CONSULTING ENGINEERS

SET NO. _____

PROJECT MANUAL

BID SET

CITY OF GRAND JUNCTION

PURDY MESA FLOWLINE CONTROL TANK

OCTOBER 2022

PROJECT MANUAL

BID SET

CITY OF GRAND JUNCTION

PURDY MESA FLOWLINE CONTROL TANK

JVA, Inc.
817 Colorado Ave, Suite 301
Glenwood Springs, CO 81601

JVA Job No. 1071.8e

October 2022

PROJECT MANUAL

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PURDY MESA FLOWLINE CONTROL TANK

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1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work will include all necessary labor, supervision, equipment, tools, and materials for a 33,000 gallon raw water storage tank with connection to the 20-inch Purdy Mesa Flowline raw water pipeline. The project generally consists of constructing a cast-in-place concrete tank with necessary site piping, site grading, electrical, instrumentation and controls. The existing pressure control tank will be demolished and removed for disposal. Coordination with the City for connection to the 20-inch Purdy Mesa Flowline is required.

B. Contractor shall furnish and pay for all materials, equipment, supplies, appurtenances; provide all construction equipment and tools; and perform all necessary labor and supervision

C. Contractor shall coordinate the progress of the Work including coordination between trades, subcontractors, suppliers, public utilities and subsequent water treatment plant contractor performing work on site and Owner to insure the progress of Work

D. It is the intent of this contract that Work proceed in the most expeditious manner possible

E. Construct the Work under contract indicated in the Bid Form

F. The cross-referencing of specification sections under the heading "Related Sections" and elsewhere within each specification section is intended as an aid to the Contractor and shall not relieve the Contractor from his responsibility to coordinate the Work under the Contract Documents. Listings of cross-references are not intended to be comprehensive. The omission of a cross-reference to an additional or related requirement shall not relieve the Contractor of his obligation to provide a complete Project.

1.3 WORK BY OTHERS

A. Construct work to allow for work by others. Coordinate construction schedule with the Owner.

1.4 CONTRACTOR USE OF SITE AND PREMISES

A. Contractor shall limit use of the premises for Work and will use the designated staging area for field offices, equipment, and material storage. Areas have been designated on the Drawings for contractor’s use

B. Coordinate use of premises under direction of Engineer and/or Owner

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

D. Contractor may use only those areas indicated on the Drawings for storage and such additional areas as Engineer may designate

E. Contractor should plan for normal workdays, Monday through Friday, within the hours of 7:00 am to 5:00 pm. Other work hours and days may be allowed by City and Engineer upon 48 hours written notice

1.5 OWNER USE OF SITE AND PREMISES

A. Owner shall coordinate with Contractor the entrance into work site for work performed under the Contract Documents to ensure Contractor’s health and safety plans are followed

B. Existing raw waterline to remain operational during construction. All access maintained.

1.6 WORK SEQUENCE AND WORK RESTRICTIONS

A. Existing raw waterline shall remain in service until construction is complete and entire system is operational and has been accepted by the City and Engineer.

B. Provide open access for Owner to property at all times during construction. Maintain minimum width clearance for access of City and Contractor personnel and emergency vehicles at all times.

C. Contractor shall submit a detailed CPM format schedule outlining all steps required to assure complete and satisfactory construction, testing, and startup work. Address all work sequence and constraints described in this Section.

D. Sequences other than those specified will be considered by Engineer, provided they afford equivalent continuity of operations

1.7 EASEMENTS AND RIGHT-OF-WAY

A. Work shall be performed on the City's property

B. Construction access to the site is available via the City's access drive from Blue Sage Drive. Access across private property is strictly prohibited.

C. Confine construction operations to the immediate vicinity of the location indicated on drawings and use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies, so as to cause the least possible damage to property

D. Construction Area Limits
   1. Confine construction operations to the immediate vicinity of the location indicated on Drawings and in accordance with the Owner
   2. Areas not designated for access roads, parking areas, storage areas, existing facilities areas, and construction areas, Contractor shall not trespass in or on these areas
      a. Contractor shall be responsible for keeping all their personnel out of areas not designated for Contractor use except in case of isolated Work located within these areas for which the Contractor shall coordinate with Owner and shall not proceed with such work without Owner approval
   3. Contractor shall use due care in placing construction tools, equipment, excavated materials, and pipeline materials and supplies, so as to cause the least possible damage to property outside the Town property
      a. Responsibility for protection and safekeeping of materials and equipment on or near the work site shall be entirely that of the Contractor and no claim shall be made against the Owner for any reason
      b. If the Owner needs access to the sites occupied by stored materials or equipment, Contractor shall provide access

E. On Private Property
   1. Do not enter for material delivery or occupy for any purpose with personnel, tools, equipment, construction materials, or excavated materials, any private property outside the designated construction easement without written permission of the owner and tenant

F. Within Street Right-of-Way and Utility Easement

1. Perform all work and conduct all operations of Contractor, his employees, and his subcontractors in accordance with the requirements of the City and/or Mesa County

1.8 PROTECTION OF PUBLIC AND PRIVATE PROPERTY

A. Protect, shore, brace, support, and maintain underground conduits, drains, and other underground construction uncovered or otherwise affected by construction operations

B. Contractor shall be responsible for all damage to streets, roads, highways, shoulders, street lighting and/or signage, embankments, culverts, location or character, which may be caused by transporting equipment, materials, or personnel to or from the Work or any part or site thereof, whether by him or his subcontractors

C. Make satisfactory and acceptable arrangements with the Owner of, or the agency or authority having jurisdiction over, any damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage

1.9 PROTECTION OF WORK AND FACILITIES

A. Contractor shall be solely responsible for the protection of Work until final acceptance

B. Contractor shall protect all and any previously performed Work, work in progress or completed by others, and existing facilities from damage during the performance of Work in the area

1.10 MAINTENANCE OF TRAFFIC

A. Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian
   1. Whenever it is necessary to cross, close, or obstruct private roads, driveways, multi use paths, and walks, provide and maintain suitable and safe detours, or other temporary expedients for accommodation of private travel
   2. Maintenance of traffic is not required if Contractor obtains written permission from the owner and tenant of private property, or from the authority having jurisdiction over public property involved, to obstruct traffic at the designated point

1.11 BARRICADES AND LIGHTS

A. Protect streets, roads, highways, and other public thorough fares which are closed to traffic by effective barricades with acceptable warning and directional signs

B. Locate barricades at the street intersecting public thoroughfare on each side of the blocked section

C. Provide suitable barriers, signs, and lights to the extent required to adequately protect the public

D. Provide similar warning signs and lights at obstructions such as material piles and equipment

E. Illuminate barricades and obstructions with warning lights from sunset to sunrise

F. Store materials and conduct work to cause the minimum obstruction to the other contracts

G. Install and maintain barricades, signs, lights, and other protective devices in conformity with applicable statutory requirements including the Manual of Uniform Traffic Control Devices and as required by Mesa County

1.12 LINES, GRADES AND SURVEY

A. Construct all Work to the lines, grades, and elevations indicated on the Drawings
   1. The Owner may employ a separate surveyor to perform a verification survey to check final layout and grades.
   2. Contractor is responsible for correcting all incorrect grades or grades not meeting specified tolerances

B. Engineer has established basic horizontal and vertical control points in the Drawings
   1. Use these points as datum for the Work
   2. Provide such competent personnel and tool, stakes, and other materials as Engineer may require in establishing or designating control points, in establishing construction easement boundaries, or in checking layout survey, and measurement work performed by Contractor

C. Provide all survey, layout, and measurement work required
   1. Work performed by a qualified professional engineer or registered land surveyor acceptable to Engineer
   2. Locate and protect control points prior to starting site work, and preserve all permanent reference points during construction
      a. Make no changes or relocations without prior written notice to Engineer
      b. Report to Engineer when any reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations
      c. Require surveyor to replace Project control points which may be lost or destroyed
      d. Establish replacements based on original survey control
   3. Establish lines and levels, locate and lay out, by instrumentation and similar appropriate means
      a. Temporary project benchmark
      b. Stakes for grading, fill and topsoil placement
      c. Utility slopes and invert elevations
   4. From time to time, verify layouts by the same methods
   5. Maintain a complete, accurate log of all control and survey work as it progresses
   6. On request of Engineer, submit documentation to verify accuracy or field engineering work

1.13 REGULATORY REQUIREMENTS

A. Comply with all federal, state, and local laws, regulations, codes, and ordinances applicable to the Work

B. References in the Contract Document to local codes shall mean the codes in effect in the City and Mesa County according to the jurisdiction in which the Work is performed

C. Other standards and codes which apply to the Work are designated in the specific technical specifications

1.14 CUTTING AND PATCHING

A. Contractor shall be responsible for all cutting, and patching, including attendant excavation and backfill, required to complete the Work or to
   1. Uncover portions of the Work to provide for installation of ill-timed work
   2. Remove and replace defective work
   3. Remove and replace work not conforming to requirements of Contract Documents
   4. Remove samples of installed work as specified for testing

B. Provide products as specified or as required to complete cutting and patching operations

C. Inspection
   1. Inspect existing conditions of the Project, including elements subject to damage or to movement during cutting and patching
   2. After uncovering work, inspect the conditions affecting the installation of products, or performance of the work
   3. Report unsatisfactory or questionable conditions to the Engineer in writing; do not proceed with the work until the Engineer has provided further instructions

D. Preparation
   1. Provide devices and methods to protect other portions of the Project from damage
   2. Provide protection from the elements for that portion of the Project which may be exposed by cutting and patching work, and maintain excavations free from water
   3. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes
   4. Restore work which has been cut or removed; install new products to provide completed Work in accord with requirements of Contract Documents

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01039

COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General requirements

B. Coordination

C. Field engineering

D. Alteration project procedures

E. Preconstruction conference

F. Progress meetings

G. Requests for information

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 01340 – Shop Drawings and Product Data

C. Section 01700 – Contract Closeout

1.3 GENERAL REQUIREMENTS

A. Refer to General Conditions for Owner meetings and other requirements

B. Engineer will schedule and administer pre-construction meeting according to agenda
   1. Prepare agenda for meetings including items required by Owner and Contractor
   2. Notify Contractor and Owner 4 days in advance of meeting date
   3. Preside at meeting

C. Contractor will schedule and administer site mobilization and weekly progress meetings. Contractor will also be responsible for coordination, field engineering, alteration, project procedures, cutting and patching procedures outlined herein. If work progress does not warrant a meeting, all parties can mutually agree to postpone meeting.
   1. Arrange for the attendance of Contractor's agents, employees, subcontractors, and suppliers as appropriate to the agenda
   2. Record the minutes; include all significant proceedings and decisions
   3. Reproduce and distribute copies of minutes within one week after each meeting
      a. To all participants in the meetings

b. To Engineer
c. To Owner

4. Owner and other inspecting parties such as the geotechnical engineer/technician as well as plant operators may attend meetings
5. Engineer will attend weekly meetings either via phone or on site

D. Representatives of contractors, subcontractors, and suppliers attending the meetings shall be qualified and authorized to act on behalf of the entity each represents

1.4 COORDINATION

A. Coordinate scheduling, submittals, and Work of the various Sections of specifications to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later by others.

B. Verify that utility requirement characteristics of operating equipment are compatible with available utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment, and coordinate preparation of grading and other requirements for installation utility work by others.

