall supply three complete sets of operation instructions and service manuals, bound in a 3-ring binder each with an electronic file(s) on a cd (pdf format) for all materials supplied, and for manufacturer’s recommended operations, service and maintenance manuals, and parts listing.

E. The pumping systems manufacturer shall have a network of service centers which shall have available spare parts and trained pump technicians to handle service, repair and warranty procedures.

1.06 SEQUENCE OF OPERATION (PLC):

A. General items applying to each alarm circuit shall include a display of condition on the system display, the illumination of a red indicating light, and manual reset of a persistent condition.

B. Alarm sequence

1. Low Discharge Pressure alarm circuit shall stop pumping system in the event discharge pressure drops below normal level. Operator Interface Device (OID), mounted in enclosure door, shall signal low discharge pressure. Pumping system shall not operate until safety has been manually reset.

2. High Discharge Pressure alarm circuit shall shut down pumping system if discharge pressure reaches a predetermined high level. OID shall signal high discharge pressure. Pumping system shall not operate until pressure is reduced and alarm has been reset.

3. Low Inlet Pressure alarm shall protect the pumps from operating without adequate inlet pressure, which could cause damage to pumps. A pressure sensor shall be installed on the suction manifold to monitor the suction pressure. This feature shall include a short time delay to handle transient conditions which can occur during the stating of a pump. OID shall signal low suction pressure. Pump system shall not start until low suction pressure is corrected and circuit has been reset. Low suction pressure alarm shall pertain to flooded suction and booster applications.

4. Main phase failure and low voltage safety circuit shall retire the pumping system if it experiences low voltage, phase failure or phase reversal as monitored at line-side of control enclosure. Phase monitor shall have a time delay to allow for transient low voltage during motor starting and to allow maximum motor protection. OID mounted in enclosure door shall signal phase failure for any affected pump.

5. Individual Phase Failure And Low Voltage alarm circuitry, as part of the overload relay circuit, shall retire any pump that experiences low voltage, phase failure or phase unbalance as monitored at the load-side of each pump motor contactor by the overload relay. Each pump motor shall have its individual protective device and time delay to allow for transient low voltage during motor starting to allow maximum motor protection. The individual pumps or pumping system shall not operate until the voltage problem has been corrected and safety has been manually reset. Incoming phase monitor safety circuit as the only phase failure sensing device is not acceptable.

6. Individual pump cycle failure alarm shall be activated if a pump is required to start at a greater frequency than that allowed by the motor manufacturer. The individual pumps or pumping system shall not operate until the problem has been corrected and alarm has been manually reset.

C. Functional Sequence, Pressure and Flow Sequencing – DIVISION 16 ELECTRICAL

1.06 MANUFACTURER'S SERVICE REPRESENTATIVE

A. The packaged pumping system manufacturer shall provide factory-direct service personnel for the set, start-up, preventative maintenance and general service of the system.

B. Instruction of OWNER's Personnel: The CONTRACTOR shall provide for the services of a factory service representative to instruct the OWNER's personnel in the operation and maintenance of the equipment. This service shall consist of a minimum of two (2) day's visit to the site for each type of similar pumps.

1.07 GUARANTEES, WARRANTIES

A. After completion, the CONTRACTOR shall furnish to the OWNER the manufacturer's written guarantees that all of the pump station related equipment will operate with the published efficiencies, heads, and flow ranges and meet these specifications. The CONTRACTOR shall also furnish the manufacturer's warranties as published in its literature and as specified.

B. The Contractor shall warranty the pump station for two (2) years after final acceptance of project by the Owner.

PART 2 - PRODUCTS

2.01 GENERAL

A. Nameplates: Pumps and motors shall have a standard nameplate securely affixed in a conspicuous place showing the manufacturer's name, address, type or style, model, serial number, and catalog number. In addition, the nameplate for each pump shall show the capacity in gpm at rated speed in rpm and head in feet of water. Nameplate for each electric motor shall show at least the minimum information required by 10.38 NEMA MG 1. Such other information as the manufacturer may consider necessary to complete identification shall be shown on the nameplate.

B. Structural Support for Pump Stations

1. The pump station shall be built on a structural steel base. The base shall provide adequate structural supports for the pumps, motors, piping and all other internal components of the station.
2. The structural steel base shall be designed with such rigidity that the base, when lifted, will not deflect more than one inch per 180 inches of length or width.
3. The structural steel base shall be furnished with ¼" thick treadplate floor plate covering the entire base. The floor plate shall be welded to the structural steel base. Where suction and discharge piping pass through the structural steel base, removable panels that provide access to pipe flanges and bolts shall be provided.

C. Pipe Supports: Pipe supports shall be designed and sized as follows:

1. Supports for 6" through 12" piping shall be 3" x 3" x ¼" wall rectangular tubing;
2. All rectangular tubing shall have capped ends;
3. Pipe supports are to be fully welded at the base. Pipe shall be supported by a saddle and shall not be welded to the support;
4. Simple pipe stands made of pipe welded only at the flow and upholding a bracket with or without a threaded hack bolt or a U-bolt are not acceptable.

2.02 MAIN PUMPS

A. Reference Section 11 21 20 – Vertical Turbine Pumps

B. The main pump(s) shall be of the vertical turbine type with flow and head defined below. The vertical turbine pumps should be manufactured according to the standards of the Hydraulic Institute and to ANSI specification No. B58.1. The bowl assembly, column pipe, line-shaft, head shaft, and discharge head shall be of U.S. manufacture.

C. The discharge head shall be of the fabricated steel type with a minimum 60,000 PSI tensile strength. The discharge shall have a working pressure of not less than 275 PSI and incorporate a 150 ANSI discharge flange. Complete discharge head shall be hydrostatically tested to a minimum of 413 PSI. A product lubricated high pressure stuffing box containing at least six rings of packing and two lantern rings shall be provided. Packing shall be compressed around shaft by an adjustable two-piece gland. Dual bypass tubing shall be included for proper packing lubrication and cooling. The discharge head stuffing box area shall also include a drain which will be piped back to drain. Discharge head shall incorporate an integral air separation chamber, allowing air to be discharged through an air release line mounted on top of head. All bolting shall be 316 SS with anti-seize compound.

D. Acceptable Pump Manufacturers
   1. Fairbanks Morse
   2. Johnston
   3. Peerless
   4. Goulds
   5. Afton

2.03 ELECTRIC MOTORS

A. Vertical Hollowshaft Motors: Motors for main pumps shall be high thrust vertical hollow shaft design, WP-I enclosure, shall have a 1.15 service factor, and class F insulation. Motors shall be wound for full voltage starting and shall be suitable for use with a soft starter controls and/or variable frequency drive with shaft grounding rings. Maximum pump run out horsepower shall not be greater than motor nameplate rating exclusive of service factor. Motor shall be rated for continuous duty and be designed to carry the maximum thrust load of the pump. Motor shall have B10 bearing life of no less than 5 years.

B. Premium Efficiency Motors. The pumping system manufacturer shall provide premium energy efficient motors to meet the minimum design efficiency ratings.

C. Motor Space Heater. The pumping system manufacturer shall provide on each pump motor a 120 volt, single phase space heater of ample size to prevent condensation from occurring within the motor during non-operating periods. The space heater shall be de-energized when the motor is running.

D. Motor Thermostats. Each motor shall be equipped with a thermostat to detect high motor temperature. Contact shall be normally closed, opening on rising temperature. Circuit shall be properly indicated and shall require a manual reset.

E. Acceptable Manufacturers
   1. Toshiba
   2. TECO – Westinghouse
   3. Siemens
   4. Baldor
   5. Nidec (US Motors)
   6. General Electric

F. Maximum ambient temperature not greater than 40 degrees C.

G. Maximum motor speed shall be 1,800 rpm.

H. Motor shaft shall be solid type.

I. Service Factor shall be 1.15 minimum.

J. Suitable for full voltage direct-on-line starting and use with specified motor starter equipment specified in Division 16.

K. The motor shall be treated NEMA Premium in accordance with NEMA MB1 9.21.4.1.

L. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins.

M. The motor nameplate horsepower shall be equal to or greater than the maximum load which will be imposed on it by the pump when operating at any point in the operating head range.

N. Motors shall have an oversized, gasketed, cast iron conduit (terminal) box, field adjustable in 90-degree increments unless the box contains equipment, diagonally split with tapped NPT threated conduit entrance hole, and shall exceed the minimum volumes defined in IEEE 841-2001.

O. Class H insulation system.

P. Totally Enclosed Fan Cooled (TEFC) enclosure.
Q. Locked Rotor Code shall be "G".
R. Rotor cage shall be constructed of copper or copper alloy bars.
S. Motor leads shall be made of ASTM B 173, class G stranded copper.
T. Bearings shall have a minimum 100,000 hours L-10 bearing life as defined in AFBMA 9 and 11. Oil reservoir with oil level sight glass shall be provided. Sight glass shall be marked with the proper static and operating oil levels.
U. The noise level as measured by IEEE Standard 85, the maximum noise level shall be 85 Dba AT 1 METER.
V. Motors shall be furnished with a space heater.
W. All motors shall be provided with 120-ohm nickel stator RTD's for winding and bearing temperature protection.
X. Motor efficiency shall not be less than 95% and power factor not less than 85% when operating at maximum speed, service factor load and rated voltage and frequency.
Y. Lightning arrester (4.5 Kv) is required to limit the magnitude of the transient voltage spike.
Z. Surge capacitor (0.5 microfarad) is required to limit the rate of rise of voltage.
AA. Motors shall have a maximum temperature rise, by resistance, of 80ºC (Class B) for continuous operation at rated load.
BB. Motors shall be provided with an anti-reverse ratchet to prevent reversing due to phase reversal of backspin at shutdown.
CC. Rotors shall be dynamically balanced. Vibration displacement shall not exceed .001 inches peak-to-peak.
DD. A fabricated steel coupling guard shall be provided.
EE. Certified test reports for motor factory performance tests shall be provided.

2.05 SHOP TESTS

A. All tests and test reports shall be made in conformity with the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be Table 14.6.3.4 Grade 1B.
B. Hydrostatic test of pressure-containing components. The minimum hydrostatic test pressure shall be 1.5 times shutoff head plus max suction pressure.
C. Nosie test.
D. Vibration test.
E. Motor test per IEEE 112.
F. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, evaluated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting.

2.06 PIPING

A. All piping shall be designed based on the maximum working pressure of the system. Piping shall be the standard schedule S steel sized per drawings. Steel pipe flanges shall conform to ANSI/AWWA C207-07 Class D; or ANSI/AWWA C207-07 Class E and/or ANSI/ASME B16.5 based on system pressure. The pipe shall be given a hydrostatic test to 125% of the maximum pump shut-off pressure. If the pumps are not fitted with suction and discharge gage taps, the provision for such shall be made in the piping system. Steel piping shall be internally coated with an NSF 61 approved epoxy paint as manufactured by Devoe Series Bar-Rust 233H; color shall be white. Piping requiring victaulic grooving shall be Schedule 80 for 4" pipe and smaller.

B. The piping system shall be sized so that pump inlet and outlet velocities are less than 8 feet per second.

C. All piping and fittings less than 1 inch, including control pilot connections, gauge connections and other device piping shall be of non-ferrous material such as stainless steel, copper, brass, bronze or plastic. Plastic fittings and/or piping or tubing shall not be used in locations where the piping is used as support.

2.07 PAINTING

A. All pre-fabricated items including, but not limited to, platform for pump mounting, panel mounting frame, and all piping shall be sandblasted per SSPC-SP10 to a near white metal condition. The cleaned steel surfaces shall immediately thereafter be primed with an industrial grade epoxy primer to a thickness of 2 1/2 to 3 mils. Paint shall be light blue color and conform to Section 09 90 00. All nuts, bolts and miscellaneous assembly hardware used for component-to-component assembly shall be stainless steel to prevent corrosion.