C. Coordinate completion and clean-up of Work of separate Sections in preparation for final completion and for portions of Work designated for Owner’s use

D. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.5 FIELD ENGINEERING

A. Employ a Land Surveyor registered in the State of Colorado and acceptable to the Engineer and Owner.

B. Contractor will locate and protect survey control and reference points.

C. Control datum for survey is that established by Owner provided survey and shown on Drawings.

D. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

1.6 ALTERATION PROJECT PROCEDURES

A. Materials: As specified in product Sections; match existing products and work for patching and extending work.

B. Where new work abuts or aligns with existing, perform a smooth and even transition. Patched work to match existing adjacent work in texture and appearance.

C. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Engineer.

D. Where a change of plane of 1/4-inch or more occurs, submit recommendation for providing a smooth transition for Engineer review.

E. Patch or replace portions of existing surfaces, which are damaged, lifted, or showing other imperfections.

F. Finish surfaces as specified in individual product sections.

1.7 PRECONSTRUCTION CONFERENCE

A. Engineer will schedule a conference after Notice of Award

B. Location: On site, in conference room, or through a virtual conference call dependent on current State health code requirements

C. Attendance
1. Owner's Representative
2. Engineer and his professional consultants
3. Geotechnical Engineer
4. Contractor's Project Manager
5. Contractor's Superintendent
6. Major Subcontractors
7. Others as Appropriate

D. Agenda:
1. Execution of Owner Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Distribution of Contract Documents.
4. Submission of list of subcontractors and suppliers, list of products, Schedule of Values, and Construction Project Schedule in critical path format.
5. Designation of personnel representing the parties in Contractor, Owner, and the Engineer.
6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, cost proposal requests, Change Orders and Contract closeout procedures.
7. Construction scheduling and updates.
8. Scheduling activities of Geotechnical Engineer, equipment manufacturers representatives, and other field tests
9. Critical work sequencing
10. Major equipment deliveries and priorities
11. Procedures for maintaining Record Documents
12. Construction facilities, controls and construction aids
13. Temporary utilities provided by Owner
14. Safety and first-aid procedures

15. Security and housekeeping procedures
16. Procedures for testing
17. QA/QC expectations
18. Inspection

1.8 PROGRESS MEETINGS

A. Contractor will schedule and administer meetings throughout progress of the Work at weekly intervals. If work progress does not warrant meeting, all parties can mutually agree to postpone the weekly meeting.

B. Location of the Meetings: The project field office of the Contractor, or other locations arranged for by Contractor, convenient to all parties

C. Contractor will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within one week to Contractor, Owner, participants, and those affected by decisions made.

D. Attendance
   1. Owner's Representative
   2. Construction Inspector
   3. Engineer, and his professional consultants as needed
   4. Contractor's Superintendent
   5. Subcontractors as appropriate to the agenda
   6. Suppliers as appropriate to the agenda
   7. Others, as appropriate

E. Suggested Agenda
   1. Review Minutes of Previous meetings
   2. Review Unresolved issues from Last Meeting
   3. Review of Work Progress
   4. Field Observations, Problems, Conflicts and Decisions
   5. RFI Review
   6. Review of Submittals Schedule and Status of Submittals
   7. Schedule
      a. General Schedule Issues
      b. Review of off-site fabrication and delivery schedules
      c. Planned progress during succeeding work period (3-week “Look ahead”)
      d. Maintenance of construction project schedule
      e. Corrective measures to regain project schedules
   8. Maintenance of Quality and Work Standards
   9. Change Orders
   10. New PR’s
   11. Accepted Change Orders
   12. Pay Requests
   13. Other Business

1.9 REQUESTS FOR INFORMATION (RFI)

A. The Contractor shall prepare and submit an RFI upon the discovery of the need for interpretation of the Contract Documents or additional information.
   1. Only the Contractor shall submit RFIs to the Engineer.
   2. RFIs shall be submitted on Engineer's RFI form. Engineer will provide a template for the Contractor upon request.

B. RFI shall include:
   1. Project Name
   2. Engineer Job Number
   3. Date
   4. Name of Contractor
   5. Name of Engineer
   6. RFI number, numbered sequentially
   7. Related specification section number, title, and related paragraphs, as needed
   8. Drawing number and detail references, as needed
   9. Field conditions
   10. Contractor's proposed solution. If the Contractor's solution(s) affect contract times or contract price, Contractor shall state the effects on the RFI.
   11. Contractor's signature
   12. Relevant attachments including but not limited to drawings, descriptions, measurements, photos, product data, and shop drawings

C. Electronically Submitted RFIs
   1. Contractor shall submit one (1) complete RFI file in Adobe Acrobat PDF format

D. Engineer's Response
   1. Engineer will review each RFI, determine action required, and respond.
   2. Engineer will review and respond to each RFI within seven (7) working days
   3. If Engineer receives an RFI after 1:00 P.M. local time, the RFI will be considered as received the following working day.
   4. Engineer will not respond to RFIs requesting approval of submittals, approval of substitutions, coordination and information already indicated in Contract Documents, adjustment in contract time or contract amount, or erroneous RFIs.
   5. Engineer may respond to RFIs on related issues with a single response.
   6. If Engineer requests additional information as a result of the RFI, any further action or RFIs submitted by the Contractor will restart a new seven (7) day review period.
   7. Contractor shall submit any request for change of contract time or contract price utilizing proper Change Order forms.

E. Contractor shall log and track all RFIs submitted organized by RFI number.
   1. RFI log shall be submitted at each progress meeting
   2. RFI log shall include:
      a. Project name
      b. Name, address, and phone number of Contractor
      c. Contractor representative name

d. RFI number
e. RFI description
f. RFI submittal date
g. RFI response date
h. Related Change Order number, as needed

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01200

PAYMENT PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

B. This information is supplemental to the requirements as stated in the General Conditions.

1.2 SUMMARY

A. This Section includes additional administrative and procedural requirements necessary to prepare and process Applications for Payment. Refer to General Conditions for most requirements of the Owner.
   1. Schedule of Values assisting in processing Applications for Payment
   2. Construction Progress Schedules

B. Base bid shall consist of concrete tank as designed and shown in plans.
   1. Bid alternative 1: include break out pricing of steel tank design option as shown on C2.1 of plans.
   2. Bid alternative 2: include base bid of concrete tanks as designed with line item of Xypex Admixture included in concrete.

1.3 DEFINITIONS

A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

1.4 PROCEDURES FOR THE SCHEDULE OF VALUES

A. Coordination: coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
   1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
      a. Application for Payment forms with Continuation Sheets
      b. Submittals Schedule
      c. O&M Manuals Schedule
   2. Submit the Schedule of Values to Engineer at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment
   3. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.

B. Format and Content: Use the Project Manual table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section.
   1. Identification: include the following Project identification on the Schedule of Values:
      a. Project name and location
      b. Name of Engineer
      c. Engineer's project number.
      d. Contractor's name and address
      e. Date of submittal
   2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
      a. Related Specification Section or Division.
      b. Description of the Work.
      c. Change Orders (numbers) that affect value.
      d. Dollar value.
      e. Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
   3. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual table of contents. Provide several line items for principal subcontract amounts, where appropriate.
   4. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
   5. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
      a. Differentiate between items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.
   6. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
   7. Allowances: Provide a separate line item in the Schedule of Values for each allowance. Show line-item value of unit-cost allowances, as a product of the unit cost, multiplied by measured quantity. Use information indicated in the Contract Documents to determine quantities.
   8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
      a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
   9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders result in a change in the Contract Sum.

1.5 APPLICATION FOR PAYMENTS

A. General

1. Submit itemized payment request as required in General Conditions together with Schedule of Values and other submittals as specified herein
2. Contractor shall not "project" work completed beyond the date of Application for Payment submittal for the purpose of payment request

B. Each Application for Payment shall be consistent with previous applications and payments as certified by the Architect and paid for by the Owner.
   1. The initial Application for Payment, the Application for Payment at time of Substantial Completion, and the final Application for Payment involve additional requirements

C. Payment Application Times: Each progress payment date is as indicated in the Agreement. The period of construction Work covered by each Application or Payment is the period indicated in the Agreement

D. Application Preparation: Complete every entry on the form, including notarization and execution by person authorized to sign legal documents on behalf of the Owner. Incomplete applications will be returned without action.
   1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions have been made.
   2. Include amounts of Change Orders issued prior to the last day of the construction period covered by the application

E. Transmittal
   1. Submit copy of each Application for Payment to the Engineer by means ensuring receipt within 24 hours
   2. Transmit each copy with a transmittal form listing attachments, and recording appropriate information related to the application in a manner acceptable to the Engineer

F. Initial Application for Payment
   1. Administrative actions and submittals that must precede or coincide with submittal of the first Application for Payment include the following:
      a. List of subcontractors
      b. List of principal suppliers and fabricators
      c. Schedule of Values
      d. Contractor's Construction Schedule (preliminary if not final)
      e. Schedule of principal products
      f. List of Contractor's staff assignments
      g. Copies of building permits
      h. Copies of authorizations and licenses from governing authorities for performance of the Work
      i. Certificates of insurance and insurance policies
      j. Performance and payment bonds, if required

G. Application for Payment at Substantial Completion

1. Following issuance of the Certificate of Substantial Completion, submit an Application for Payment. This application shall reflect any Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of Work
    a. Administrative actions and submittals that shall precede or coincide with this application include:
        i) Occupancy permits and similar approvals
        ii) Warranties (guarantees) and maintenance agreements
        iii) Test/adjust/balance records
        iv) Maintenance instructions
        v) Meter readings
        vi) Start-up performance reports
        vii) Change-over information related to Owner's occupancy, use, operation and maintenance
        viii) Final cleaning
        ix) Application for reduction of retainage, and consent of surety
        x) Advice on shifting insurance coverages
    b. List of incomplete Work, recognized as exceptions to Architect's Certificate of Substantial Completion

H. Application for Final Payment
1. Application for final payment will activate the advertisement for final payment published by the City. This is a 30-day advertisement and release of retainage will only be approved upon close of the advertisement period, assuming no claims have been made against the contractor. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Price, previous payments, and sum remaining due.
2. Application for Final Payment will not be considered until the following have been accomplished:
    a. Completion of Project closeout requirements
    b. Completion of items specified for completion after Substantial Completion
    c. Assurance that unsettled claims will be settled
    d. Assurance that Work not complete and accepted will be completed without undue delay
    e. Transmittal of required Project construction records to Owner
    f. Proof that taxes, fees and similar obligations have been paid
    g. Removal of temporary facilities and services
    h. Removal of surplus materials, rubbish and similar elements

1.6 PROCEDURES FOR THE CONSTRUCTION PROGRESS SCHEDULE

A. Coordination: coordinate preparation and updates of Contractor’s Construction Schedule with the preparation of Schedule of Values.
1. Correlate line items in the Construction Schedule with required project tasks, including the following:
    a. Mobilization/demobilization
    b. Permits and regulatory requirements

c. Submittals
d. Equipment
e. O&M Manuals
f. Work breakdown of major project work
g. Major subcontractors work
h. Startup and commissioning
i. Training
j. Substantial completion
k. Final completion
l. Milestones and operational shutdown requirements

B. Utilize the Critical Path Method (CPM) type construction schedule to establish preliminary progress schedule and track Work progress
   1. After acceptance by Engineer of preliminary Progress Schedule submitted per requirements of General Conditions, set preliminary Progress Schedule as the Construction Baseline Schedule
   2. Update and submit the construction progress schedule on a monthly basis with the pay application
      a. Monthly submittal should indicate progress of tasks, changes to baseline schedule logic, work additions such as change orders, milestone and contract date changes
      b. Submit two (2) color print copies, 11” x 17” size, and one pdf copy
      c. Upon request provide copy of project schedule CPM data file

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01340

SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submission of all shop drawings and product data as required by the Contract Documents for all equipment and materials to be furnished under this contract unless specifically indicated otherwise

1.2 RELATED SECTIONS

A. Section 01600 – Materials and Equipment

B. Section 01730 – Operations and Maintenance Data

C. Specification Divisions 2 thru 16

1.3 SUBMITTALS

A. Definitions
   1. Technical submittals: Shop drawings, product data and samples prepared by Contractor, subcontractors, suppliers, or manufacturers
      a. Shall be submitted by the Contractor to Engineer for approval for the use of Equipment and Materials to complete the Work or as needed to describe the following:
         i) Operation and maintenance
         ii) Technical properties
         iii) Installation
      b. Shop drawings: Custom prepared data for the Project and Work including performance and capacity curves, diagrams, bills of material, instructions, and other information
      c. Product data: Non-custom prepared printed information for the Project and Work on materials and products
      d. Samples: Fabricated and non-fabricated tangible samples of products and material
         i) Used for visual inspection and testing and analysis
   2. Informational submittals: Reports, administrative informational submittals, certification and guarantees not including and defined as shop drawings, samples and product data
      a. Reports: Include laboratory reports and tests, technical procedures and records and design analysis
      b. Administrative informational submittals: Submittals necessary for administrative records such as construction photographs, work records, schedules, standards, record project data, safety data, and similar information submittals
      c. Certification: Includes manufacturer or supplier certificates and guarantees

B. General Requirements
   1. Quality
      a. Shall be of suitable quality for legibility and reproduction purposes
      b. Shall be useable for reproduction yielding legible hard copy
      c. Submittals not conforming to specified requirements herein and as specified in Divisions 2 through 16 shall be subject to rejection by Engineer and upon Engineer request, Contractor shall resubmit documents that are in conformance
   2. Dimensions
      a. English units shall be provided on submittals
      b. Metric units are acceptable in addition to English units
      c. English units shall govern
   3. Form of submittals
      a. Submittals shall be transmitted in electronic format as specified herein
      b. Scanned submittals are acceptable
      c. Electronic project documents and submittals shall be transmitted in the following format:
         i) Native electronic format, nonproprietary
         ii) Adobe PDF produced from native electronic format
      d. Filename:
         i) Shall be consistent for the initial and any subsequent submission revisions for a single submittal
         ii) Contractor shall use a consistent naming convention for all submittals
            a) Use number of original submittal followed directly by a capital letter corresponding to the number of times a submittal is resubmitted (i.e., #001, #001A, #001B, etc.)
   4. Non-conforming submittals shall be subject to rejection by Owner and/or Engineer
   5. Submittal completion requirements
      a. Submittals shall include design criteria, dimensions, construction materials and all other information specified for a complete submittal to facilitate Engineer review of the submittal information adequately
      b. In the event various drawings are included a submittal for a class of Equipment, Contractor shall annotate clearly which parts apply to furnished Equipment
         i) Information not pertaining to the submittal shall be clearly annotated. Highlighting of such information will cause rejection of the submittal by the Engineer
      c. Contract Drawings
         i) Copies or portions thereof will not be allowed as acceptable fabrication or erection drawings
         ii) In the event Contract Drawings are used by the Engineer for erection drawings to annotate information on erection or identify reference details, Engineer title block and professional seal shall be removed and replaced with the Contractor's title block on the Contract Drawing(s). Contractor shall revise such erection drawings for subsequent revisions by the Engineer to Contract Drawings

C. Preparation
   1. Shop Drawings

a. Drawings shall be presented in a clear and thorough manner:
b. Identify details by reference to sheet and detail, schedule or room numbers shown on Contract Drawings
c. Identify equipment by reference to equipment name and tag number shown on Contract Drawings
d. Scale and Measurements: Make drawings accurate to a scale with sufficient detail to show the kind, size, arrangement and function of component materials and devices
e. Minimum sheet size: 8.5" by 11"
f. Fabrication drawing size: 11" by 17" or 24" by 36"

2. Product Data
   a. Clearly mark each copy to identify pertinent products or models submitted for review
   b. Identify equipment by reference to equipment name and P&ID number
   c. Catalog cut sheets: Cross-out or hatch irrelevant data

D. Technical Submittals: Shop Drawings and Product Data Submittal Requirements
   1. Shop Drawings and Product Data shall include the following, at a minimum:
      a. Specifications of manufacturer(s)
      b. Equipment parts and catalogs
      c. Bills of materials, material lists, and schedules
      d. Shop erection and fabrication drawings
      e. Drawings shall include equipment dimensions, weights, installation location requirements, plates required, main components, support details, anchor bolt details/sizes/locations, support base sizes, baseplate sizes, spacing and clearance requirements for installation, erection, operation and maintenance disassembly
      f. Electrical requirements:
         i) Shall include schematic diagrams including one-line diagrams, terminal block numbers, internal wiring diagrams, external connections, controls, and any other information as requested in individual specification sections
      g. List of spare parts
      h. Instruction and Operation and Maintenance (O&M) manuals
         i) As specified herein and in Specification Section 01730
      i. Manufacturer’s performance testing of equipment
      j. Concrete mix design data and information
      k. Performance characteristics and capacities
      l. External connections, anchorages, and supports required
      m. Other drawings, parts, catalogs, specifications, samples, or data necessary for the Engineer to determine conformance with Contract Documents
   2. Samples – Office samples shall be of sufficient size and quantity to clearly illustrate:
      a. Functional characteristics of the product, with integrally related parts and attachment devices
      b. Full range of color, texture and pattern
      c. Comply with requirements identified in individual specification sections

E. Construction Schedule: Designate in the construction schedule, or in a separate coordinated shop drawing schedule, the dates for submission and the dates that reviewed Shop Drawings and Product Data will be needed, if accelerated review is requested

F. Field samples and Mock-ups:
   1. Contractor shall erect, at the Project Site, at a location acceptable to the Engineer and Owner
   2. Size or area: as specified in the respective specification section
   3. Fabricate each sample and mock-up complete and finished
   4. Remove mock-ups at conclusion of Work or when acceptable to Engineer

1.4 CONTRACTOR RESPONSIBILITIES

A. Review shop drawings and product data prior to submission for accuracy and completeness of each submission

B. Approve and stamp each submission before submitting to Engineer

C. Determine and verify:
   1. Field measurements
   2. Field construction criteria
   3. Catalog numbers and similar data
   4. Conformance with specifications and identification of all deviations
   5. Confirm assignment of unit responsibility

D. Prior to each submission, carefully review and coordinate all aspects of each item being submitted

E. Verify that each item and the corresponding submittal conform in all respects with specified requirements of the Work and of the Contract Documents with respect to means, methods, techniques, sequences, and operations of construction, and safety precautions and programs incidental thereto

F. Make submissions promptly in accordance with Construction Schedule, and in such sequence as to cause no delay in the Work or in the work of any other Contractor

G. Limit requirement for accelerated submittal review by Engineer to no more than 10% percent of total number of submittals
   1. Accelerated submittal review period: less than 14 calendar days

H. Notify Engineer in writing, at time of submission, of any deviations in the submittals from Contract Document requirements:
   1. Identify and tabulate all deviations in transmittal letter
   2. Indicate essential details of all changes proposed, including modifications to other facilities that may be a result of the deviation
   3. Include required piping and wiring diagrams

1.5 SUBMISSION REQUIREMENTS

A. Make submissions far enough in advance of scheduled dates for installation to provide time required for reviews, for securing necessary approvals, for possible revisions and resubmissions, and for placing orders and securing delivery

B. In scheduling, allow fourteen (14) calendar days for review by Engineer following receipt of submission in Engineer's office:
   1. Time required to mail submissions or resubmissions is not considered a part of review period

C. Submittal Naming and Numbering
   1. Assign a unique number to include all shop drawings, product data and other information required for individual specification sections, beginning with #001.
   2. Resubmissions shall have the original number with a letter, starting with "A". If the first submittal required resubmission, it would be labeled #001A.
   3. Each specification section may still have more than one submittal number for later submissions (i.e., Preliminary O&M Manuals, Final O&M Manuals, etc.)
   4. Contractor shall use a consistent naming convention for all submittals

D. Quantity of Submittals Required
   1. Shop Drawings and Product Data:
      a. Initial submittal:
         i) Electronic – One (1) copy to Engineer
      b. Resubmittal:
         i) Electronic – One (1) copy to Engineer
      c. Final Submittal for Distribution
         i) Paper hard copy - Maximum of two (2) copies for Contractor's use, plus a maximum of three (3) copies which will be distributed by Engineer when approved. Do not submit more than five (5) copies
         ii) One (1) electronic copy to Engineer
      d. As –constructed document submittals
         i) Paper hard copy – Maximum of two (2) copies for Contractor's use, plus a maximum of three (3) copies which will be distributed by Engineer when approved. Do not submit more than five (5) copies
         ii) Electronic – One (1) copy to Engineer and one (1) copy to Owner
   2. Samples
      a. Initial submittal:
         i) Submit three (3) of each sample unless specified otherwise in individual specification section
      b. Resubmittal:
         i) Submit three (3) to Engineer
      c. One (1) sample of approved sample submittal will be returned to Contractor
   3. Informational submittals
      a. Technical reports and administrative submittals
         i) Electronic – One (1) copy to Engineer
         ii) Paper: Three (3) copies to Engineer
      b. Certificates and guarantees:

i) Electronic – One (1) copy to Engineer
ii) Paper: Three (3) copies to Engineer

c. Test reports
i) Paper
a) Owner: Two (2) copies
b) Engineer: One (1) copy
c) Contractor: Two (2) copies
d) Manufacturer/supplier: One (1) copy

4. Instruction and O&M manuals
a. In accordance to Specification Section 01730
5. At no additional cost to the Owner and whether or not submittals are copyrighted, the Owner may copy and use for staff training and/or internal operations any submittals approved for final distribution as well as required by this Contract

E. Submittal Transmittal Requirements
1. Accompany each submittal with a letter of transmittal showing all information required for identification and checking
2. Shall include:
a. Drawing numbers and titles
b. Revision number
c. Electronic filename
d. Deviations from Contract Documents: As specified herein
e. Submittals unidentifiable will be returned for proper identification
f. Date