2.08 VALVES AND APPURTENANCES

A. Pump check valves shall be provided for each pump. They shall be of the silent type, wafer style and shall be cast from grade 35 cast iron. They shall have machined bronze disc, seat and stem, aligned and spring assisted to allow proper seating and full closure before flow reversal occurs. The valve design shall incorporate a center guided, spring loaded poppet, guided at opposite ends and having a short linear stroke that generates a flow area equal to the pipe diameter. Internals shall be machined bronze disc, seat, and stem guide. Disc shall incorporate a Buna-N insert to provide resilient sealing. Dual disc style or swing check valves shall not be accepted. Valves shall be sized to permit full pump capacity to discharge through them without exceeding a pressure drop of 2.5 PSI. Check valves through 8" shall be model 1406R rated at 400 psi working pressure as manufactured by Valmatic. Check valves 10” and above shall be model 1806 rated at 400 psi working pressure as manufactured by Valmatic. Valve size and rating shall be as called for in the detail drawings.

B. AWWA Pump Isolation Valves: Gate Valves shall be designed and manufactured in accordance with the America Water Works Association AWWA C509 and AWWA C515. Gate Valves shall be tested in accordance with Testing Section 5.1 of American Water Works Association AWWA C509 and AWWA C515.

1. Connections: Resilient Seated Gate Valves shall be provided with flanged ends in accordance with ANSI B16.1, class 125 flanges or ANSI B16.42. 4-inch through 12-inch valves shall be provided with ANSI B16.1 Class 250 flanges.

2. Design: Valves shall be non-rising stem. Valves shall be supplied with thick-walled ductile iron bodies, bonnets, and glands providing twice the tensile strength over grey/ductile iron. Valve stems shall rotate freely in the valve bonnet recess. Design of the stuffing box shall permit repacking under line pressure. All valve fasteners shall be rust proof. Valve castings shall be marked with the requirements of AWWA C509 and AWWA C515. The direction of rotation for operating the 2” operating nut or hand wheel to open the valve will be left (counterclockwise); unless otherwise specified. Each 2” operating nut and hand wheel shall have cast thereon in word “OPEN” and an arrow indicating the direction to open. Below ground valves shall be equipped with spur gear for vertical opening.

3. Materials: Valves shall be supplied with ductile iron discs, 2” operating nuts on above ground valves, spur gears for below ground valves and hand wheels for above ground valves. Valves shall be supplied with EPDM encapsulated rubber wedge and EPDM gaskets and O-rings. Stuffing box glands shall be bronze with ductile iron gland followers. Gate valve stem shall be Stainless Steel per latest AWWA standards. Body and bonnet fasteners shall be made stainless steel.

4. Coatings Internal and external coatings shall be Fusion Bonded Epoxy Coating NSF-61 Approved in accordance with AWWA C550.
5. Manual Gearing All Gate Valves 18-inch and larger shall be supplied with spur gearing for this application.
6. Manufacturer: All valves shall be hydrostatically and seat tested per AWWA C509 and C515 to structural integrity. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals.

C. Pump Discharge Flexible Pipe Connectors. Each pump discharge connection shall include a flanged flexible connector, single sphere type, rated at 225 psi maximum working pressure. Connectors shall be installed between the pump and its isolation valves. Connectors shall be model 240AA/EE as manufactured by Proco industries.

D. Dismantling Joint. Dismantling Joints shall be provided on the suction branch of each pump to provide adjustability to Equipment. Longitudinal adjustment shall be accomplished by the telescoping action of the Spigot inside the Flanged Coupling Adapter. The Dismantling Joint shall have a body made of carbon steel per ASTM A53, ASTM A512, ASTM A283 GRC, or ASTM A36 having a minimum yield of 30,000 PSI. The flanges shall be carbon steel per AWWA C207 Class D. The dismantling joint shall have a spigot made of carbon steel per ASTM A53, ASTM A512, or carbon steel having a minimum yield strength of 30,000 PSI. The follower flange shall be ductile iron per ASTM A536, steel section per ASTM A576GR1020HR, or carbon steel having a minimum yield of 30,000 PSI. The finish shall be fusion-bonded epoxy to an average of 12-mil thickness. Studs shall meet ASTM A325 or A307. Tie Rods shall meet ASTM A 193 GR B7. The gaskets shall be Nitrile (Buna N) NSF 61 listed, compounded to resist water, oil acids, alkalies, most (aliphatic) hydrocarbon fluids and many other chemicals. The dismantling joint shall be a Smith-Blair, Inc., 970 series or approved equal.

E. Air release/ Vacuum valve: Air/Vacuum valves shall be fully automatic float operated valves designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall re-open during draining or if a negative pressure occurs.

1. Standards, Approvals and Verification: Valves shall be manufactured and tested in accordance with American Water Works Association (AWWA) Standard C512. Valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components – Health Effects. Manufacturer shall have a quality management system that is certified to ISO 9001 by an accredited, certifying body.
2. Connections: Valve sizes 3 in. (76 mm) and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection. Valve sizes 4 in. (100 mm) and larger shall have bolted flange inlets with threaded or plain outlets and protective hoods to prevent debris from entering the valve. Flanges shall be in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.5 for Class 150 or Class 300 steel flanges. The valve shall have two additional NPT connections for the addition of Air Release Valves, gauges, testing, and draining.
3. Design: The valve body shall provide a through flow area equal to the nominal valve size. A bolted cover with alloy screws and flat gasket shall be provided to allow for maintenance and repair. Floats shall be unconditionally guaranteed against failure including pressure surges. The float shall have a hexagonal guide

shaft supported in the body by circular bushings to prevent binding from debris. The float shall be protected against direct water impact by an internal baffle. The resilient seat shall provide drop tight shut off to the full valve pressure rating. The seat shall be a minimum of .5 in. (12 mm) thick on 2 in. (50 mm) and larger valves and secured in such a manner as to prevent distortion. Valves with working pressures above 400 psig (2760 kPa) shall have metal seats with synthetic seals. On valve sizes 4 in. (100 mm) and larger, the cover shall be fitted to the valve body by means of a machined register to maintain concentricity between the top and bottom guide bushings at all times. The float shall be double guided with a guide shaft extending through the float to prevent any contact with the body. A resilient bumper shall be provided to cushion the float during sudden opening conditions.

4. Materials: The valve body, cover, and baffle shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves. Class 300 ductile iron valves shall be constructed of ASTM A536 Grade 65-45-12 ductile iron. Class 300 steel valves shall be constructed of ASTM A216 Grade WCB cast steel. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N. Class 300 steel valves shall have a 316 stainless steel Seat with Buna-N seal to provide an initial contact to Buna-N with final metal to metal contact to prevent over compression of the resilient seal.

5. Manufacture: The manufacturer shall demonstrate a minimum of five (5) years experience in the manufacture of air valves. When requested, the manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals. The exterior of the valve shall be coated with a universal alkyd primer. Air/Vacuum Valves shall be Series 100 as manufactured by Val-Matic Valve and Manufacturing Corporation, Elmhurst, Il, USA or approved equal.

F. Air Release Valves: Each Pump head shall be equipped with a 1" air release valve and isolating ball valve. Air release valve discharge line shall be piped to the edge of the skid with 1/2" copper tubing. Valve shall include a stainless steel float and compound lever. Valve shall be rated at 150 psi working pressure, shall incorporate a 23/64" diameter orifice, and shall be capable of expelling air at a rate greater than 125 SCFM at 100 psi line pressure. Valves shall be mounted at the pump discharge heads.

G. Provide EBAA Flex-tend Expansion Joint on suction and discharge piping of the station.

H. Surge Anticipator Valve.

1. Surge Anticipator valve shall be single-seated, diaphragm operated, pilot-controlled, globe or angle valve. It shall be spring loaded & hydraulically operated. Valve spring shall be of stainless steel. Seat ring shall be of stainless steel & readily replaceable with no special tools.

2. Diaphragm assembly shall be fully guided, top and bottom. Diaphragm shall be of nylon reinforced Buna-N synthetic rubber and shall be fully supported by the valve casting in both the full-open and full-closed positions to eliminate strain on the diaphragm. All necessary repairs shall be possible without removing valve from the line. Packing glands are not permitted. Disc shall be synthetic rubber (Buna-N) and have a rectangular cross section. Valve disc and seat shall have an anti-cavitation design of intermeshing orifices to prevent cavitation from discharge pressure to atmosphere.

3. The main valve shall be equipped with the following accessories to ensure proper operation.
   a. All control valve pilots shall have stainless steel seats, Buna-N sealing surface and a Buna-N diaphragm. Pilot valve bodies shall be from bronze.
   b. Pressure-sustaining pilot shall be sensitive to valve inlet pressure. Pilot shall be normally closed and spring-loaded with spring tension adjustment. Pilot shall open automatically against the spring-loading set when pilot inlet pressure exceeds the set value. This pilot shall function to maintain a minimum valve inlet pressure which shall prevent the pumps from operating under an unstable or overloaded condition.
   c. Surge anticipation pilot shall be sensitive to discharge pressure. Pilot shall be reverse-acting, spring-loaded diaphragm type that operates hydraulically or pneumatically. This pilot shall function to monitor downstream pressure, opening on a significant drop in discharge pressure.
   d. Isolation cocks shall be provided on control tubing at the valve inlet, outlet and bonnet ports on valves 4" and larger. These valves shall be situated such that the control valve may be manually closed & the valve trim isolated and serviced.
   e. Strainers shall be provided to remove any solids that may be of sufficient size to damage or plug the pilots and other control components. The inner mesh shall be of MONEL and shall be designed to support the outer screen. The outer screen shall be of 0.008" MONEL wire, having a 40 x 40 mesh.
4. An isolation valve shall be provided at the inlet of the surge anticipator valve, conforming to the requirements of the discharge butterfly pump isolation valve specification.
5. Valve shall be model 52-03 as manufactured by Cla-Val Company of Newport Beach, CA, or equal.

2.09 ELECTRICAL

A. Electrical Design

1. Electrical service provided to the pump station will be 480 volt, 3 phase, 60 hertz**.** A main disconnect shall be provided to completely isolate all controls and motor starting equipment from incoming power. Main disconnect shall have a through the door operator, and shall be sized as shown in the pump schedule. Main disconnect shall be interlocked with door.
2. The electrical apparatus and control panel design, assembly, and installation, and the integration of component parts will be the responsibility of the manufacturer of record for this booster pumping equipment. That manufacturer shall maintain at his regular place of business a complete electrical design, assembly and test facility to assure continuity of electrical design with equipment application. Manufacturer, without exception, shall maintain, at his facility, under the same roof as the fabrication, painting, and assembly of the mechanical components, a fully equipped panel shop. Manufacturer, without exception, shall be authorized by Underwriters' Laboratories to label its manufactured control panels as UL Listed under category NITW/NITW7. Manufacturer, without exception, shall conform to the latest edition of NFPA 79 in the manufacturing of its control panels.

3. The manufacture of electrical control panels and their mounting and installation shall be done in strict accordance with the requirements of UL Standard 508A and the National Electrical Code (NEC), latest revision, to afford a measure of security as to the ability of the eventual owner to safely operate the equipment.

4. All service entrance, power distribution, control and starting equipment panels shall be constructed and installed in strict accordance with Underwriter's Laboratories (UL) Standard 508 "Industrial Control Equipment." The UL label shall also include an SE "Service Entrance" rating stating that the main distribution panel is suitable for use as service entrance equipment. The panels shall be shop inspected by UL, or constructed in a UL recognized facility.

5. Control panels shall bear a serialized UL label indicating acceptance under Standard 508A and under Enclosed Industrial Control Panel. In addition, a photocopy of the UL labels for this specific project shall be transmitted to both the project engineer and the contractor for their permanent project files prior to shipment of the equipment covered under these specifications.