F. Submittals Requirements
1. Submittal number
2. Date of submission and dates of any previous submissions
3. Project title and number
4. Owner Contract identification number if applicable
5. Names of:
a. Contractor
b. Supplier
c. Manufacturer
6. Identification of the product, with the specification section number
7. Field dimensions, clearly identified as such
8. Relation to adjacent or critical features of the Work or materials
9. Applicable standards, such as ASTM or Federal Specification numbers
10. Identification of deviations from Contract Documents:
a. If Contractor proposes to provide material or equipment of Work which deviates from the Project Manual, Contractor shall indicate so under “deviations” on the transmittal form accompanying the submittal copies
b. Identify all requested deviations as specified and on the copies of Specifications and Drawings required by paragraph below.
11. Confirmation of compliance with Contract Documents and, if applicable, identification of deviations from Contract Documents:

a. Provide the following documents to demonstrate compliance with the contract specifications:
    i) A copy of the relevant Drawing(s) with all addendum updates that apply to the equipment in various Divisions marked to show specific changes necessary for the equipment proposed in the Contractor's submittal
        a) If no changes are required, the Drawing(s) shall be clearly marked "No Changes Required"
        b) Failure to include copies of relevant Drawing(s) with the submittal, whether changes are required or not, shall be cause for rejection of the entire submittal with no further review by Engineer
        c) Relevant Drawing(s) include as a minimum the control diagrams, process and instrumentation diagrams (P&IDs), and Process (P) drawings.
    ii) A copy of each pertinent specification section with all addendum updates included, all referenced and applicable specifications sections, with their respective addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate the requested deviations from the specification requirements:
        a) If deviations from the specifications are indicated and, therefore requested, by the Contractor, the submittal shall be accompanied by a detailed, written justification for each deviation
        b) Failure to include a copy of the marked up specification sections, along with justification for any requested deviations to the specification requirements, with the submittal shall be cause for rejection of the entire submittal with no further review by Engineer

12. Identification of revisions on resubmissions
13. An 8" by 4" blank space for Contractor's and Engineer's stamps
14. Stamp cover sheet of each submittal as identified in letter of transmittal
15. Contractor's stamp: Initialed or signed, certifying review and approval of submittal, verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the Work and of Contract Documents. Use stamp to include wording similar to the following:

This submittal has been reviewed by [*Name of Contractor*] and approved with respect to the means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incidental thereto. [*Name of Contractor*] also warrants that this submittal complies with contract documents and comprises no deviations thereto: Section No:____ Submittal No: Date:_____ By:

G. For equipment that is provided directly by manufacturer without specification provide:
    1. Shop drawings: Illustrate complete assembly of products; foundation, installation and anchor requirements; dimensions and total weights of each, electrical wiring diagrams

2. Product data: Provide manufacturer’s literature including general assembly, materials of construction, model and type, detailed data describing parts and accessories, sufficient data to verify compliance with specifications
3. Manufacturer’s installation instructions: Provide detailed connection requirements and startup instructions
4. Manufacturer’s field report: Indicate personnel present and actual start-up procedures that were performed by manufacturer’s representative
5. Field report and test results shall be submitted to the Engineer by the Contractor

H. Submittal Log:
1. Maintain an accurate submittal log for duration of the Work showing current status of all submissions
2. Show submittal number, section number, section title, submittal description, dates and disposition of submittal
3. Make submittal log available to Engineer for Engineer's review upon request

I. Unless specified otherwise, make submissions in groups to facilitate efficient review and approval:
1. Include all associated items from individual specification sections to assure that all information is available for checking each item when it is received
2. Submit a complete initial submittal including all components when an item consists of components from several sources
3. Partial submittals may be rejected as not complying with provisions of the Contract
4. Engineer will not be held liable for delays due to poorly organized or incomplete submissions
5. Do not include items from more than one specification section for any one submittal number

J. Contractor may require subcontractors to provide drawings, setting diagrams and similar information to help coordinate the Work, but such data shall remain between Contractor and his subcontractors and will not be reviewed by Engineer unless specifically called for within the Contract Documents

K. All submittals for each component of multi-component systems shall be compiled and submitted through the Contractor to the Engineer by the manufacturer having System Responsibility

1.6 DISPOSITION OF SHOP DRAWINGS, PRODUCT DATA, AND INFORMATION SUBMITTALS

A. "No Exceptions Taken": Approved with No Corrections Noted
1. One copy sent to Owner
2. One copy sent to Resident Project Representative
3. One copy retained in Engineer's file
4. Remaining copies returned to Contractor for his use
   a. One copy to be kept on file at Contractor's office at job site
   b. Remaining copies for Contractor's office file, suppliers, or subcontractors

5. No corrections or comments noted on the submittal or on a Submittal Response Summary Sheet
6. Issues or miscellaneous comments pertaining to other related items of the Work may be included in transmittal letter
7. Resubmission not required

B. "Exceptions Noted": Approved with Corrections Noted
1. One copy sent to Owner
2. One copy sent to Resident Project Representative
3. One copy retained in Engineer's file
4. Remaining copies returned to Contractor for his use
   a. One copy to be kept on file at Contractor's office at job site
   b. Remaining copies for Contractor's office file, suppliers or subcontractors
   c. Copies of submittal data in operation and maintenance manuals to be revised according to corrections
5. Comply with corrections or comments as noted on the submittal or on a Submittal Response Summary Sheet
6. Resubmission not required

C. "Revise And Resubmit": Incorrect information provided or Significant Information Still Required
1. One copy sent to Resident Project Representative
2. One copy retained in Engineer's file
3. All remaining copies returned to Contractor for revision and re-submittal
4. Copy of transmittal letter and/or Submittal Response Summary Sheet sent to Owner. A "No Exceptions Taken" or "Exceptions Noted" submittal it will be forwarded to Owner after review per above disposition requirements
5. Submittal is either: incorrectly annotated; specific comments need to be addressed and incorporated in re-submittal; and/or additional information may be required as noted on the submittal or on a Submittal Response Summary Sheet
6. Submitted information may not include or address specific item required per the specification as identified on the submittal or on a Submittal Response Summary Sheet
7. Specific information related to identified item may be required for final approval of submittal
8. Resubmission of entire submittal may be required or resubmission of specific item may be required as identified on the submittal or on a Submittal Response Summary Sheet

D. "Rejected": Returned for Correction
1. One copy sent to Resident Project Representative
2. One copy retained in Engineer's file
3. All remaining copies returned to Contractor
4. Copy of transmittal letter and/or Submittal Response sent to Owner
5. Contractor required to resubmit complete submittal package in accordance with Contract Documents
6. Submittal does not comply with provisions of Contract Documents as noted on the submittal or on a Submittal Response Summary Sheet

7. Resubmission required

E. “Receipt Acknowledged”: For Reference Purposes Only, or for Record Copy:
1. Applicable to manufacturer or Contractor provided calculations and other miscellaneous documentation no subject to Engineer review and approval
2. One copy sent to Resident Project Representative
3. One copy retained in Engineer's file
4. One copy returned to Contractor
5. Copy of transmittal letter sent to Owner
6. Remaining submittal copies destroyed
7. Detailed review and comment by Engineer not required
8. Resubmission not required

1.7 DISPOSITION OF SAMPLES

A. "No Exceptions Taken": Approved with No Corrections Noted
1. One sample sent to Owner
2. One sample sent to Resident Project Representative
3. One sample retained in Engineer's file
4. Acknowledgement: Copy of transmittal letter sent to Contractor
5. Resubmission not required

B. "Exceptions Noted": Approved with Corrections Noted
1. One sample sent to Owner
2. One sample sent to Resident Project Representative
3. One sample retained in Engineer's file
4. Acknowledgement: Copy of transmittal letter sent to Contractor
5. Work performed or products furnished to comply with exceptions noted in acknowledgement
6. Resubmission not required

C. "Rejected": Returned for Correction
1. One sample retained in Engineer's file
2. Remaining samples sent to Contractor for resubmittal and compliance with the Contract Documents as noted in transmittal letter
3. Copy of transmittal letter sent to Owner
4. Resubmission required

1.8 RESUBMISSION REQUIREMENTS

A. Make any corrections or changes in submittals required by Engineer and resubmit until approved

B. Transmit each resubmission under new letter of transmittal. Use number of original submittal followed directly by a capital letter corresponding to the number of times a submittal is resubmitted (i.e., #001, #001A, #001B, etc.)

C. Shop Drawings and Product Data

1. Revise initial drawings or data and resubmit as specified for the initial submittal
2. Indicate any changes which have been made other than those requested by Engineer

D. Samples: Submit new samples as required for initial submittal

E. Reimbursement of Resubmission Review Costs:
1. Review of first submittal and one resubmittal will be performed by Engineer at no cost to Contractor
2. Cost for review of subsequent resubmissions will be directly paid by Contractor
3. Engineer will document work-hours required for review and costs for Engineer review will be deducted from payments due Contractor as Change Order deducts
4. Charges for review of resubmissions will include Engineer at maximum rate of $150 per hour and administrative staff at maximum rate of $75 per hour

1.9 PROJECT RECORD SUBMITTALS

A. After completion of the Work and prior to final payment, Contractor shall furnish record documents and final approved shop drawings and samples (as-constructed shop drawings and samples) in the number of copies specified herein.
1. Contractor shall provide additional copies of final approved shop drawings and samples for insertion in Equipment instruction and O&M manuals as required
2. All copies shall be clearly marked “Project Record”

1.10 ENGINEER'S OR CITY PROJECT ENGINEER’S DUTIES

A. Review submittals with reasonable promptness and in accordance with approved submission schedule provided that each submittal has been called for by the Contract Documents and is stamped by Contractor as indicated above
1. No extensions of time are allowed due to Engineer’s or City Project Engineer’s delay in reviewing submittals unless all the following criteria are met:
a. Contractor has notified Engineer or City Project Engineer in writing that timely review of particular submittal in question is critical to the progress of the Work and Contractor has identified the requested submittal return date.
b. Engineer or City Project Engineer has failed to return submittal within 21 days of receipt of the submittal or receipt of said notice, whichever is later
c. Contractor demonstrates that delay in progress of the Work was directly attributable to Engineer’s or City Project Engineer’s failure to return submittal within 21 days
2. No extensions of time are allowed due to delays in progress of the Work caused by rejection and subsequent resubmission of data, including multiple resubmissions
3. Engineer’s or City Project Engineer’s review shall not extend to means, methods, techniques, sequences, construction operations, and safety precautions and programs incidental thereto. No information regarding these items will be reviewed whether or not included in submittals
4. In the event that Engineer or City Project Engineer will require more than 21 calendar days to perform review, Engineer or City Project Engineer shall so notify Contractor

B. Review drawings and data submitted only for general conformity with Contract Documents
   1. Engineer's or City Project Engineer's review of drawings and data returned marked No Exceptions Taken or Exceptions Noted does not indicate a thorough review of all dimensions, quantities, and details of material, equipment device or items shown
   2. Engineer's or City Project Engineer's review does not relieve Contractor of responsibility for errors, omissions or deviations nor responsibility for compliance with the Contract Documents

C. Assume that no shop drawing or related submittal comprises a deviation to the Contract Documents unless Contractor advises Engineer or City Project Engineer otherwise in writing which is acknowledged by Engineer or City Project Engineer in writing:
   1. Consider and review only those deviations from the Contract Documents clearly identified as such on the submittal and tabulated on the Contractor's transmittal sheet.

D. Review informational submittals for indications of Work or Material deficiencies and will respond to Contractor regarding such deficiencies

E. Return submittals to Contractor for distribution or for resubmission

F. Transmit, unreviewed, to Contractor all copies of submittals received directly from suppliers, manufacturers and subcontractors

G. Transmit, unreviewed, to Contractor all copies of submittals not called for by the Contract Documents or which have not been approved by Contractor

H. Engineer or City Project Engineer's will not review uncalled-for shop drawings or product data except by special arrangement

I. Affix stamp and indicate approval for submittal or resubmission requirements with the following stamp:

☐ NO EXCEPTIONS TAKEN ☐ EXCEPTIONS NOTED
☐ REVISE & RESUBMIT ☐ REJECTED
This review was performed only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Modifications or comments made on the shop drawings and product data during this review do not relieve Contractor from responsibility for compliance with the requirements of the plans and specifications. Contractor is responsible for: dimensions and quantities; information that pertains solely to the fabrication processes or to the means, methods, of construction; coordination of the work of all trades.

JVA, Inc.

Date_____ By_____

1.11 SUBMITTAL SCHEDULE

A. Unless indicated otherwise, provide all submittals required by individual sections of the Contract Documents to establish compliance with the specified requirements.

B. Contractor to produce schedule of submittals for Engineer review

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Construction record photographs prior to commencing and during the course of the Work

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work

B. Section 01700 – Contract Closeout: Project Record Documents

1.3 PHOTOGRAPHY REQUIRED

A. Take photographs of the existing conditions prior to commencing work to document existing conditions

B. Take photographs on the date on which each scheduled Application for Payment is due. Intent is for digital photos to be kept as project record

C. CD, hard drive, or cloud drive sharing of Digital photos become the property of Owner

1.4 COSTS OF PHOTOGRAPHY

A. Pay all costs for specified photography and printing
   1. Parties requiring additional photography or prints will pay for them directly

1.5 DELIVERY OF PHOTOS

A. Submit digital photos to the Engineer with monthly pay requests or within 20 days of photo date

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 TECHNIQUE

A. Factual Presentation

B. Correct Exposure and Focus
   1. High resolution and sharpness

2. Maximum depth-of-field
3. Minimum distortion

3.2 VIEWS REQUIRED

A. Photograph from locations to adequately illustrate the condition of construction and the state of the Project
   1. Photographic survey of the existing site
      a. Show all areas to be modified
      b. Show all areas in which Contractor will conduct operations or store equipment
   2. Weekly photographs
      a. Minimum of eight (8) views weekly until final acceptance
      b. Views as designated by the Engineer or Owner

3.3 PHOTOGRAPH REQUIREMENTS FOR PROGRESS SITE PHOTOGRAPHS

A. Responsibility
   1. Site photographs for Owner record of construction progress shall be the responsibility of the Contractor
   2. Contractor shall be responsible for site photographs including the existing and progress of Work

B. Photographs shall include, but not limited to, the following:
   1. Existing site: Photographs of existing site conditions before site work commences
      a. Number of views shall be sufficient to cover the existing site conditions
   2. Progress of work: Shall include photographs from clearing throughout construction
      a. Number of views shall be sufficient to cover progress in Work and shall include a minimum of eight (8) different views
   3. After completion of Work: Shall be sufficient to show completed and finished Work

C. Digital images
   1. Provide images in uncompressed JPEG format
   2. Minimum resolution: 1500 x 2200
   3. Submitted digital images shall not be cropped

D. Identify each digital image file
   1. Name of project
   2. Orientation and description of view
   3. Date and time of exposure

3.4 ADDITIONAL PHOTOGRAPHS

A. Contractor shall provide additional photographs upon the request of the Engineer

B. Additional photographs may include, but not limited to, the following:
   1. Publicity photographs
   2. Special events at Project site
   3. Major phase of Work

4. Substantial Completion
5. Follow-up investigations for on-site events such as construction damage or losses
6. Additional record photographs during final acceptance

3.5 PROJECT RECORD

A. Submit CD of all photos, grouped by date

B. Engineer will distribute, after review
   1. One copy of each view to Owner
   2. One copy of each view to Engineer's file
   3. One copy of each view returned to Contractor for inclusion in Project Record Document

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance / Control of installation

B. Inspection and testing laboratory services

C. Qualification of laboratory

D. Laboratory duties

E. Limitations of authority of testing laboratory

F. Contractor's responsibilities

G. Field testing

H. Testing and services schedule

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

B. Section 01340 - Shop Drawings, Product Data, and Samples

C. Section 01600 - Material and Equipment

1.3 REFERENCES

A. Conform to reference standard by date of issue current on date of Contract Documents

B. Obtain copies of standards when required by Contract Documents

C. Where specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding

D. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Provide copies of written reports for materials, equipment or systems as scheduled at the end of this section. Reference each report by respective section number.

C. Laboratory Test Reports: Provide written reports of each test and inspection to Engineer. Each report shall include:
   1. Date issued
   2. Project title and number
   3. Testing laboratory name, address and telephone number
   4. Name and signature of laboratory inspector
   5. Date and time of sampling or inspection
   6. Record of temperature and weather conditions
   7. Date of test
   8. Identification of product and specification section
   9. Location of sample or test in the Project
   10. Type of inspection or test
   11. Results of tests and compliance with Contract Documents
   12. Interpretation of test results when requested by Engineer

D. Shop Test Reports: Provide reports detailing results of tests and certification from manufacturer to verify compliance with specifications

E. Field Test Reports: Provide reports detailing results of the tests. Indicate compliance or non-compliance with Contract Documents. Identify corrective action for materials and equipment which fails to pass field tests.

1.5 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship to produce Work of specified quality

B. Comply fully with manufacturer's instructions, including each step in sequence

C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding

D. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship

E. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion or disfigurement

F. Inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of public authorities: Conditions of the Contract

G. Certification of products: Respective sections of specifications

H. Laboratory tests required and standards for testing: Respective sections of specifications

1.6 INSPECTION AND TESTING LABORATORY SERVICES

A. Owner will employ and pay for the services of a testing agency to perform specified laboratory testing of materials where the technical specifications specifically obligate the Owner to provide the services
   1. It is the Contractor’s responsibility to initiate and coordinate all required tests and inspections including conformance with requirements of all applicable public agencies and authorities. Contractor will be responsible for coordinating the testing requirement with testing agency and provide the testing agency no less than two (2) working days advance notification to schedule tests.
   2. Employment of the testing agency shall in no way relieve Contractor's obligations to perform the Work of the Contract
   3. Contractor shall employ and pay for the services of a testing agency to perform all specified services and testing not specifically identified in the technical specifications to be provided by Owner related to the design of mixes, products and equipment, to Engineer's review of proposed materials and equipment before, during and after incorporation in the Work and to retest materials and equipment which fail original tests

B. Retesting required because of non-conformance to specified requirements shall be performed by the same testing agency on instructions by the Engineer. Payment for retesting will be charged to the Contractor by deducting inspection or testing charges from the Contract Sum/Price

1.7 QUALIFICATION OF TESTING AGENCY

A. Meet "Recommended Requirements for Independent Laboratory Qualification", published by American Council of Independent Laboratories

B. Meet basic requirements of ASTM E 329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction" as applicable

C. Authorized to operate in the State in which the Project is located

1.8 TESTING AGENCY DUTIES

A. Cooperate with Engineer and Contractor; provide qualified personnel after due notice

B. Perform specified inspections, sampling, and testing of materials and methods of construction
   1. Comply with specified standards
   2. Ascertain compliance of materials with requirements of Contract Documents

C. Promptly notify Engineer and Contractor of observed irregularities or deficiencies of work or products

1.9 LIMITATIONS OF AUTHORITY OF TESTING AGENCY

A. Testing Agency Is Not Authorized To
   1. Release, revoke, alter or enlarge on requirements of Contract Documents
   2. Approve or accept any portion of the Work
   3. Owner employed testing agency shall not perform any duties of the Contractor

1.10 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory and testing agency personnel and provide access to Work

B. Secure and deliver to the laboratory adequate quantities of representative samples of materials proposed to be used and which require testing

C. Provide to the laboratory the preliminary design mix proposed to be used for concrete and other material mixes which require control by the testing laboratory

D. Furnish copies of product test reports as required

E. Furnish Incidental Labor and Facilities
   1. To provide access to Work to be tested
   2. To obtain and handle samples at the project site or at the source of the product to be tested
   3. To facilitate inspections and tests
   4. For storage and curing of test samples

F. Cooperate with testing agency; furnish samples of materials, design mix, equipment, tools, storage and assistance as requested
   1. Notify Engineer and testing agency 24 hours prior to expected time for operations requiring services to allow for scheduling of tests and laboratory assignment of personnel
   2. Make arrangements with testing agency and pay for additional samples and tests required for Contractor's use

1.11 FIELD TESTING

A. Contractor shall pay all costs associated with standard field testing of materials as detailed in these specifications. Contractor shall pay all costs for testing of piping and equipment as detailed in these specifications. Owner’s testing agency will take concrete samples, cure and break samples and report results. Owner's testing agency will also provide compaction testing and proctors for backfill operations. Contractor shall pay for all retesting due to tests indicating failed conditions.

B. Provide all required materials, labor, equipment, water, and power required for testing

C. Perform all tests in presence of Engineer and provide one copy of field test results to Engineer same day of tests

D. Repair with no additional compensation all materials and equipment which fail during testing

1.12 LABORATORY TESTING AND SERVICES SCHEDULE

A. Testing laboratory services shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment, or System	Quality Assurance(QA) or Quality Control (QC)	Owner (O) or Contractor (C) Provided
02300	Earthwork	QA	O
02300	Earthwork	QC	C

1.13 FIELD TESTING AND SERVICES SCHEDULE

A. Field testing shall be provided for, but shall not be limited to, the following:

Specification Section	Type of Material, Equipment, or System	Quality Assurance(QA) or Quality Control (QC)	Owner (O) or Contractor (C) Provided
02300	Earthwork	QA	O
02300	Earthwork	QC	C
02510	Water Distribution System	QA	O
02510	Water Distribution System	QC	C
02676	Disinfection of Water System	QA	O
02676	Disinfection of Water System	QC	C

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, heating, ventilating, telephone service, water and sanitary facilities

B. Temporary Controls: Barriers, enclosures and fencing, protection of the Work, and water control.

C. Construction Staging Facilities: Access roads, parking areas, progress cleaning, project signage, storage and temporary buildings.

1.2 GENERAL REQUIREMENTS

A. Furnish, install and maintain all temporary utilities to assure continuous service required for the Work, except as allowed herein, and remove on completion of Work. Modify and extend systems, as work progress requires.

B. Furnish, install and maintain all construction aids required for the Work, except as allowed herein, and remove on completion of the Work

C. Furnish, install and maintain fences and barriers as required for protection of the public, property and the Work

D. Contractor may use existing roadways for access and parking only where designated by Owner.

E. Provide a field office for the use of the Contractor’s Superintendent, Owner’ Representatives, and Engineer in the designated staging area

F. Products may be new or used, but must be serviceable, adequate for the intended purpose, and must not violate the requirements of any applicable codes or standards

G. Clean and repair damage caused by temporary installations or use of temporary facilities. Grade and seed all disturbed areas not detailed on the drawings for other treatment

H. Provide contractor information sign posted at accessible location with contractor name and emergency phone contact information.

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies

1. Comply with applicable Federal and State rules and regulations, local codes and ordinances
2. Comply with utility company requirements

1.4 TEMPORARY ELECTRICITY

A. Contractor shall pay all costs associated with power service to the field offices and pay all costs for energy used.

B. Arrange for and pay all costs associated with temporary power service either from the local utility or a portable engine-generator

C. Provide power outlets for construction operations, with branch wiring and distribution boxes located at the site. Provide flexible power cords as required

D. Provide main service disconnect and over current protection at convenient location

E. Pay all costs for installation and removal of temporary electrical service

1.5 TEMPORARY LIGHTING

A. Provide and maintain lighting to exterior staging and storage areas after dark for security purposes as required

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

C. Maintain lighting and provide routine repairs

1.6 TEMPORARY WATER SERVICE

A. Potable water does exist on the site. Provide and pay for all temporary potable water.

B. Provide all drinking water required by construction personnel and Owner's representatives. Pay all costs for temporary water service.