6. All control panels shall be E.T.L. Listed under Category 4 - Industrial Control Equipment. Each completed panel shall bear an E.T.L. listing label. The listing label shall include the station manufacturer's name, address and telephone number. The station manufacturer shall have quarterly inspections performed at the manufacturer's facilities to ensure that the products being listed comply with the report and procedural guide for that product.

7. Each electrical equipment item in the station shall be properly grounded per Section 250 of the National Electrical Code. Items to be grounded include, but are not limited to, pump motor frames, control panel, transformer, convenience receptacles, dedicated receptacle for heater, air conditioner, dehumidifier, lights, light switch, exhaust fans and pressure switches.

8. All ground wires from installed equipment shall be in conduit and shall lead back to the control panel to a plated aluminum ground buss specific for grounding purposes and so labeled. The ground buss shall be complete with a lug large enough to accept the installing electrician's bare copper earth ground wire. The bus shall serve as a bond between the earth ground and the equipment ground wires.

9. Electrical equipment shall be protected by a U.L. approved Category C and Category B surge arrestor to suppress voltage surges on incoming power. Surge arrestor shall be connected to the line side of the main disconnect and to ground. The device shall be rated according to IEEE C62.41 Category C to withstand a impulse of 10Kv/10Ka and shall be rated according to IEEE C62.41 Category B to withstand a ring wave of 6Kv/500a and an impulse of 6Kv/3Ka. Pass through voltage to the end equipment for a 480v device shall not exceed 1800V when subjected to a 8ms * 20ms wave shape resulting in the following performance statistics: 3720 joules minimum with a power dissipation of 82,500,000VA at 1800V maximum pass voltage to the protected equipment. Response time shall be less than 5 nanoseconds.

B. Control Enclosure, with Air Conditioner. Controls shall be housed in a NEMA 4 enclosure with integral latches. The control enclosure shall be constructed of 12 gauge steel and the back plate assembly shall be constructed of 12 gauge steel. All indicating lights, reset buttons, selector switches and the operator interface device (OID) shall be mounted on enclosure door and shall be rated NEMA 4. All internal components shall be

mounted and secured to the removable back plate assembly. All equipment and wiring shall be mounted within the enclosure and labeled for proper identification. All adjustments and maintenance shall be able to be done from the front of the control enclosure. A complete wiring circuit and legend with all terminals, components, and wiring identification shall be provided. Enclosure and internally mounted equipment shall be cooled using a cabinet mounted air conditioner. Air conditioner shall be rated NEMA 4, and shall not allow any air exchange from enclosure external air to internal air. Air conditioner shall be sized to assure adequate removal of all heat with all electrical equipment operating at maximum demand.

C. Non Fusible Main Disconnect. A non-fusible main disconnect shall be provided within the controls enclosure to completely isolate all controls and motor starting equipment from incoming power. Main disconnect shall include a through door operator, and shall be sized for the full load amps of the pumping system, plus 15%. Disconnect shall be as manufactured by ABB or Allen Bradley. Main disconnect shall be interlocked with door.

D. Control Power. Power for the controls shall be provided by a control power transformer which shall provide 120 volt, single phase power for the pumping system control operation. Control power transformer shall not be used for any load other than controls. The control power transformer shall be protected on the primary side by control limiting fuses of adequate size and voltage rating. All control components shall be protected by time delay circuit breakers of adequate size. The control power transformer shall be as manufactured by Acme.

E. Conduit

1. All wiring within the equipment enclosure and outside of the control panel or panels shall be run in conduit or metallic wire-ways, except for the watertight flexible conduit and fittings properly used to connect pump drivers, fan motors, solenoid valves, limit switches, etc., where flexible connections are best utilized.
2. Service entrance conduits shall be intermediate metal conduit (IMC) and shall be sized to accept the inbound service conductors in accordance with the National Electric Code. Conduit shall be provided from the utility power source to the pump station, through an opening in the skid and shall terminate at the pump station control center. Service conduit and wiring shall be provided by the installing contractor.
3. Conduit and metallic wire-ways shall be sized for the type, number and size of equipment conductors to be carried, in compliance with Article 358, Article 376 or Article 344 of the National Electrical Code as applicable and NEMA TC-2, Federal WC-1094A and UL-651 – Underwriter's Laboratory Specifications, except that maximum fill shall be 30% of conduit capacity.
4. Where flexible conduit is necessary, the conduit shall be liquid-tight, flexible, metal, corrosion resistant, non-conductive, UL listed flexible conduit. Flexible conduit shall be sized for the type, number and size of equipment conductors to be carried, in compliance with Article 350 of the National Electrical Code.

F. Wiring

1. Motor circuit wiring shall be sized for load. All branch circuit conductors which supply a single motor shall have an ampacity of not less than 125 percent of the motor full load current based upon NEC table 430.250. Wiring shall be dual rated type THHN/THWN, as set forth in Article 310 and 430 Part II of the National Electrical Code.

2. Control and accessory wiring shall be sized for load, type MTW/AWM (Machine Tool Wire/Appliance Wiring Material) as set forth in Article 310 and 670 of the National Electrical Code, except where accessories are furnished with a manufacturer supplied UL approved rubber cord and plug.

G. All alarms shall be indicated by a single red general alarm light. Specific alarm conditions along with procedures for correction shall be displayed in English on the operator interface device (OID).

1. Low Discharge Pressure alarm circuit shall shut down pumping system in the event discharge pressure drops below normal level. Pump station shut-down shall follow Owner defined procedure to protect pumps and motors, and to minimize or eliminate pressure surges from pump shut down. Operator interface device (OID), mounted in enclosure door, shall signal low discharge pressure. Pumping system shall not operate until safety has been manually reset. Pressure monitoring signals shall be 4-20 mA analog signals and through dry contacts only.

2. High Discharge Pressure alarm circuit shall shut down pumping system if discharge pressure reaches a predetermined high level. Pump station shut-down shall follow Owner defined procedure to protect pumps and motors, and to minimize or eliminate pressure surges from pump shut down Operator interface device (OID), mounted in enclosure door, shall signal high discharge pressure. Pumping system shall not operate until pressure is reduced and alarm has been reset. Pressure monitoring signals shall be 4-20 mA analog signals and through dry contacts only.

3. Low Inlet Pressure alarm shall protect the pumps from operating without adequate inlet pressure, which could cause damage to pumps. A pressure sensor shall be installed on the suction manifold to monitor the suction pressure. This feature shall include a short time delay to handle transient conditions which can occur during the stating of a pump. Operator interface device (OID), mounted in enclosure door, shall signal low suction pressure. Pump system shall not start until low suction pressure is corrected and circuit has been reset. Low suction pressure alarm shall pertain to flooded suction and booster applications.

4. Main phase failure and low voltage safety circuit shall retire the pumping system if it experiences low voltage, phase failure or phase reversal as monitored at line-side of control enclosure. Phase monitor shall have a time delay to allow for transient low voltage during motor starting and to allow maximum motor protection. Operator interface device (OID), mounted in enclosure door, shall signal phase failure for any affected pump.

5. Individual Phase Failure And Low Voltage alarm circuitry, as part of the overload relay circuit, shall retire any pump that experiences high current draw, low voltage, phase failure or phase unbalance as monitored at the load-side of each pump motor contactor by the overload relay. Each pump motor shall have its individual protective device and time delay to allow for transient low voltage during motor starting to allow maximum motor protection. The individual pumps or pumping system shall not operate until the voltage problem has been corrected and safety has been manually reset. Incoming phase monitor safety circuit as the only phase failure sensing device is not acceptable.

6. Individual pump cycle failure alarm shall be activated if a pump is required to start at a greater frequency than that allowed by the motor manufacturer. The

individual pumps or pumping system shall not operate until the problem has been corrected and alarm has been manually reset.

7. Individual pump failure alarm shall retire any pump that fails to produce pressure for any reason. Sensor shall be independent of incoming pressure, and shall be inhibited for five seconds after pump is required to start. Thereafter it shall be active until the pump is retired. Failure shall be displayed on the OID, and the red alarm light shall be illuminated. Controls shall automatically shift the sequence to the remaining pump(s).

H. Panel face switches and lights:

1. Individual pump run lights - Green
2. General alarm light - Red
3. Individual pump Hand-Off-Auto switches
4. PLC Test-Off-Auto switch

I. PLC shall date and time stamp functions using its on board real time clock calendar.

J. Light test sequence. Pressing the reset button for 5 seconds shall illuminate all indicating lights.

K. All pumping system shutdowns shall be of the controlled type which sequentially phases pumps off at user selectable intervals to reduce water hammer within the distribution system. Activation of any automatically reset alarm, three times within thirty minutes, shall cause a hard lockout of the pumping system requiring manual reset.

L. The pumping system shall include a NEMA 4, LCD display which shall be mounted on the control panel door. This device shall allow the operator to view and modify each register in the PLC. The unit shall store its messages in non-volatile memory. The operator interface device shall incorporate password protection for protecting data integrity. The device shall allow for display and modification of all timer values, set points, lockout times, etc. The device shall communicate with the PLC through an IP Ethernet protocol. In addition to normal data entry keys, the device shall include a minimum of the following function keys labeled:

1. Events: Causes the last 254 sequential pumping system events with date and time of occurrence to be displayed. Events shall include but shall not be limited to: alarms, starting of individual pumps, stopping of individual pumps.
2. Pumplog #1: Operator shall be able to scroll through the historical pumping system flows and pressures for up to the last 7 days. Sampling time periods shall be changeable by the operator (from 10 seconds to 60 minutes). Averages shall be taken over the sample period and the average shall be recorded with date and time stamp.
3. Pumplog #2: Station flow and pressure shall be shown every second for the previous 60 seconds and every minute for the previous 90 minutes. If a shutdown occurs, the flow and pressure tables shall be locked in so that the operator may view pumping system performance immediately before the shutdown occurred.
4. Status: OID shall display the current operating status. When the station is running, the display shall show the setpoint pressure, actual pressure upstream and downstream of the control valve, and flow. The last nine alarms recorded in memory shall be displayed with related detailed information on the alarm, time

of occurrence, date, pumps operating at time of alarm. Information as to how to correct the alarm condition shall be displayed

5. Daily Log/Total: Shall display the following: last time of log reset, individual pump run times, run times since last reset, number of pump starts, pump starts since last reset, total flow, and total flow since last reset.

6. Scroll Key: Shall be used to scroll up and down through data.

M. The OID shall be an information system only and not required for pumping system operation. No switches, reset buttons, general alarm light, or run lights shall be included within this unit. The pumping system shall be fully functional in the event of OID failure. Display device shall be as manufactured by Schneider Electric.

2.10 INSTRUMENTATION

A. Pressure Gauges

1. System suction and discharge pressure gauges shall be panel mounted. Provide a pressure gauge on each pump discharge and the discharge header and located as shown on the drawings.

2. Pressure gauges shall be glycerin or silicone filled with a built-in pressure snubber to reduce wear from vibration.

3. Pressure gauges shall have a minimum 4.5” diameter face, complying with ASME B40.100, Grade A.

4. Pressure gauges shall be turret style. Case material shall be stainless steel with clear acrylic faces. Each gauge installation shall include an isolation ball valve.

5. The gauge shall be bottom connected and accept a 1/4" NPT female thread. Combination pressure gauge range and scale graduations shall be in PSI and feet of water. Pressure gauges shall be rated at a minimum of 30% higher pressure than the highest attainable pressure from operations of the pumps at shutoff head conditions. Gauges shall include bronze internals.

6. All gauges will be panel mounted off the pipeline and be connected to their respective sensing point via stainless steel tubing. The gauge trim tubing shall be complete with both isolating and vent valves, and the tubing shall be so arranged as to easily vent air and facilitate gauge removal. Gauges mounted directly to the pipeline or at the sensing point will not be accepted.

B. Pressure Transmitters

1. The manufacturer shall provide two-wire, 4 to 20 mA dc analog output pressure transmitter.

2. Pressure transducer shall be mounted on the discharge header and shall provide all pressure signals for the control logic.