1.7 TEMPORARY SANITARY FACILITIES

A. Provide sanitary facilities at staging area
1. As required by laws and regulations
2. Not less than 1 facility

B. Service, clean and maintain facilities and enclosures

1.8 CONSTRUCTION AIDS

A. Provide construction aids and equipment required by personnel and to facilitate the execution of the Work: scaffolds staging, ladders, stairs, ramps, runways, platforms, railways, hoists, cranes, chutes and other such facilities and equipment

B. Relocate construction aids as required by progress of construction, by storage or work requirements, and to accommodate legitimate requirements by Owner

C. Completely remove temporary materials, equipment, and services at completion of the Project

D. Clean, repair damage caused by installation or by use of temporary facilities
   1. Remove foundations and underground installations for construction aids
   2. Grade the areas for the site affected by temporary installations to required elevations and slopes and clean the area and seed unless specified as shown on the drawings to be different

1.9 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition

B. Provide suitable barriers as required for public protection of Owner's employees

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

D. Install facilities of a neat and reasonable uniform appearance, structurally adequate for the required purposes

E. Relocate barriers as required by progress of construction

F. Completely remove barriers, including foundations, when construction has progressed to the point that they are no longer needed

G. Clean and repair damage caused by installation, fill and grade the areas of the site to required elevations and slopes and clean the area

1.10 TEMPORARY FENCING

A. Construction: Commercial grade chain link fence

B. Provide additional fencing to protect stored materials & products or to insure public safety and the safety of Owner's employees

C. Provide Owner two (2) keys to lock(s)

D. The site of the work is fenced

1.11 STORMWATER MANAGEMENT

A. Refer to SWMP in the drawings and comply with all conditions of CDPHE Stormwater Discharge Permit. Contractor responsible for both permit filing and any required reporting.

B. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment as necessary.

C. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

D. Perform work in phases and restore areas where work is complete.

1.12 FUGITIVE DUST PERMIT

A. Comply with all conditions of CDPHE Fugitive Dust Permit. Contractor responsible for both permit filing and any required reporting.

B. Contractor to pay for all metered water used in dust abatement

1.13 CONSTRUCTION DEWATERING

A. Comply will all conditions and requirements of CDPHE Construction Dewatering Permit. The Contractor shall be responsible for any permit filing and reporting necessary.

1.14 EROSION AND SEDIMENT CONTROL

A. Install sediment control fencing at site perimeter where necessary to prevent erosion and sedimentation from occurring off site.

B. During and after site grading, maintain a roughened surface on all disturbed areas to minimize erosion potential.

C. Construct and maintain drainage swales with staked straw bale barriers to control drainage patterns and minimize erosion.

D. Provide and maintain gravel sediment traps at inlets to prevent siltation.

E. Provide and maintain rock check dams if required.

F. Soils can be stockpiled on site as directed by Owner. Rock to be hauled off not crushed and stockpiled onsite.

1.15 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification Sections

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage

C. Protect finished driving surfaces, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects

D. Prohibit construction traffic from entering future landscaped areas after grades have been established and topsoil restored

1.16 SECURITY

A. Provide security and facilities to protect Work from unauthorized entry, vandalism, or theft

B. Coordinate with Owner's security program

1.17 ACCESS ROADS

A. Maintain existing roads accessing public thoroughfares to construction staging area.

B. Extend and relocate as Work progress requires. Provide detours necessary for unimpeded traffic flow

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

D. Provide means of removing mud from vehicle wheels before entering public paved streets as required by SWMP and Owner

1.18 PARKING

A. Paved and unpaved surfaces adjacent to the staging area can accommodate construction personnel until the designated building staging area has been established

B. If staging area space is not adequate, provide additional off-site parking at location designated by Owner

1.19 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition

B. Remove waste materials, debris, and rubbish from site periodically and dispose off-site in accordance with local and state regulations. Due to high winds experienced at the site, waste removal must be done immediately after it is generated
   1. It is not permissible to bury waster, debris, rubbish underground whether in the trench or elsewhere

1.20 FIELD OFFICES AND SHEDS

A. Construction
   1. Structurally sound, weather-tight, with floors raised above ground
   2. Temperature transmission resistance: Compatible with occupancy and storage requirements
   3. At Contractor's option, portable or mobile buildings modified for office use may be used

4. Fill and grade sites for temporary structures to provide surface drainage
5. Construct temporary field offices and storage sheds on proper foundations, provide connections for utility services
    a. Secure portable or mobile buildings for winds to 110 mph
    b. Provide steps and landings at entrance door
6. Mount thermometer at convenient outside location, not in direct sunlight
7. Provide periodic maintenance and cleaning for temporary structures, furnishings, equipment and services
8. Remove temporary field offices, contents, and service at a time they are no longer needed
9. Remove storage sheds when they are no longer needed
10. Remove foundations and debris; grade the site to required elevations and clean the areas

B. Contractor's Office and Facilities
    1. Size: As required for general use and to provide space for project progress meetings
    2. Furnishings in meeting area
        a. Conference table and chairs for at least 12 persons
        b. Racks and files for project record documents in, or adjacent to, the meeting area
        c. Engineer and Owner will have use of meeting area and telephone when on site. Meeting area: 200 square feet minimum, minimum dimension 8 feet
    3. Other furnishings: Contractor's option
    4. One 10-inch outdoor-type thermometer

C. Existing facilities at the site shall not be used for field offices or storage. Coordinate with water department staff for location.

D. Fire protection equipment. Contractor shall provide and maintain fire extinguishers and active fire hydrants where indicated, maintain fire lanes to hydrants, and provide other equipment as necessary for proper fire protection during construction. Such equipment shall be for fire protection only.

1.21 REMOVAL OF TEMPORARY UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, materials, prior to Final Application for Payment

B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated

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

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 01700

CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Substantial completion

B. Final acceptance

C. Project record documents

D. Closeout procedures

E. Final cleaning

F. Final adjustment of accounts

G. Final application for payment

1.2 RELATED SECTIONS

A. Section 00700 – General Conditions

B. Section 01500 – Construction Facilities and Temporary Controls

C. Section 01340 – Shop Drawings and Product Data

1.3 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Prior to requesting inspection for certification of Substantial Completion, complete the following and list exceptions in the request:
   1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100% completion for the portion of the Work claimed as Substantially Complete
      a. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price
      b. If 100% completion cannot be shown, include a list of incomplete items, the value of incomplete Work, and reasons the Work is not complete. All items remaining outstanding on the Contractor's punch list shall include a projected date of completion and/or correction with an explanation of why such item is not presently completed
   2. Advise Owner of pending insurance changeover requirements
   3. Submit specific warranties, workmanship Bonds, maintenance agreements, final certifications, and similar documents

4. Obtain and submit releases enabling Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases
5. Submit record drawings, instruction books and operating manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information
6. Deliver tools, spare parts, extra stock, and similar items
7. Make final changeover of permanent locks and transmit keys to Owner. Advise Owner's personnel of changeover in security provisions
8. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes

B. Inspection Procedures: On receipt of a request for inspection, Engineer and City Inspector will either proceed with inspection or advise Contractor of unfilled preliminary procedure requirements.
   1. Engineering will repeat inspection when requested and assured by Contractor that the Work is Substantially Complete.
   2. Results of the completed inspection will form the basis of requirements for final acceptance

1.4 FINAL ACCEPTANCE

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
   1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required
   2. Submit an updated final statement, accounting for final additional changes to the Contract Price
   3. Submit a certified copy of Engineer’s final inspection list of items to be completed or corrected, endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by Engineer.
   4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the Date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work
   5. Advertisement for Final Payment - 30 days
   6. Submit consent of surety to final payment
   7. Submit evidence of final, continuing insurance coverage complying with insurance requirements

B. Reinspection Procedure: Engineer will reinspect the Work upon receipt of notice that the Work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to Engineer.
   1. Upon completion of reinspection, Engineer will prepare a certificate of final acceptance. If the Work is incomplete, Engineer will advise Contractor of Work that

is incomplete or of obligations that have not been fulfilled but are required for final acceptance
2. If necessary, reinspection will be repeated, but at the expense of the Contractor who will reimburse the Owner for these services by the Engineer

1.5 PROJECT RECORD DOCUMENTS

A. General
1. Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours
2. Maintain on site, one set of the following record documents; record actual revisions to the Work:
   a. Contract Drawings
   b. Specifications
   c. Addenda
   d. Change Orders and other Modifications to the Contract
   e. Reviewed shop drawings, product data, and samples
   f. Field test reports
   g. Construction photographs
3. Store Record Documents and samples separate from documents used for construction
   a. Provide files and racks for storage of documents
   b. Provide locked cabinet or secure storage space for samples

B. Record Drawings
1. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings
2. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown
3. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings
4. Give particular attention to concealed elements that would be difficult to measure and record at a later date
   a. Record information concurrently with construction progress
   b. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work. Mark each document "Project Record" in neat, large, printed letters
   c. Mark new information that is important to Owner but was not shown on Contract Drawings or Shop Drawings
   d. Note related Change Order numbers where applicable
   e. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set
   f. Upon completion of the Work, submit record drawings to Engineer for Owner's records

g. In addition to Items I and II in the General Contract Conditions, Section 54, As-Built record information will be provided to, and approved by City staff prior to Final Acceptance of the Project. Information to be provided must be in electronic format (e.g. AutoCAD and/or survey files) along with a PDF set of As-Built drawings. As-Built electronic files must contain information suitable for the City to maintain Utility records to the standards set forth in the new Colorado 811 One Call/Subsurface Utility Law (effective August 8, 2018) and standards as described in the American Society of Civil Engineers (ASCE) Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data (ASCE 38-02).
h. Electronic information for As-Built records shall include, but is not limited to, verification of all horizontal and vertical changes in pipe alignments, elbows, tees, manholes, valves, control structures, service taps, service pipe (horizontal and vertical deflections to ROW line, meter pits, or clean-outs, whichever is closer), beginning and ending of slip-lined segments, tie-in or connection to existing infrastructure, etc. Distance between As-Built data points along pipe alignment is dependent on the amount of deflection used to install the pipe in the field. There must be sufficient point data to create a plan and profile of all infrastructure accurate to within eighteen inches (18") of the physical structures anywhere along the project.

5. Contract Drawings and approved Shop Drawings: Legibly mark each item to record actual construction, including:
   a. Measured depths of elements of foundation in relation to finish grade or first floor datum
   b. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvement
   c. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of construction.
   d. Field changes of dimensions and details
   e. Changes made by Addenda or Change Order(s), if any
   f. Details not on original Contract Drawings
   g. References to related Shop Drawings and Modifications

C. Record Specifications: Maintain one complete copy of the Project Manual including addenda. Include with the Project Manual one copy of other written construction documents, such as Change Orders and Modifications issued in printed form during construction
   1. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications.
   2. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
   3. Note related record drawing information and product data.
   4. Upon completion of the Work, submit record Specifications to Engineer for Owner's records

D. Record Product Data: Maintain one copy of each product data Submittal. Note related Change Orders and markup of record drawings and specifications.