3. The pressure transmitter shall be provided with direct connect pressure seals.

4. Accuracy: ±0.25% of calibrated span.

5. Span Limits: From 1 to 1000 psi

6. Damping: Settable for a range of none to 8 seconds.

7. RFI Protection: The maximum error shall be no more than an additional ±0.1% of calibrated span for 30 V/m field intensity between 27 and 1000 MHz.

8. Resolution of the transducer shall be greater than the resolution of the analog to digital conversion for PLC operation. Transducer shall be rated for pressures

greater than station discharge pressure, and shall provide gauge pressure output, rather than absolute pressure.

9. The electronics housing shall be NEMA 4X rated and constructed of 316 stainless steel or aluminum with an epoxy finish. It shall consist of two compartments for field wiring and electronics. The housing shall be sealed with O-rings for double protection against moisture or other contaminants.
10. Electronics shall be easily field replaceable.
11. The pressure transmitter shall have an LCD Indicator with on-board pushbuttons for calibration and configuration.
12. The pressure transmitter shall be connected direct to process piping or pressure seal with 1/2 NPT external threads to process piping.
13. Sensor material shall be 316 S.S.
14. Unit shall be outdoor rated and include stainless steel flanges and include SS tag for FM explosion proof rating. The unit shall be provided with an overpressure limit of 1500psi. Input range shall be 150psi.
15. Power supply shall be 24 VDC. Unit shall be Rosemount model 2088 or approved equal.

2.11 MANUFACTURER

A. Acceptable Manufacturers:

1. FLO-PAK (Patterson Pump Company)
2. Motor Controls Inc.
3. Or Engineer Pre-Approved Equal.

B. The pump station manufacturer shall provide certification that station design, construction and controls have been reviewed and certified by Underwriters Laboratories Inc. The station manufacturer shall have listings under Industrial Control Panels and Factory Automation Equipment (Cat. No. Packaged Pumping Systems). These certifications are to ensure that the customer is receiving a safe, and thoroughly tested product, which meets national quality standards.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Unloading and installation is the responsibility of the Contractor. All materials, including lubricants and anchor bolts, equipment, and labor to install the pump shall be provided, installed and/or performed by Contractor.

B. Pumping system manufacturer shall supply a technician for one eight (8) hour day to meet the shipment and advise the contractor on unloading and setting the pumping system.

C. When discharge piping, electrical connections, and electrical inspection have been completed, the pumping system manufacturer shall be contacted for startup. A minimum one week notice shall be given to manufacturer prior to scheduled startup date. During start up, the complete pumping system shall be inspected for proper installation, and shall be given a running test of normal start and stop, and fully loaded operating conditions. During this test, each pump shall demonstrate its ability to operate without undue vibration, or overheating and shall demonstrate its general fitness for service. All defects shall be corrected and adjustments made at the expense of the pumping system

manufacturer. Test shall be repeated until satisfactory results are obtained. Startup assistance shall be provided by the manufacturer of at least one 8 hour day.

3.02 FIELD TESTING

A. Start-up service support shall be provided by the pump station manufacturer. A minimum of one day of service shall be provided at initial commission with the second day being provided approximately one month after initial start-up. At the first visit, a training session shall be given to the owner or the Owner's representative to familiarize them with the pumping system operation, maintenance and adjustments. The second day shall be used to fine-tune the system operation and to provide follow-up training. During start-up the Contractor shall operate the pumps through normal start and stop, and full load conditions. The pump station manufacturers shall make any adjustments and correct any defects at no cost to the Owner. Tests shall be performed until satisfactory results are obtained. A training session shall be performed at the time of start-up.

B. Alignment and Vibration Analysis:

1. The Contractor shall laser align the pumps and motors. The laser alignment shall be completed to verify the angular and offset tolerances specified by the manufacturer. A laser alignment report shall be provided showing the results of the recorded data.

2. The Contractor shall provide a full vibration analysis of the high service pumping units including the pumps and motors. The measurement locations for the motor shall be recorded at a minimum of five points and the locations for the pump shall be recorded at a minimum of the specified measurement locations called out by the Hydraulic Institute. The frequency spectrum is to be recorded to at least 192,000 CPM with the lines of resolution set at a minimum of 6,400 lines. The vibration analysis shall also include a determination of the natural frequency. If the natural frequency is within a possible operating envelope of the equipment, the System Integrator shall lockout operation in the VFD at that frequency. The margin of safety to be used shall be agreed upon by the Engineer and System Integrator. A full report showing the frequency response up to a minimum of 25,000 CPM shall be provided, and the analysis must show that the vibration in the preferred operating range of the pumping units is within the latest edition of the standards held by the Hydraulic Institute.

3. Any corrective action required to bring the pumping units into compliance shall be the responsibility of the Contractor.

END OF SECTION

SECTION 46 0103
STARTUP AND COMMISSIONING PROCEDURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Pre-Startup and Startup procedures.

B. Submittal requirements.

C. Owner operating personnel pre-Startup orientations.

D. Prefunctional checklist requirements.

E. Functional test procedures.

F. Scope and procedures for commissioning.

1.02 RELATED REQUIREMENTS

A. Section 46 0106 - Operation and Maintenance Manual.

1.03 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures; except:
   1. Make submittals on time schedule specified by Owner's representative.
   2. Submit draft submittals intended for the use of the Owner's representative, in preparing final documents, in editable electronic format, Microsoft Word 2010, or later edition, preferred.
   3. Allow for time required for review and approval.

B. Summary Startup and Commissioning Schedule: Within 60 days after award of Contract, submit anticipated dates for Phases 1 and 2, with start and duration of major testing activities; indicate activities on the critical path.
   1. Re-submit anticipated startup dates monthly, but not less than 4 weeks prior to Startup.

C. Startup Plan and Forms.

D. Pre-Functional Checklists.

E. Functional Test Procedures and Forms.

F. Commissioning Plan.

G. Completed Pre-Functional Checklists.

H. Completed Startup Reports.

I. Completed Functional Test Reports.

J. Completed Commissioning Reports.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Contractor shall provide qualified personnel handling, equipment, testing equipment, fluids, meters, tools, etc., necessary for initial startup and calibration of all project facilities.
   2. Where required elsewhere herein the Technical Specifications, Contractor shall require qualified manufacturers' representatives and technical staff to be present for the applicable startup, calibration and adjustment of equipment provided by manufacturer.
   3. All technical support shall be available as needed by the Contractor to complete startup, calibration and adjustment of the Project at no cost to the Owner.

PART 2 PRODUCTS

2.01 DOCUMENTATION IDENTIFICATION SYSTEM

A. Give each submitted form or report a unique identification; use the following scheme.

B. Type of Document: Use the following prefixes:
   1. Pre-Functional Checklist: PFC-.
   2. Startup Plan: SP-.
   3. Startup Report: SR-.
   4. Functional Test Procedure: FTP-.
   5. Functional Test Report: FTR-.

C. For Unit Processes: Use the Unit Process specification section number (series 4600xx) and assign letters sequentially (A, B, C, etc.) to indicate the commissioning activities relevant to the process as a whole.

D. For Individual Components: Use the unique Plant ID number; see Section 46 0500.

E. Test, Revision, or Submittal Number: Number each successive iteration sequentially, starting with 1.

F. Example: FTP-460023-A.2 would be the Functional Test Procedure for the Pump Station, revision 2.

G. Example: FTP-460023-001.1 would be the Functional Test Procedure for equipment item 1 in the Influent Pump Station, probably a pump, first submittal.

H. Example: PC-460023-001.2 would be the Pre-Functional Checklist for equipment item 1 in the Influent Pump Station, probably a pump, revision 2.

2.02 TEST EQUIPMENT

A. Provide all testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will not become the property of Owner.

B. Test Equipment Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
   1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5 degree F and resolution of plus/minus 0.1 degree F.
   2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.
   3. Calibration: According to the manufacturer's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.

C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

D. Dataloggers: Independent equipment and software for monitoring flows, currents, status, pressures, etc. of equipment.

PART 3 EXECUTION

3.01 STARTUP PLAN AND STARTUP

A. Startup Plan: Prepare an overall startup plan covering all operating equipment, devices, and unit processes, with forms for startup reports.

1. Organize the plan in sequence of startup, grouped by Unit Process, and proceeding from individual components to sub-systems to Unit Process.
2. For each Unit Process, prepare a Startup Report form.
3. List all equipment by Plant ID and description.
4. Include anticipated date and duration of startup and functional testing for each item.
5. Cross-reference individual equipment Startup Plans, Startup Report forms, Pre-Functional Checklists, and Functional Test Procedures by identifying number.
6. If special equipment, personnel, or other conditions are necessary for startup or testing, describe them.
7. Submit for approval and revise as directed.

B. Unit Process Startup Report Forms: Prepare a form for each Unit Process, for recording results of startup.

C. Updating Plan: Keep plan up to date as startup and testing progress.

D. Equipment Startup Plans: Prepare a Startup Plan for each item of operating equipment and device.
1. Incorporate manufacturer's recommended startup procedures, checklists, etc.
2. Reference Pre-Functional Checklist by identifying number.
3. If Pre-Functional Checklist covers all startup activities, no separate equipment startup plan is necessary; cross-reference the Pre-Functional Checklist on overall Startup Plan with notation that no separate equipment startup plan is required.

E. Operating Personnel Orientations: Prior to startup of any Unit Process, or modified portion of existing Unit Process, conduct an operating personnel orientation.
1. Timing: Not more than 2 weeks and not less than 1 week prior to startup so that personnel can review O&M Manual.
2. Owner will designate personnel to attend; also require attendance by installers' and manufacturers' representatives.
3. Handouts: Make minimum of 6 printed copies of relevant layouts and diagrams from O&M Manual.
4. Review the sequence of startup activities, the Pre-Functional Checklists and startup forms, and explain the expected results.
5. Review and discuss problems that might occur during startup, especially any not discussed in the O&M Manual because they would not be encountered in normal operation, and preparations made to correct them.
6. Spend at least 1 hour in visual orientation on-site, pointing out all components of the process and answering questions.

F. Execution: Execute startup of each item of operating equipment, device, and unit process; fill out relevant Startup Report form
1. Verify that startup procedures are correctly described in O&M Manual.
2. Submit Pre-Functional Checklists and equipment startup reports together with overall Unit Process Startup Report.
3. Submit completed Unit Process Startup Reports within two days of completion.

G. Deficiencies: Correct deficiencies and restart, at no extra cost to Owner; if difficulty in correction would delay progress, report deficiency immediately.

3.02 PREFUNCTIONAL CHECKLISTS

A. Draft Checklists: Prepare a Pre-Functional Checklist for each item of operating equipment, device, and unit process.
1. Submit for approval and revise as directed.

2. No sampling of identical or near-identical items is allowed.
3. These checklists do not replace manufacturers' recommended startup checklists, regardless of apparent redundancy.

B. Forms: Include the following types of information:
1. Plant ID number.
2. Manufacturer, model number, and relevant capacity information.
3. Serial number of installed unit.
4. List of inspections to be conducted to document proper installation; these will be primarily static inspections and procedures; for equipment and systems may include normal manufacturers' start-up checklist items and minor testing.
5. Include field quality control inspections and tests specified in individual specification sections.
6. Sensor and actuator calibration information.
7. Status of O&M data submissions.
8. Status of Startup Plan submissions.
9. Status of Training Plan submissions.
10. Certification by installing contractor that the unit is properly installed and ready for Startup
11. Spaces for witnessing, dates, and conditions.