1. Mark record documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the Site and from the manufacturer's installation instructions and recommendations.
2. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation.
3. Upon completion of markup, submit complete set of record product data to Engineer for Owner's records
4. Legibly mark and record at each Product section description of actual Products installed, including the following:
    a. Manufacturer's name, product model, number, trade name and supplies
    b. Product substitutions or alternates utilized
    c. Changes made by Addenda, field order or change order

E. Record Samples Submitted: Immediately prior to Substantial Completion, Contractor shall meet with Engineer and Owner's personnel at the Project Site to determine which Samples are to be transmitted to Owner for record purposes. Comply with Owner's instructions regarding packaging, identification, and delivery to Owner.

F. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record keeping and Submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records, and place in good order. Identify miscellaneous records properly and bind or file, ready for continued use and reference. Submit to Engineer for Owner's records

G. Maintenance Manuals: Contractor shall organize operation and maintenance data as specified in Section 01730

H. Submit documents to Engineer with claim for final Application for Payment

I. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes

J. Make documents and samples available at all times for inspection by Engineer

K. Label each document "Project Record" in neat, large printed letters

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 CLOSEOUT PROCEDURES

A. General
1. Comply with requirements stated in the Owner's General Conditions of the Contract and in these specifications for administrative procedures in closing out the Work

2. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's inspection
3. Provide submittals to Engineer/Owner that are required by governing or other authorities
4. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due

B. Operation and Maintenance Instructions: Arrange for each installer of Equipment that requires regular maintenance to meet with Owner's personnel at Project Site to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
1. Maintenance manuals
2. Record documents
3. Spare parts, materials and tools
4. Lubricants and fuels
5. Identification systems
6. Control sequences
7. Hazards, hazardous chemicals data sheets
8. Cleaning
9. Warranties and bonds
10. Maintenance agreements and similar continuing commitments

C. As part of instruction for operating Equipment, demonstrate the following procedures:
1. Startup
2. Shutdown
3. Emergency operations
4. Noise and vibration adjustments
5. Safety procedures
6. Economy and efficiency adjustments
7. Effective energy utilization

3.2 FINAL CLEANING

A. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion
    a. Remove labels that are not permanent labels
    b. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition
    c. Wipe surfaces of mechanical and electrical Equipment. Remove excess lubrication and other substances

2. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction
3. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the Site and dispose of lawfully.
    a. Where extra materials of value remaining after completion of associated Work become Owner's property. Dispose of these materials as directed by Owner

3.3 CONTRACTOR'S CLOSEOUT SUBMITTALS

A. Evidence of Payment and Release of Liens: As specified in the General Conditions

B. Final inspection reports by all regulatory agencies demonstrating the agencies' final approval

C. At Contract close-out, deliver Record Documents to Engineer for the Owner

D. Accompany Submittal with Transmittal Letter in Duplicate, Containing
1. Date
2. Project title and number
3. Contractor's name and address
4. Title and number of each Record Document
5. Signature of Contractor or his authorized representative

3.4 FINAL ADJUSTMENTS OF ACCOUNTS

A. Submit a Final Statement of Accounting to Engineer

B. Statement Shall Reflect All Adjustments to the Contract Sum
1. The original Contract Sum
2. Additions and deductions resulting from
    a. Previous Change Orders
    b. Deductions for uncorrected Work
    c. Deductions for liquidated damages
    d. Deductions for reinspection payments
    e. Other adjustments
3. Total Contract Sum, as adjusted
4. Previous payments
5. Sum remaining due

3.5 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment in accordance with procedures and requirements stated in the General Conditions of the Contract

B. City Warranty period is 1 year from date of Final Acceptance

END OF SECTION

SECTION 02616

SITE PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Piping and necessary appurtenances for exterior concrete structures and for exterior buried locations:
   1. Raw water piping

1.2 RELATED SECTIONS

A. Section 03300 – Cast-In-Place Concrete

B. Section 03600 – Non-Shrink Grout

C. Section 15060 – Pipe and Pipe Fittings

D. Section 15100 – Valves, Cocks, and Hydrants

1.3 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. T180 – Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

B. American National Standards Institute (ANSI):
   1. B16.1/16.5 – Pipe Flanges and Fittings Package

C. American Society of Testing and Materials (ASTM):
   1. A36 – Standard Specification for Carbon Structural Steel
   2. A48 – Standard Specification for Gray Iron Castings
   3. A53 – Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless
   4. A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
   5. A185 – Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
   6. A242 – Standard Specification for High-Strength Low-Allow Structural Steel
   7. A276 – Standard Specification for Stainless Steel Bars and Shapes
   8. A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 psi Tensile Strength
   9. A449 – Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
   10. A536 – Standard Specification for Ductile Iron Castings

11. A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
12. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings
13. C33 – Standard Specification for Concrete Aggregates
14. C136 – Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
15. C150 – Standard Specification for Portland Cement
16. D429 – Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates
17. D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
18. D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
19. D1351 – Standard Specification for Thermoplastic Polyethylene Insulation for Electrical Wire and Cable
20. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3))
21. D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
22. D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
23. D2241 – Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
24. D2466 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
25. D2467 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
26. D2454 – Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
27. D2672 – Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement
28. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
29. D3139 – Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
30. D3950 – Standard Specification for Strapping, Nonmetallic (and Joining Methods)
31. D4253 – Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
32. D4254 – Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative DensityD6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
33. F412 – Standard Terminology Relating to Plastic Piping Systems
34. F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

D. American Water Works Association (AWWA):
   1. C200 – Standard for Steel Water Pipe 6 In. (150 mm) and Larger
   2. C203 – Standard for Coal-Tar Protective Coatings & Linings for Steel Water Pipes
   3. C206 – Standard for Field Welding of Steel Water Pipe

4. C207 – Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
5. C213 – Standard for Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
6. C214 – Standard for Tape Coatings for Steel Water Pipelines
7. C219 – Standard for Bolted, Sleeve-Type Couplings for Plain-End Pipe
8. C500 – Metal-Seated Gate Valves for Water Supply Service
9. C504 – Standard for Rubber-Seated Butterfly Valves
10. C508 – Swing-Check Valves for Waterworks Service 2 In. Through 24 In.
11. C509 – Resilient Seated Gate Valves for Water Supply Service
12. C512 – Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
13. C515 – Standard for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
14. C550 – Protective Interior Coatings for Valves and Hydrants
15. C604 – Standard for Installation of Buried Steel Water Pipe – 4 In. (100 mm) and Larger
16. C605 – Standard for Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
17. C606 – Grooved and Shouldered Joints C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution
18. C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution
19. C905 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm)
20. M11 – Steel Pipe - A Guide for Design and Installation
21. M17 – Installation, Field Testing, and Maintenance of Fire Hydrants
22. M23 – PVC Pipe Design and Installation

E. Uni-Bell PVC Pipe Assocation (Uni-Bell):
1. Handbook of PVC Pipe Design and Construction

F. National Association of Corrosion Engineers (NACE):
1. SP0169 – Control of External Corrosion on Underground or Submerged Metallic Piping Systems
2. SP0286 – Electrical Isolation of Cathodically Protected Pipelines

G. American Welding Society (AWS):
1. D1.1 – Structural Welding Code – Steel

H. Uni-Bell PVC Pipe Association:
1. Uni-Pub-8: Tapping Guide for PVC Pressure Pipe

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Shop Drawings:
   1. Provide drawings with pipe and structure details, design standards, reinforcement, dimensions, layout fabrication and assembly drawings and shall include, but not limited to, the following:
      A. Layout of pipe drawings
      B. Pipe and joint details
      C. Restrained joint locations
      D. Specials, fittings, and coupling details
      E. Specification data sheets
      F. Certificates of compliance with applicable standard and specification and testing certificates
   2. Provide additional detailed information including elevations, fittings, specialty materials or fabrications for special or custom features, structures, junctions and/or pipes
   3. Specifications, data sheets and affidavits of compliance for coatings and linings
   4. Provide pipe-laying and installation schedule

C. Product Data: Provide sufficient data on features, pipe, joints, gasket material, lubricant and accessories to verify compliance with specifications

D. Manufacturers Certificate and affidavits:
   1. Furnish the following prior to fabrication
      A. Details: Pipe, joint, special, fitting and coupling
      B. Shop coating
      C. Shop coatings and linings: specifications, data sheets, and compliance affidavits
   2. Furnish the following prior to shipment
      A. Compliance affidavit for applicable standards
      B. Test certificates

E. Test Reports: Submit all shop and field test reports in accordance with Division 1 Specifications

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience

B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 1 Specifications

B. Accurately record actual locations of piping mains, valves, connections, centerline of pressure pipe elevations, and top of gravity pipe elevations

C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities

1.7 QUALITY ASSURANCE

A. Manufacturers shall be experienced in the design and manufacturing of materials specified herein for a minimum period of 5 years

B. All PVC and steel pipe, regardless of diameter, shall be supplied by a single manufacturer

C. Contractor shall conduct visual inspection before installation

D. Provide manufacturer's name and pressure rating marked on piping and valves

E. Provide piping complete with all fittings, jointing materials, supports, joint restraint system, and necessary appurtenances for watertight, fully operational water lines

1.8 REGULATORY REQUIREMENTS

A. Conform to all State and local municipal codes and ordinances, laws and regulations

B. In case of apparent conflict, State and local requirements govern over these specifications

C. In absence of State and local regulations, International Plumbing Code applies

D. Contractor, not Owner, shall prepare, submit, pay, and otherwise obtain all necessary permits from all appropriate entities

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 1 Specifications

B. Delivery
   1. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, heat, and direct sunlight

C. Storage
   1. Store pipe, fittings and gaskets in clean locations protected from environmental conditions such as: direct sunlight, mud, etc.
   2. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months
   3. Store pipe on a flat surface which provides even support for the barrel with bell ends overhanging
      A. Do not stack pipe higher than 5 feet

D. Storage: Use the following precautions for valves, during storage:
   1. Do not remove end protectors unless necessary for inspection; then reinstall for storage
      A. Protect valves from weather by storing indoors or support valves off ground or pavement in watertight enclosures when outdoor storage is necessary

E. Handling
   1. Handle so as to insure installation in sound undamaged condition. Do not damage the pipe by impact, bending, compression or abrasion during handling or storage
   2. Use equipment, tools and methods for unloading, reloading, hauling and laying that do not damage pipe or cause an impact. Damaged pipe will be cause for rejection
   3. Use hooks or straps with broad, well padded contact surfaces for lifting sections of pipe

F. Preparation for Transport:
   1. Prepare valves, for shipping as follows: Ensure that valves are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends, flange faces, and weld ends. Set valves in best position for handling. Set valves closed to prevent rattling.