C. Execution: Fill out and submit Pre-Functional Checklists after completion of installation of each item of equipment.
1. Each line item without deficiency is to be witnessed, initialed, and dated by the actual witness; checklists are not complete until all line items are initialed and dated complete without deficiencies.
2. Checklists with incomplete items may be submitted for approval provided the Contractor attests that incomplete items do not preclude the performance of safe and reliable Functional Testing; re-submission of the Checklist is required upon completion of remaining items.
3. Individual Checklists may contain line items that are the responsibility of more than one installer; assign responsibility to appropriate installers or subcontractors, with identification recorded on the form.
4. If any Checklist line item is not relevant, record reasons on the form.
5. Regardless of these reporting requirements, Contractor is responsible for correct startup and operation.
6. Submit completed Checklists within two days of completion.

D. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner; if difficulty in correction would delay progress, report deficiency immediately.

3.03 FUNCTIONAL TESTS

A. At least one Functional Test is required for each item of operating equipment, device, and unit process, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.
1. Some test procedures are included in the Contract Documents; where Functional Test procedures are not included in the Contract Documents, propose test procedures appropriate to the equipment or process being tested.
2. Examples of Functional Testing:
a. Test the dynamic function and operation of equipment using manual (direct observation) or monitoring methods under full operation.

b. Unit processes are run through all the control system's sequences of operation and components are verified to be responding as the sequence's state.

B. Functional Test Procedures: Prepare descriptions of functional tests, with forms for recording test conditions and results.
1. Submit for approval and revise as directed.
2. List steps to be taken to demonstrate performance, in order of occurrence.
3. List test apparatus, if any.
4. List performance criteria which if achieved demonstrate satisfactory performance.

C. Functional Test Report Forms: Include the following types of information:
1. Plant ID number, for equipment, or Unit Process identification.
2. Manufacturer, model number, and relevant capacity information.
3. Serial number of installed unit.
4. Test apparatus calibration information.
5. List of test steps, with spaces for results, witnessing, and dates.
6. Final results.

D. Execution: Perform Functional Tests and fill out and submit test report form after completion of test.
1. Verify that operating functions and procedures are correctly and completely described in O&M Manual.
2. Use the approved test report form.
3. Submit completed test report form within two days of completion.
4. If a deficiency is not corrected and re-tested immediately, document the deficiency and intentions regarding correction.

E. Deficiencies: Correct deficiencies and re-test at no extra cost to Owner, including cost of Owner representative witnessing; if difficulty in correction of deficiency would delay progress, report deficiency immediately.
1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents or does not perform properly.
2. Coordinate scheduling of re-tests with Owner's representative.
3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.

F. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to seasonal requirements or other conditions; performance of these tests remains the Contractor's responsibility regardless of timing.

3.04 TEST PROCEDURES - GENERAL

A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

B. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.

C. Sampling: Where Functional Testing of fewer than the total number of multiple identical or near-identical items is explicitly permitted, perform sampling as follows:
   1. Identical Units: Defined as units with same application and sequence of operation; only minor size or capacity difference.
   2. Sampling is not allowed for:
      a. Major equipment.
      b. Life-safety-critical equipment.
      c. Pre-Functional Checklist execution.
   3. XX = the percent of the group of identical equipment to be included in each sample; defined for specific type of equipment.
   4. YY = the percent of the sample that if failed will require another sample to be tested; defined for specific type of equipment.
   5. Randomly test at least XX percent of each group of identical equipment, but not less than three units. This constitutes the "first sample."
   6. If YY percent of the units in the first sample fail, test another XX percent of the remaining identical units.
   7. If YY percent of the units in the second sample fail, test all remaining identical units.
   8. If frequent failures occur, resulting in more troubleshooting than testing, stop the testing and perform and document a checkout of the remaining units prior to continuing testing.

D. Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the “observation”).

E. Simulating Conditions: If necessary, artificially create the necessary condition for the purpose of testing the response of a sensor or process.

F. Simulating Signals: Disconnect the sensor and use a signal generator to send an appropriate signal to amperage, resistance or pressure to the transducer and control system to simulate the sensor value.

G. Over-Writing Values: Change the sensor value known to the control system in the control system to see the response of the system; for example, change the dissolved oxygen level to see the response of the aeration system.

H. Indirect Indicators: Remote indicators of a response or condition, such as a reading from a control system screen reporting a valve to be 100 percent closed, are considered indirect indicators.

I. Trending: Where trending is called for in Functional Test Procedures:
   1. For points monitored by the process control system, use the trending function of the process control system, after having verified its proper operation using its Functional Test.
   2. For characteristics that cannot be measured using sensors, take samples and perform laboratory analysis.
   3. Provide hard copies of trended data in columnar format with time down left column and at least 5 columns of point values on same page.
   4. Graphical output is desirable and is required for all output if the system can produce it.
   5. Organize trended data by Unit Process.
   6. Trending may be used to augment, but not replace, manual testing.

J. Laboratory Analysis: Use an independent testing agency specializing in water/wastewater testing; obtain Owner's approval of agency prior to starting testing.

3.05 COMMISSIONING PLAN AND COMMISSIONING

A. Commissioning Plan: Prepare an overall commissioning plan covering all unit processes, with forms for reports.
   1. Organize the plan in sequence by Process.
   2. List the commissioning activities to be conducted.
   3. Include anticipated date and duration of each activity.
   4. Cross-reference individual equipment Startup Plans, Startup Report forms, Pre-Functional Checklists, and Functional Test Procedures by identifying number.
   5. If special equipment, personnel, or other conditions are necessary for commissioning, describe them.
   6. Submit for approval and revise as directed.

B. Execution: Execute each commissioning activity; fill out relevant report form.
   1. Submit completed Reports within two days of completion.

C. Deficiencies: Correct deficiencies found at no extra cost to Owner.

END OF SECTION

SECTION 46 0106
OPERATION AND MAINTENANCE MANUAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Operation and maintenance data submittals.

1.02 RELATED REQUIREMENTS

A. Section 01 3050.10 – Shop Drawings, Product Data.

B. Individual Product Sections: Additional requirements for operation and maintenance data.

PART 2 OPERATION AND MAINTENANCE MANUAL

2.01 DOCUMENT FORMATS - FINAL

A. Editable Document Format: Microsoft Word 2010 or later, Open Document Format (ODF), or Rich Text Format (RTF); use for documents prepared specifically for this plant.

B. PDF Format: Adobe Reader version 10 or later; use for:
   1. Approved submittals, such as product data, shop drawings, O&M data; furnish PDF of approved copy, not original
   2. O&M documents prepared by manufacturers.
   3. Project record documents, as described in Section 01 7800 - Closeout Submittals and in individual Sections.
   4. Startup checklists and functional test reports.
   5. Other documents that will not need to be modified in the future.

C. Drawings: Convert to PDF format, maintaining original document page size (i.e. do not reduce a large size drawing to 8-1/2 by 11, or any different size).

2.02 ORGANIZATION OF MANUAL

A. The function of this manual is to make needed information quickly and easily found and understood. To increase effectiveness the following general principles should be observed:
   1. Generally, use less narrative and more diagrams, charts, and checklists.
   2. An operator looking for a specific piece of information should not have to read an essay to find it.
   3. Do not include information that is not specific to this plant.
   4. If both graphic and text are needed for the same subject, place the graphic above the text.
   5. If footnotes or legends are used, make them large enough to read easily and place above or to the left of the chart or table they refer to, so they are not overlooked.
   6. If a graphic will fit in a page of a normal browser window, insert it as a picture in the page; if very large, link to it as an external PDF file.
   7. Very large drawings and diagrams should not be used as a primary information source; if they are the only source of a particular item of information, consider snipping relevant portions to insert as pictures.
   8. Content management system software uses HTML editors in which tables are often difficult to format; charts and tables may be made as pictures if the original editable document is also furnished and linked to.

2.03 EMERGENCY OPERATIONS

2.04 PLANT-WIDE INFORMATION

A. Provide the following information from a plant-wide point of view.

B. Plant Layout: Simple one-page plan-view diagram identifying buildings, structures, manholes, pipelines, major valves, and incoming utilities.
   1. Include locations of equipment that first-responders would be concerned with, including incoming power lines, main breakers, gas meters, fuel tanks, chemical storage, backflow preventers, fire hydrants, etc.
   2. Do not reduce construction site drawings unless they are legible at small size; otherwise, prepare simplified diagram with only necessary detail.

C. Overall Process Description: Briefly describe type(s) of treatment process used and summarize the unit processes involved.
   1. Redundancy: Describe specific provisions that allow for continued operation in case of unit outages.
   2. Future Development: Describe what provisions for future additions or expansion have been made, such as piping stubs, extra channels, etc.

D. Summary of Design Data: Tabular view of overall plant and individual unit processes; show design population, flows, design capacity, and effluent quality goals.

E. Flow Diagrams: Simple schematics showing individual processes and flow sequence; diagrams that relate flows to actual physical layout are preferred.

F. Hydraulic Profile: Simple schematic of hydraulic profile through entire process.

G. Equipment Cross-Reference Lists: Tabular summary lists of all equipment items by:
   1. Plant identification number in alphanumeric order.
   2. Flow sequence order and plant identification in alphanumeric order.
   3. Generic item type (e.g. valve, controller, pump) and plant identification number in alphanumeric order.

H. Electrical Power: Simple schematic of power distribution system, showing switchboards, panelboards, and circuits; diagrams that reflect actual physical layout are preferred.

I. Standby Power: Briefly describe nature of standby power and procedure for conversion to standby power and vice versa. (Details to be given in Unit Process - Main and Standby Power.)

J. Post-Disaster Startup: Assuming both normal and standby power go out, describe in detail the process of re-starting the plant.
   1. Include a list of settings that are not saved upon power loss.
   2. Identify which functions are critical and which are non-critical.
   3. If sequencing is critical, describe the sequence of starting equipment and processes including clearing of lockouts.

K. O - Safety: Describe safety and accident prevention procedures.
   1. Explain Confined Space entry precautions and define procedures.
   2. Include first aid procedures for dealing with accidents or reference a first aid handbook and kit kept on hand.

L. "Manual on the Manual": Describe editing existing pages, creating new pages, modifying menus, linking to external files, moving to a different server or host, and restoring from backup.
   1. Detail the steps in the backup process, the schedule for making backups, and where backups are stored.
   2. Detail the login security policy, how to change access rights, and who can do so.
   3. Provide a printable version of the "manual on the manual" (PDF) and include a link to it on the home page.

2.05 PLANT MANAGEMENT INFORMATION

A. O - Preventative Maintenance: Description of asset management system to be used to schedule and track maintenance activities.

B. O - Operator and Management Responsibilities: Describe plant operating and maintenance personnel required, operator certification requirements, and estimated work hours to operate and maintain the plant.
   1. Include time allowances for continuing education.
   2. Describe any necessary delegation of authority by permit holding organization.

2.06 EQUIPMENT INFORMATION

A. For each individual item of equipment, provide the following information; use a consistent format for all equipment, including order of presentation of information and starting each item on a new page.

B. See individual product specification sections for additional requirements.

C. Equipment Summary Sheet:
   1. Plant identification number; if there is more than one item that is exactly identical, use one sheet for all.
   2. Generic name of item (e.g. Return Activated Sludge Pump).
   3. Location in plant, such as Unit Process.
   4. General description including component parts.
   5. Manufacturer name, model or series name or number, serial number, and date installed.
   6. Installer/Supplier name, address, contact name and phone number.
   7. Service organization name, address, contact name and phone number.
   8. Identify where spare parts and consumables are stored on site.

D. Design Data: List design capacity and other operating parameters.
   1. Pumps: Include pump curve for the specific pump installed, shutoff head, discharge head, and suction head; identify impeller trim and motor horsepower.
   2. Startup Form: Recorded actual values of design parameters at startup.
   3. Manufacturer's design data sheets may be linked to or referenced.

E. Product Data: Project record copy of approved submittals.
   1. If no approved product data submittal exists, provide manufacturer's current data sheet marked to clearly identify specific products and components that were installed; delete or cross out inapplicable information.

F. Shop Drawings: Project record copy of approved shop drawings.

G. Wiring Diagrams: As installed.

H. Operating Procedures:
   1. Describe start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
   2. Manufacturer's printed procedures may be used, provided they are in electronic form.
   3. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific equipment.

I. Maintenance Requirements:
   1. Provide summary of necessary maintenance activities for this equipment in this particular plant, prepared from manufacturer data, with necessary frequency.

2. Describe routine procedures for preventative maintenance and trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
3. Manufacturer's servicing and lubrication schedule, and list of lubricants required.
4. Manufacturer's illustrations, assembly drawings, and diagrams required for maintenance.
5. Manufacturer's printed procedures may be used, provided they are in electronic form.
6. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific equipment.

J. Tools: List of tools necessary for adjustment, operation, maintenance and disassembly; identify by manufacturer and model number any special tools that are specific to the equipment, not commonly encountered in repair shops, or only available from limited sources.

K. Replaceable Parts and Consumable Supplies:
1. Manufacturer's parts list with model numbers, prices, and edition date.
2. List of parts that manufacturer recommends having on hand, with quantities.
3. List of parts that require long lead time, with time estimates.
4. Nearby Sources: Name, address, phone number.

L. Equipment Startup Reports:
1. Completed Pre-Functional Checklist.
2. Completed Functional Test report.

M. Additional Requirements: As specified in individual product specification sections.

END OF SECTION

SECTION 46 0509
PIPING AND EQUIPMENT SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Supports, hangers, and guides.

B. Vibration isolation and snubbers.

C. Seismic restraints for suspended piping.

D. Anchors and fasteners to supporting structures.

1.02 REFERENCE STANDARDS

A. ASCE 7 - Minimum Design Loads for Buildings and Other Structures; 2010, with 2013 Supplements and Errata.

B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.

C. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999 (Reapproved 2014).

D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.

E. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping; 2014.

F. ASTM A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality; 1990b (Reapproved 2012).

G. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Furnish support and anchorage items to be embedded in concrete to concrete form installer for installation in forms.

1.04 SUBMITTALS

A. See Section 01 3050.10 – Shop Drawings, Product Submittals.

B. Product Data: Manufacturer's published literature for each factory-fabricated item, showing size, materials of construction, and loading capacity.

C. Shop Drawings: Detailed fabrication and installation drawings showing how each item of equipment, enclosure, and piping is supported and anchored.
   1. Identify item supported/anchored and loads on supports/anchors
   2. For supports, show member sizes, components, and connections.
   3. For vibration isolation, identify isolator type, base type, and loads on each isolator.
   4. For seismic restraints for suspended piping, identify design loads in all directions.
   5. For anchors, show anchor and fastener type, size, quantity, diameter, depth of penetration, edge distance, and spacing.
   6. Include the calculations and prescriptive design tables used for design, sizing, and selection.

1.05 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 DESIGN REQUIREMENTS

A. Drawings do not show all details of supports and anchors; design supports and anchors to resist all live and dead loads.
   1. Design Loads: As specified in ASCE 7.
   2. Comply with applicable requirements of authorities having jurisdiction.
   3. Select and design supports for piping in accordance with MSS SP-58.

B. Anchor all equipment, enclosures, and piping, including fittings, valves, and other items attached to piping, to structure capable of supporting them, whether such anchorage is shown on the drawings or not.

C. Provide cathodic protection for buried ferrous piping.

D. Provide vibration isolation for pumps, blowers, air compressors, and other equipment as indicated on the drawings.
   1. Provide vibration isolation for piping connected to equipment provided with vibration isolation, for specified distances from equipment.

E. Provide support for all piping not indicated to be direct-buried, whether such support is shown on the drawings or not; unless otherwise indicated, support piping from structure above.

F. Provide thrust blocking for direct-buried piping whether shown on the drawings or not.
   1. At minimum, provide thrust blocking at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.
   2. Do not use thrust blocking for any plastic piping.

G. Bracing: Brace hanging pipes against movement using longitudinal and lateral sway bracing and seismic restraints.
   1. Provide supports, braces, and anchors to resist gravity and seismic design forces.
   2. Brace vibration isolator-supported pipe with cable bracing or other means designed to prevent transmission of vibration to the structure.
   3. Brace every run 5 feet or more in length with at least two transverse and one longitudinal bracing locations.
   4. Piping of Ductile Iron or Steel, with Welded or Screwed Connections:
      a. Provide transverse bracing at spacing not more than 20 feet on center.
      b. Provide longitudinal bracing at spacing not more than 20 feet on center.
   5. Other Piping:
      a. Provide transverse bracing at spacing not more than 20 feet on center.
      b. Provide Longitudinal bracing at spacing not more than 20 feet on center.
   6. Provide lateral restraint for risers at not more than 20 feet on center or as required for horizontal runs, whichever is less.

H. Do Not:
   1. Do not support piping connections to equipment by the equipment; provide separate pipe supports.
   2. Do not support large or heavy valves, fittings, or equipment by the piping; provide separate supports.
   3. Do not support pipes by other pipes.
   4. Do not use existing supports to support additional new piping unless it is shown that existing supports are adequate for the additional loads; provide reinforcement if necessary.
   5. Do not block equipment access areas or bridge crane runs with pipe supports.

I. Piping Support Types:
   1. Single Horizontal Suspended Piping: Use adjustable swivel-ring hangers.
   2. Single Horizontal Wall Mounted Piping: Use wall brackets.
   3. Multiple Horizontal Piping: Use racks for floor-supported piping and trapeze hangers for suspended piping.
   4. Horizontal Pedestal Mounted Piping: Use saddle type supports.
   5. Vertical Piping Adjacent to Walls: Use wall brackets as appropriate.
   6. Insulated Piping: Provide oversized supports to fit insulation inserts, galvanized or stainless steel protection shields, and oversized rollers.
   7. Attachments to Structural Steel: Use beam clamps attached to top flange.
   8. Base Flanges Adjacent to Rotating Equipment: Provide pedestal type support under pipe.
   9. Pipe Sizes 2.5 inch and Larger: Provide means of vertical adjustment after erection while supporting load.

J. Piping Support Locations:
   1. Provide supports at spacings indicated by MSS SP-58.
   2. Provide individual supports at piping changes in direction and changes in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the drawings.

K. Piping Isolation Locations: Isolate piping supports for the following distances from equipment:
   1. Where a flexible piping connector occurs within specified distance, pipe isolation is not required beyond the connector.

2.02 MATERIALS

A. Materials: Unless otherwise indicated, provide all support products made of one or more of the following:
   1. Stainless steel, TP304, with No.1 finish.
   2. Carbon steel, ASTM A36/A36M, with hot-dipped galvanized finish, ASTM A153/A153M.
   3. Polyvinylchloride (PVC) or chlorinated polyvinylchloride (CPVC) plastic.
   4. Chloroprene rubber.
   5. Polyethylene.

B. Structural Steel Shapes: Use carbon steel with shop primed finish only in areas defined as "Indoor Dry".

C. Seismic Restraints for Suspended Piping and Equipment: Cable and rigid types; arranged to resist seismic loads in all directions.
   1. Cable Type: Steel wire strand cables, with protective thimbles to prevent cable wear.
      a. Capacity: Based on the lesser of cable capacity or anchor load taking into account bracket geometry.
      b. Connections: Use overlapping wire rope U clips, cable clamping bolts, swaged sleeves or seismically rated tool-less wedge insert lock connectors.
   2. Rigid Type: Steel elements capable of carrying compression and tension loads in addition to seismic loads.
      a. Capacity: Based on the lesser of structural element capacity or anchor load taking into account bracket geometry.
      b. Anchorage: Capable of carrying additional tension loads generated by the vertical component of the rigid brace compression which is additive to any static load requirements on the system.
   3. For Clevis Hangers: Internally brace clevis hanger bracket cross bolt to prevent deformation.

4. For Vertical Suspension Rods: Provide bracing of sufficient strength to prevent rod buckling from vertical compression forces utilizing series of attachment clips.

D. Racks and Trapeze Hangers: Fabricate of structural steel channel shapes, designed to suit conditions at points of installation.
   1. Use clamps or clips to secure pipes to racks, while allowing sliding or rolling movement due to thermal expansion.
   2. At each support where an anchor is not provided, provide an intermediate pipe guide that allows movement but keeps pipe aligned.

E. Hanger Rods:
   1. Material: Carbon steel, ASTM A576.
   2. Rod Diameter: 1/2 inch, minimum.
   3. Rod Diameter: As indicated on the drawings.

F. Bracing: Structural steel angle or channel shapes, not rods or cables.

G. Brackets: Welded, pre-punched with minimum of two fastener holes.

2.03 PIPE SUPPORTS, GUIDES, AND ANCHORS

A. Pipe Supports:
   1. Liquid Temperatures Up To 122 degrees F:
      a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
      b. Support From Below: MSS SP-58 Types 35 through 38.

B. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
   1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
   2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

C. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.

D. Pipe Hangers: For a given pipe run use hangers of the same type and material.
   1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
   2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.

E. Intermediate Pipe Guides: Use pipe clamps with oversize pipe sleeve that provides clearance around pipe.
   1. Pipe Diameter 6 inches and Smaller: Provide minimum clearance of 0.16 inch.
   2. Pipe Diameter 8 inches: Provide U-bolts with double nuts providing minimum clearance of 0.28 inch.
   3. Pipe Diameter 8 inches: 0.625 inch U-bolt.
   4. Pipe Diameter 10 inches: 0.75 inch U-bolt.
   5. Pipe Diameter 12 to 16 inches: 0.875 inch U-bolt.
   6. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.

F. Pipe Alignment Guides: Galvanized steel.
   1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.
   2. Pipe Diameter 10 inches and Larger: Roller type.

G. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.

2.04 VIBRATION ISOLATORS AND SNUBBERS

A. Vibration Isolation - General: Maintain stability and uniform deflection under all operating loads.

2.05 ANCHORS AND FASTENERS

A. Anchor and Fastener Applications:
   1. Submerged and Splash Zone Locations: Use stainless steel TP304L or TP316L.
   2. Anchoring Steel To Concrete: Use Type 316 stainless steel.
   3. Anchoring or Connecting Fiberglass Reinforced Plastic to Anything: Use stainless steel machine bolts.
   4. Anchoring or Connecting Aluminum to Anything: Use stainless steel machine bolts.
   5. Anchoring or Connecting Steel to Steel: Use either galvanized steel, stainless steel, or wrought iron, unless otherwise indicated for corrosion zone.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install manufactured products in accordance with manufacturers' instructions.

B. Install supports, hangers, guides, anchors, and fasteners as specified, as indicated on the drawings, in accordance with approved shop drawings and as specified.

C. Do not use any of the following anchor or fastener types:
   1. Impact expansion hammer drive type.
   2. Explosive charge drive type.
   3. Lead shields.
   4. Plastic or fiber inserts.
   5. Drilled-in plastic sleeve and nail drive systems.

D. Do not use drilled-in adhesive anchors for overhead hung supports.

E. Do not make holes in structural steel for hanger supports.

F. Vibration Isolation: Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height; when full load is applied, adjust isolators to load and remove shims.

END OF SECTION

SECTION 46 0909
PROGRAMMABLE LOGIC CONTROLLERS (PLC)

PART 1 - GENERAL

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Monitor and control operation of process equipment and instrumentation using programmable logic controllers (PLCs).
   1. Provide end-to-end process control loop accuracy from sensor to display and final control element.
   2. Use sequences of operation, setpoints, settings, and alarm limits as indicated.
   3. Provide for operator interaction, process equipment control, and monitoring.
   4. Provide hardware configured and sized to support expansion as specified and shown on the drawings.
   5. Include all necessary field preamplifiers, signal conditioners, offset and span adjustments, amplifiers, transducers, transmitters, control devices, and engineering unit conversions and algorithms for applications.

B. Minimum Number of PLCs: As indicated, in locations shown on drawings.

C. Number of Points Per PLC: 20, minimum; 80, maximum.

D. Power Supply: 120 volts AC, single phase, 60 Hz power source; provide local transformers as needed for signal transmission and subsystem operation.

E. Connecting Conductors: Suitable for installed service.

F. All PLC's shall be provided through the Pump Station Manufacturer.

2.02 PROGRAMMABLE LOGIC CONTROLLERS (PLC) FUNCTIONALITY

A. Programmable Logic Controllers (PLCs): Capable of receiving discrete and analog inputs and, through programming, able to control discrete and analog output functions, perform data handling operations and communicate with external devices; complete with all hardware and software required to perform functions indicated.
   1. Programmability: Support the full complement of process control functions as described in IEC 61131-3; allow for use of any combination of function blocks, ladder logic diagrams, sequential function charts, and text programming within a single controller.
   2. Provide a scheme of priority levels that prevents interference with a command of high priority by a command of lower priority; make override commands entered by operator have higher priority than those of resident programs.
   3. Provide for operation of PLC in stand-alone mode.

B. Operator Interfaces: Provide following operator input methods:
   1. PLC Operator Interface: Keypad or other interface allowing programming, data entry, and access to diagnostics.
   2. Portable Computer Interface: For loading of software and data files.

C. Communications Interfaces: Provide peer-to-peer communication with other controllers, devices, and operator stations; acceptable communications protocols:
   1. PLC manufacturer's standard communication architecture and protocol.
   2. Ethernet architecture and protocol.
   3. Combination of any of the above.

D. Basic Operation: Continuously 1) scan inputs and record status, 2) execute resident programs and record outputs, and 3) update outputs; 4) periodically perform self-diagnostics.

1. Maintain point database in memory containing parameters, constraints and latest value or status of points connected.
2. Use data in memory for execution of resident program.

E. Resident Programs: Program each PLC to achieve the sequences of operation, parameters, constraints, and interlocks necessary to provide indicated process control.
1. Ensure that resident programs do not conflict with each other.
2. Program Inputs and Outputs: Use program inputs listed for each application program to calculate the required program outputs.
3. Default Values: To accommodate conditions where specific program inputs are not available, define appropriate "default" values or virtual points that allow the program to operate.
4. Failure Mode: In the event of PLC failure, make the controlled equipment continue to function in its indicated failure mode.

F. Point Definitions:
1. AO: Analog output.
2. AI: Analog input.
3. DO: Digital output.
4. DI: Digital input.
5. PA: Pulse accumulator input.

G. Control Function Definitions:
1. PI Control: Proportional control and proportional plus integral control.
2. Two Position Control: Control a two state device by comparing set point against process variable and established dead band.
3. Floating Point Control: Exercise control when error signal exceeds selected dead band and maintain control until error is within dead band limits.
4. Signal Selection: Allow selection of highest or lowest analog value from a group of analog values as basis of control; allow "cascading" of analog values so that large numbers of inputs can be reduced to one or two outputs.
5. Signal Averaging: Allow mathematical calculation of average analog value from a group of analog values as basis of control; allow "weighting" of individual analog values so that function output can be biased as necessary to achieve proper control.
6. Reset Function: Develop analog output based on up to two analog inputs and one operator-specified reset schedule.

H. Startup: Automatic commencement of operation upon power-up without human intervention, including startup of all connected I/O functions; restart upon detection of power failure at the PLC, with start time delays between successive commands to prevent demand surges or overload trips.

I. Failure Mode: Upon failure for any reason, perform an orderly shutdown and update all PLC outputs to their predetermined failure mode state.

J. Logic (Virtual) Points: Provide for software points that are not directly associated with a physical I/O function to be entered and recorded in point database.
1. Allow for analog and discrete points created either by calculation from physical points or by entering other data having properties of real points, including alarms, without associated hardware.
2. Use point identification that is consistent with physical point identification.

K. State Variables: Where an analog point represents more than two (up to 8) specific states, allow for each state to be named with names usable in programs and for display; e.g. "high", "low", alarm states.

L. Constraints: Provide constraints checking function requiring constraints values to "pass" before execution of relevant program.
   1. Allow for unique constraints to be assigned to each point.
   2. For analog inputs, allow for high and low "reasonableness" values or one differential "rate-of-change" value.
   3. Allow constraints checking to be disabled for any individual point from central station.
   4. Equipment constraint types, for example:
      a. Maximum starts (cycles) per hour.
      b. Minimum off time.
      c. Minimum on time.
      d. High limit (value in engineering units).
      e. Low limit (value in engineering units).

M. Analog Totalization: Provide analog totalization function and allow any analog point to be operator assignable to totalization program; allow for up to eight analog values to be totalized within selectable time period.

2.03 PLC HARDWARE

A. Approved manufacturers: Refer to SAWS approved Materials and Products List.

B. Programmable Logic Controllers (PLCs): Modular or loop type; microprocessor based.
   1. Operating System: Manufacturer's standard.
   2. Comply with requirements of Class A computing devices, labeled as set forth in 47 CFR 15.
   3. Conducted Susceptibility: Able to withstand test as specified in NEMA ICS 1, NEMA ICS 2, NEMA ICS 3.
   4. Surge Withstand Capability: Able to withstand test as specified in IEEE C37.90.1.
   5. Central Processing Units: Provide time of day, scanning, application program execution, storage of application programs, storage of numerical values related to application process and logic, I/O bus traffic control, peripheral and external device communications, and self-diagnostics.
   6. Service Temperature Range: Function properly at temperatures between 32 and 122 degrees F at 5 to 95 percent relative humidity non-condensing.
   7. Storage Temperature Range: Tolerate storage temperatures between minus 40 and plus 140 degrees F at 5 to 95 percent relative humidity non-condensing.

C. Modular PLCs: Modular, field expandable design allowing system to be tailored to process control application.
   1. Expandable through use of additional hardware and/or user software.
   2. As minimum, include mounting backplane, power supply module, self-contained central processing unit module, communications module, and input/output module grouped together in a single mounting rack or cabinet for each PLC.
   3. Communications between modules accomplished through mounting backplane, with all modules plugging directly into backplane; no wire connectors permitted between modules.
   4. Rack Size: As needed.
   5. Hot Plugging and Hot Swapping: Allow for installation, removal and replacement of modules under power and without restarting.
   6. Power Supply Module: Provide power supply modules as required to power other modules installed in same cabinet and to remote cabinets or modules as indicated.
      a. Power Characteristics: 120 volts AC nominal, plus or minus 5 percent.
      b. Protection: Monitor incoming line voltage level and provide over current and over voltage protection.

c. Voltage Out Of Range: Continue to provide power for adequate amount of time to allow for safe and orderly shutdown.
d. Uninterruptibility: Capable of withstanding power loss for minimum of 20 milliseconds while still remaining in operation and providing adequate power to all connected modules.
e. On-Off Switch: Integral to power supply module; if not standard equipment, provide miniature toggle type switch located near PLC and clearly labeled as to its function.
f. Indicating Light: Show proper operation of module by lighted indicator.

7. Input/Output Modules: Self-contained microprocessor based units that provide interface to field devices; visual indication of on-off status of individual inputs or outputs.

D. Loop Type PLCs: Self-contained, single or multiple loop controllers depending on the control system requirements; micro-processor based.
1. Include at minimum, central processing unit, program memory, power supply, input/output capability, network communications capability, display, and keyboard.
2. Provide a scalable process variable for each loop.
3. Analog Input Signals: Based on use of proportional, integral and derivative control logic.
4. Analog Outputs: Configured as direct acting or reverse acting.
5. Operator Functions:
a. Auto/manual selection for control of each loop output.
b. Remote and local setpoint adjustment selection with adjustable high-end and low-end limits.
c. Ratio and bias adjustment on remote setpoint input.
d. Selection of self-tune or manual-tune mode.
e. Anti-reset wind-up feature.
6. Power to Analog Output Loops: 20 mA DC when connected to load of 600 ohms.
7. Power Supply to Controller: 120 volts AC.
8. Power Consumption: 25 watts, maximum.
9. Noise Isolation: Provide electrical noise isolation between AC power line and process variable inputs, remote setpoint inputs and output signals, not less than 100 dB at 60 Hz common mode rejection ratio and not less than 60 dB at 60 Hz normal-mode rejection ratio.
10. Control Parameter Input and Display: On front panel keyboard; display appropriate units of measure with decimal point and polarity indication.
11. Self-Tuning: Operating only when selected from front panel; modify mode constants for proportional, integral, and derivative modes of control as required.
12. Manual Tuning: Individually adjustable mode constants for proportional, integral, and derivative modes of control, set for the appropriate value if a particular control mode action is required or to zero if that particular mode is not desired.
a. Proportional mode constant adjustable from 0 to 200 percent of input signal range.
b. Integral mode constant adjustable from 0 to 20 repeats per minute.
c. Derivative mode constant adjustable from 0 to 5 minutes.

E. Program Storage/Memory Requirements: Memory capacity based on system control requirements and such that, when system is completely programmed and functional, no more than 50 percent of memory allocated for these purposes is used.
1. For Operating System: Manufacturer's standard non-volatile memory.
2. For Application Memory: Battery backed random access memory (RAM).
3. For Storage of User Programs: Electronically erasable, programmable, read only memory (EEPROM), loaded operator interface panel, central station, or portable computer plugged into controller.

F. Input/Output Characteristics: Allow for analog input, analog output, discrete input and discrete output, in number and type as indicated.
   1. Accuracy: Plus or minus 0.25 percent of input span.
   2. Spare Capacity: Minimum of 20 percent spare input and output points (no less than two points) for each point type provided, in each PLC.
   3. Malfunction Tolerance: During normal operation, prevent malfunction in any input/output channel from affecting operation of CPU and other channels.
   4. Input and Output Circuits: Minimum optical isolation of 1500 VRMS and filtered to guard against high voltage transients from externally connected devices.
   5. Analog Input Circuits: Plus/minus 10V.
   6. Discrete Input Circuits: 5 volt TTL.
   7. Analog Output Circuits: Plus/minus 10V.
   8. Discrete Output Circuits: 5 volt TTL.

G. Wiring Connections: Heavy duty, self-lifting, pressure type screw terminals with easy wire insertion and secure connections; capable of accepting two #14 AWG wires; hinged protective cover, with write-on areas for identification of the external circuits.

H. On-Off Switch: Provide integral ON-OFF power switch for each PLC; if not standard equipment, provide miniature toggle type switch located in panel near PLC, clearly labeled as to its function.

I. Self-Diagnostics: Diagnostic routines implemented in firmware that provide information on configuration and status of CPU, memory, communications and input/output; continuously executed along with normal operations.
   1. At Power Up and Normal Shutdown: Provide more extensive diagnostics.
   2. Fault Logging: Store input/output and system faults in fault tables accessible for display.
   3. Shutdown on Fault: When a fault affects input/output or communications modules shut down only affected hardware and continue operation using unaffected components.
   4. Fault Annunciation: At PLC operator interface.
   5. Provide access to diagnostic software via all specified operator interfaces.

2.04 PLC PANELS

A. Panels: Factory assemble PLCs and their accessories in enclosed panels, provided by Pump Station Manufacturer, delivered as complete unit with panel fabrication and device mounting as indicated or otherwise required.
   1. Enclosures: As specified in Section 46 0500 for electrical enclosures.
   2. Power and Control Connection Points: Bottom-entry
   3. Power Circuits: Each panel powered by dedicated 120 volts AC circuit, with 10 amp fuse, and disconnect switch located inside panel.
   4. Terminate wiring inside panel on terminal blocks.
   5. Uninterruptible Power Supply (UPS): Where the equipment served by a PLC is powered by a standalone uninterruptible power supply (UPS), as opposed to an emergency power system serving the whole system, provide a UPS for the PLC panel.

B. Uninterruptible Power Supply (UPS): Self-contained UPS sized to provide minimum of 10 minutes of PLC operation, with surge suppression, noise filtering (normal and common mode), short circuit protection and voltage regulation (brownout and overvoltage protection), complete with all necessary power supplies, transformers, batteries, and accessories.
   1. Visual indication of normal power operation, UPS operation, abnormal operation and visual and audible indication of low battery power.
   2. Comply with 47 CFR 15, Part A for radio noise emissions.

C. Indicator Lights: Heavy-duty long-life LED type complying with NEMA ICS 1, NEMA ICS 2 and UL 508; push to test (lamp) type.
   1. Style: Round with lens color as indicated.
   2. Size: To fit 0.875 inch mounting hole.
   3. Identification: Legend plate labeled to reflect function being indicated.

D. Selector Switches: Heavy duty, complying with NEMA ICS 1, NEMA ICS 2 and UL 508, with switch positions as indicated or required by sequence of operation.
   1. Style: Round, illuminated.
   2. Size: To fit 0.875 inch mounting hole.
   3. Rating: 600 volts, 10 amperes continuous.
   4. Identification: Legend plate labeled to reflect function being indicated.
   5. Auxiliary Contacts: Where indicated or required, provide dual auxiliary contacts for the automatic position to provide position sensing by SCADA system; rated for 120 volt AC, 1A minimum.
   6. Key Operation: Where indicated, provide key-operated switches; keyed alike.

E. Push Buttons: Heavy duty, complying with NEMA ICS 1, NEMA ICS 2 and UL 508, with number and type of contacts as indicated or required by sequence of operation.
   1. Style: Round.
   2. Size: To fit 0.875 inch mounting hole.
   3. Rating: 600 volts, 10 amperes continuous.
   4. Identification: Legend plate labeled to reflect function being indicated.

F. Relays: Complying with IEEE C37.90 and derated for altitude above 1,500 m.
   1. Relay Coils: 120 volt AC, with matching mounting socket.
   2. Power Consumption: Not more than 3 watts.

G. Terminal Blocks: Bakelite or other suitable insulating material with full deep barriers between each pair of terminals, complying with NEMA ICS 4 and UL 1059.
   1. For Conductors Exiting Panels: Two-way type with double terminals, one for internal wiring connection and one for external wiring connection.
   2. Identification: Provide identification strip as part of terminal block; label each terminal by number shown on final wiring diagrams.

H. Power Line Conditioner: Provide both voltage regulation and noise rejection for each panel separately.
   1. Type: Ferro-resonant design, with no moving parts and no tap switching, while electrically isolating secondary from power line side.
   2. Size: For 125 percent of actual connected load.
   3. At 85 Percent Load: When input voltage fluctuates between minus 20 percent to plus 10 percent of nominal voltage, control output voltage within plus or minus 1 percent of nominal voltage.
   4. During Load Changes of Zero to Full Load: Control output voltage within plus or minus 3 percent of nominal voltage.
   5. Correction of Load Switching Disturbances: Accomplish 95 percent correction within 2 cycles of onset of disturbance and full correction within 5 cycles.

I. Power Line Surge Protection: Protect panels from power line surges in accordance with IEEE C62.41.1 and IEEE C62.41.2; do not use fuses for surge protection.

J. Sensor and Control Wiring Surge Protection: Protect PLC inputs and outputs from surges induced on control and sensor wiring; do not use fuses for surge protection; test inputs and outputs in both normal and common mode using the following two waveforms and submit certified test reports:

1. First: 10 microseconds by 1000 microseconds with peak voltage of 1500 volts and peak current of 60 amperes.
2. Second: 8 microseconds by 20 microseconds with peak voltage of 1000 volts and peak current of 500 amperes.

2.05 PLC PANEL ACCESSORIES

A. Convenience Outlet: Inside panel, provide 120 volt AC, 20 amp, ground fault interruption (GFI) type duplex convenience outlet, on a circuit separate from panel power circuit.

B. Interior Light: Inside panel, provide 40 watt compact fluorescent light operated by manual on-off switch mounted on interior door of enclosure, on same circuit as convenience outlet.

C. Ventilation System: Provide one or more ventilation fans inside panel, each with line voltage thermostat.
   1. Air Flow: 100 cfm, minimum.
   2. Thermostat Setpoints: Adjustable in minimum range of 70 to 140 degrees F.
   3. Fan Power: 120 volt AC, single phase.
   4. Filters: At each supply and exhaust grille provide filter that is easily removed for cleaning or replacement.

2.06 ACCESSORY EQUIPMENT

A. Transformers: For control voltages below 120 volt AC, feed transformers from nearest power panel or motor control center, using circuits provided for that purpose.
   1. Provide a disconnect switch on the primary side and a fuse on the secondary side.
   2. Enclose transformers in steel cabinet with conduit connections.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment as indicated and in accordance with manufacturers' instructions.

3.02 FIELD QUALITY CONTROL - SEE SECTION 46 0903

END OF SECTION

SECTION 46 0916
CONTROL VALVES

PART 1 - GENERAL

PART 2 - PRODUCTS

2.01 REQUIREMENTS APPLICABLE TO ALL VALVES

A. See drawings for valve sizes, valve ratings, operator types, and piping types and sizes.

B. Provide valves suitable for the service indicated and coordinated to piping system.
   1. Provide valves that will withstand working pressure indicated or working pressure of pipe to which valve is connected, whichever is greater.
   2. Provide valves of sizes indicated or of port diameter/area equal to that of pipe to which valve is connected, whichever is larger.
   3. Provide valves that open by turning counterclockwise, with direction of opening integrally marked on operating nut or operator.
   4. Valve End Connections: As indicated; if not indicated, provide end connections of the same type as indicated for joints in pipe to which valve is connected.
   5. Factory install operators and accessories.

C. Identification and Tagging: In addition to the information required by Sections 01 7800, 01 7810, 46 0103, and 46 0106, mark valves in accordance with MSS SP-25 using identification tags securely attached; on tags show the service, valve identification number from the drawings, manufacturer's name and model number.
   1. Identification Tags: 1.375 inches diameter, minimum; engraved laminated plastic with black lettering.
   2. Attachment: No. 12 AWG copper wire.

2.02 VALVE OPERATORS

A. Operator Types:
   1. For each valve controlled by process control system, provide remote-controlled automatic operator, electric and pneumatic types as indicated.
   2. For each valve not controlled by process control system, provide a manual operator, except for self-actuated valves.

B. Operators: Sized to operate valve for full range of pressures and velocities and of the type specified for application.:
   1. Maximum Force to Operate: Not more than 39.3 pounds-force under any operating condition including initial breakaway; provide gear reduction where necessary to reduce force to operate.
   2. Locking: Self-locking or equipped with self-locking device; padlock eyes on valve handles; wheels lockable with chain and padlock.
   3. Quarter Turn Valves: Provide position indicator.
   4. Direct-Buried Quarter-Turn Valves: Operator designed to withstand input torque of 450 foot-pounds at fully open or fully closed positions; grease packed and gasketed to withstand submersion in water to 10.2 psig.

C. Automatic Operators: Actuator, valve stem coupling, gearing if required, size and configuration to suit full range of valve operation, and additional requirements as indicated.
   1. Totally enclosed valve actuating mechanism with adjustable travel stops and valve position indicator.
   2. For Quarter Turn Valves: Reversing, bi-directional operation.

3. Provide manual override mechanism unless specifically indicated as "no manual override"; with lockable motor de-clutch mechanism.
4. On loss of control signal, maintain valve in last position, unless otherwise indicated.
5. Housing: NEMA 250 Type 4X enclosure.

D. Manual Operators:
1. Direct-Buried Valves Larger Than 2-1/2 inches: 2 inch operating nut.
2. Direct-Buried Valves 2 inches and Smaller: Cross handle for operation by forked key.
3. Exposed Valves: Hand wheel type operator except where other type is permitted or required.
4. Hand Wheels: Galvanized and painted.
5. Lever handles are allowed on quarter-turn valves 8 inches and smaller.

2.03 ELECTRIC VALVE OPERATORS

A. Electric Operators: Motor-operated.
1. Gearing: Two-stage, planetary, permanently lubricated self-locking gear train with self-lubricating bearings; connections via male output staff.
2. Start-up Torque: 120 foot-pound.
3. Stall Torque: 150 foot-pound.
4. Duty Cycle: 75 percent.
5. Equipped with AC thermal overload protector with automatic reset or non-overloading under normal operating conditions.

B. Positioners: For modulating actuators provide positioner controlling the valve position as function of input signals; direct acting; with corrosion-resistant, splash- and moisture-proof enclosure with gasketed cover.

2.04 PNEUMATIC VALVE OPERATORS

A. Diaphragm Actuators: Spring return with steel or aluminum diaphragm case and spring barrel, steel spring and actuator stem, and fabric-reinforced chloroprene diaphragm; factory lubricated and sealed.

B. Pressure Regulator: Adjustable reduced pressure range as required by valve actuator; gauge range 1.33 to 2 times maximum operating pressure; with internal relief, filter, outlet pressure gauge, aluminum body and hand wheel.

C. Positioners: Pneumatic force balance instruments to control valve position as function of input signal, suitable for either double acting or spring return actuator, with zero and span adjustment and field reversible for direct or reverse action
1. Accomplish positive positioning of valve by mechanical feedback connection from valve actuating mechanism, consisting of a characterized linear cam allowing adjustment of valve positioning and input signal.
2. Provide gauges for supply and output pressure and for input signal pressure.
3. Input: Pneumatic or DC electric, unless otherwise indicated.
4. Pneumatic Input: 3 to 15 psig.
5. DC Electric Input: 4 to 20 mA; provide transducer to convert electrical signal to appropriate pneumatic signal; transducer to be integral with positioner or separate component.
   a. Separate transducers factory mounted on actuator.
   b. Transducer must operate without line electric power.
6. Enclosures: Corrosion-resistant, splash- and moisture-proof with gasketed cover.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install valves as nearly as possible in position indicated on the drawings, located and oriented to provide easy access to valve operator and to avoid interference with other equipment.

C. Install valves without exerting distortion or strain on appurtenances.

D. Flanged Connections:
   1. Install flanged valve bolt holes so as to straddle vertical centerline of pipe.
   2. Clean flanged faces prior to inserting gasket and bolts.
   3. Tighten nuts progressively and uniformly.

E. Threaded Connections: Clean threads by wire brushing or swabbing prior to installation.

F. Manual Valve Orientation in Horizontal Runs of Pipe:
   1. Where pipe centerline elevation is 54 inches or less above finished floor, install valve with operating stem of in vertical position, unless otherwise indicated.
   2. Where pipe centerline elevation is between 54 inches and 81 inches above finish floor, install valve with stem in horizontal position, unless otherwise indicated.

3.02 FIELD QUALITY CONTROL - PRIOR TO STARTUP

A. Demonstrate proper valve operation while testing pipelines or as a separate step.
   1. Show that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, and in both directions for two-way valve applications.
   2. Count and record the number of turns required to open and close each valve, and account for any discrepancies from manufacturer's data.

B. Isolation Valve Leak Check:
   1. With full pressure in the system, command valve closed.
   2. Use an ultra-sonic flow meter to detect flow or leakage.

C. Actuator Range Check: Verify proper operation of actuators and positioners.
   1. Verify that actuator extreme positions are correct.
   2. Apply a signal to actuator through its controller.
   3. Record the signal levels for the extreme positions.
   4. Vary the signal over its full range and verify that actuators travel in the correct direction and from one extreme position to the other.

D. Valve Stroke Setup and Check:
   1. Verify the actual positions against the control system readout.
   2. Set pump to normal operating mode.
   3. Command valve closed; visually verify that valve is closed and adjust output zero signal as required.
   4. Command valve to open; verify position is full open and adjust output signal as required.
   5. Command valve to a few intermediate positions.
   6. If actual valve position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

END OF SECTION