G. Deliver and store valves and accessories in shipping containers with labeling in place in accordance with AWWA C500/C509

H. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

I. Seal valve ends to prevent entry of foreign materials into valve body

J. During loading, transporting and unloading, exercise care to prevent damage to material
   1. Use nylon slings only
   2. Do not drop pipe or fittings
   3. Do not roll or skid against pipe already on ground
   4. Repair any damage done to coating or lining
   5. Handle per manufacturer's recommendations
   6. Store rubber gaskets in cool dark location
   7. Store all material on wood pallets or timbers

K. Adequately tag or otherwise mark all piping and fittings as to size

L. Shop coated materials shall be handled, transported, stored and shipped in a manner that will prevent damage to the coating and lining. Coating or lining damaged in handling or other operations shall be repaired to the approval of and at no additional cost to the Owner

M. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline and before final acceptance by the Engineer shall be repaired in accordance with these Specifications and at no additional cost to the Owner

1.10 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication
   2. Indicate field measurements on Shop Drawings

1.11 JOB CONDITIONS

A. All work which requires the interruption of active water service lines must be completed as quickly as possible in order to minimize inconvenience to customers and risk to the City of Grand Junction and coordinated as specified in Division 1

B. Underground Obstructions
   1. Underground Obstructions known to Engineer are shown on Drawings
      A. Locations shown may prove inaccurate and other obstructions not known to Engineer may be encountered
      B. Contractor shall field locate and verify all obstructions where or not shown on the Drawings
   2. Notify each utility owner and request utility be field located by surface reference at least 48 hours prior to trenching or excavation
   3. Expose and verify size, location and elevation of underground utilities and other obstructions where conflicts might exist sufficiently in advance to permit changes in the event of a conflict
      A. Notify Engineer and Owner in case of a conflict
      B. In case of a conflict, the proposed work may be changed by Engineer
   4. Maintain, protect, and support by shoring, bracing or other means existing utilities and appurtenances

C. Verify existing system operation, pressures, and valve settings (open or closed) prior to construction

1.12 ENVIRONMENTAL REQUIREMENTS

A. Weather limitations: Do not install piping over frozen surfaces or in standing water

PART 2 PRODUCTS

2.1 GENERAL

A. Provide pipes and fittings of the following materials, joint types, sizes, and weight/class indicated on Drawings or as specified herein

B. Fittings: Furnish bends, ells, tees, wyes, couplings and other fittings of the same type and class of material having equal or superior physical and chemical properties as acceptable to the Engineer

C. All buried PVC pipe shall be installed with tracer wire and metallic core identification tape

2.2 PVC PIPE – 14” TO 48” DIAMETER

A. Manufacturers
   1. JM Eagle
   2. North American Pipe Corporation

3. Diamond Plastic Industries
4. Vinyltech Corporation
5. Or accepted substitution

B. The following piping shall be large diameter PVC pipe as indicated on the Drawings and as specified herein:
   1. Water transmission mains: 18" and 20” diameter

C. Pipe: AWWA C905, SDR 35, and DR 18 except as otherwise specified or indicated on the Drawings

D. Marking: Identification markings on pipe shall conform to AWWA C905

E. Fittings: Ductile iron fittings, ANSI A 21.53/AWWA C153 or ANSI A21.10/AWWA C110
   1. Working pressure rating: 250 psi rating
   2. Joint: mechanical joints with restraints
   3. Coating:
      A. Exterior: AWWA C153
      B. Asphalt coated interior: AWWA C104 and C153, lined with double thickness cement and seal coated
      C. Or interior and exterior: AWWA C116, fusion bonded epoxy coating

F. Joints: ASTM D3139, integral bell or mechanical joint
   1. Push-on joints: pipe to pipe joints, except as otherwise specified or indicated on Drawings. Push on joints are not permitted on fittings or valves
      A. Integral bell type with elastomeric gaskets, ASTM F477 factory installed
      B. Suitable for buried service
      C. Gaskets:
         i) Material: Virgin SBR rubber suitable for potable conforming to AWWA C111
         ii) Lubricant shall be suitable for potable water contact
   2. Restraint device for PVC push on joint
      A. Restraint material: ASTM A536, ductile iron
      B. A backup ring shall be used behind the PVC bell. A restraint ring, incorporating a plurality of individually-actuating gripping surfaces, shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring
      C. Pressure rating consistent with pipe pressure rating
      D. Restraint coatings shall be consistent with manufacturer's standard
      E. Manufacturers:
         i) EBAA Iron Inc. "Series 2800"
         ii) Romac Industries "Series 470"
         iii) Or accepted substitution
   3. Mechanical joint restraint
      A. Provide mechanical joint restraint for all ductile iron fittings connecting to PVC pipe

B. Restraint devices for shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA A21.10/ C110
C. Pressure rating consistent with pipe pressure rating
D. Restraint coatings shall be consistent with manufacturer's standard
E. Manufacturer:
i) EBAA Iron "MEGALUG 2000 PV"
ii) Romac Industries "Roma-Grip"
iii) Or accepted substitution

G. Couplings
1. Mechanical couplings:
A. Dresser Style 38
B. Rockwell 411
C. Or accepted substitution
2. Insulated Mechanical Couplings:
A. Dresser Style 39
B. Or accepted substitution
3. Transition Couplings:
A. Rockwell 415
B. Dresser Style 39
C. Or accepted substitution
4. Glands color coded: Black

H. Couplings
1. Provide for connection between PVC and steel water distribution pipe
2. Material: Ductile Iron, ASTM A536 Grade 65-45-12
3. End Rings: Ductile Iron, ASTM A536
4. Gaskets: Virgin SBR rubber suitable for potable conforming to AWWA C111
5. Bolts and Heavy Hex Nuts: UNC 5/8" rolled threads with black finish.
6. Manufacturer:
A. JCM
B. EJ Prescott
C. Or accepted substitution

2.3 DUCTILE IRON PIPING (DIP)

A. The following piping shall be DIP as indicated on the drawings and as specified herein
1. As indicated in Piping Schedule below

B. Shall be in accordance with AWWA C115, C150, and C151 except as otherwise specified or indicated on Drawings

C. Contractor shall submit complete process piping drawings and shall include all location and dimensions of piping, fittings, valves, and coupling

D. Manufacturers
1. U.S. Pipe

2. American Cast Iron Pipe Company
3. McWane Cast Iron Pipe Company
4. Pacific States Cast Iron Pipe Company
5. Griffin Pipe Products Company
6. Or accepted substitution

E. Pipe
   1. ANSI A21.51/AWWA C151: As listed below except as otherwise specified or indicated on Drawings
      A. Where fitted with push-on joints, mechanical joints or mechanical joints with joint restraint device, or restrained joints: minimum pressure class wall thickness that meets project pressure and structural requirements, unless otherwise specified or indicated on the Drawings.
      B. Where fitted with flanged, grooved or restrained joints: Class 53
      C. 4-Inch to 12-Inch: Class 350
      D. Thickness (minimum) for screw-on flanges shall be in accordance with AWWA C115
      E. Pipe with grooved or shouldered joints for any restrained joint shall have wall thickness increased to provide the minimum wall thickness in accordance with AWWA C606

F. Fittings
   1. Ductile iron full body fittings
      A. ANSI A21.10/AWWA C110, ASTM A536
      B. 24-inch and below: 350 psi rating, mechanical joint
   2. Ductile iron compact fittings
      A. ANSI A21.53/AWWA C153
      B. 24-inch and below: 350 psi rating, mechanical joint
   3. Fittings shall have a pressure rating no less than that of adjoining pipe
   4. Fittings for pipe with mechanical or push-on joints shall have mechanical joints in accordance with ANSI A21.11/AWWA C111
   5. Comply with requirements for restrained fittings as indicated on Drawings
   6. Tapping Sleeve and Tapping Valve:
      A. Complete assembly, including tapping sleeve, tapping valve, and bolts and nuts. Use sleeve and valve compatible with tapping machine
      B. Tapping Sleeve: Cast-iron or ductile-iron 2-piece bolted sleeve with flanged outlet for new branch connection. Sleeve may have mechanical joint ends with rubber gaskets or sealing rings in sleeve body. Use sleeves that mate with size and type of pipe material being tapped. Outlet flange shall be of a size required for branch connection
   7. Provide all specials, taps, flanges, plugs and wall fittings as required
   8. Provide openings for air valve, drain, sampling, testing, sensing and all other connections with threaded bosses sized and located as indicated and specified
      A. Threaded connections:
         i) Shall be in accordance with ANSI B2.1.NPT: provide boss or tapping saddle at all tapped connections

G. Joints

1. All joints shall be of restrained type unless otherwise indicated on Drawings
2. Mechanical and push-on joints:
   A. Shall have a pressure rating no less than that of adjoining pipe
   B. Mechanical joints:
      i) Less than 30-inches in diameter: Shall be in accordance with ANSI A21.11/AWWA C111
   C. Push-on joints:
      i) Less than 24-inches in diameter: Shall be in accordance with ANSI A21.11/AWWA C111
      ii) Gaskets shall be neoprene or other synthetic rubber (SBR). Natural rubber is not acceptable.
   D. Push-on joints:
      i) 30-inches in diameter and greater: Shall be in accordance with ANSI A21.11/AWWA C111
      ii) Gaskets shall be neoprene or other synthetic rubber (SBR). Natural rubber is not acceptable.
   E. Lubricant: Heavy vegetable soap non-toxic solution suitable for potable water contact
3. Mechanical joints with tie rods:
   A. Tie rods: ASTM A307, galvanized entire length
   B. Steel pipe spacers: ASTM A120, standard weight galvanized
   C. Washers: ANSI A27.2 plain steel, galvanized
   D. Plastic plugs: As recommended by pipe manufacturer
4. Threaded connections:
   A. ANSI B1.20.3 NPT: Provide boss or tapping saddle at all tapped connections
5. Mechanical joint restraint device
   A. 360° serration lock engagement type
   B. Nuts and bolts torqued to requirements of manufacturer
   C. Working pressure rated at 150 psi minimum
   D. 24-inch and below:
      i) EBBA Iron Inc., Meg-a-Lug Series 1100
      ii) Uni-Flange Corporation, 1400 Series
      iii) Or accepted substitution
6. Push-on joint restraint device
   A. 360 degree serration lock engagement type
   B. Nuts and bolts torqued to requirements of manufacturer
   C. Working pressure rated at 150 psi minimum
   D. 24-inch and below:
      i) EBBA Iron Inc., Megalug Series 1700
      ii) Uni-Flange Corporation, 1490 Series
      iii) Or accepted substitution
7. Restrained push-on joints
   A. 30-inch and below:
      i) American Flex-Ring
      ii) Griffin Snap-Lok
      iii) U.S. Pipe TR-Flex
      iv) Or accepted substitution

8. Restrained mechanical joints
    A. 30-inch and below:
        i) Griffin Bolt-Lok
        ii) American MJ Coupled Joint
        iii) Or accepted substitution
9. Restrained mechanical joints at fittings
    A. EBAA Iron Inc., Megalug Series 1100
    B. Uni-Flange Corporation (Ford Meter Box), 1400 Series
    C. Or accepted substitution
10. Bolts and nuts: Corrosion-resistant bolts and nuts for use with ductile iron joints shall be high strength, low alloy steel as specified in ANSI/AWWA C111/ANSI A21.11
    A. Cor-Ten
    B. Usalloy
    C. Durabolt
    D. Or accepted substitution
11. Gaskets shall be neoprene or other synthetic rubber (SBR). Natural rubber is not acceptable.

H. Couplings
1. Mechanical Couplings:
    A. Dresser Style 38
    B. Rockwell 411
    C. Romac Industries 501
    D. Smith Blair 461
    E. Or accepted substitution
2. Insulated Mechanical Couplings:
    A. Dresser Style 39
    B. Romac Industries IC501
    C. Or accepted substitution
3. Transition Couplings:
    A. Rockwell 415
    B. Dresser Style 39
    C. Romac Industries TC400
    D. Smith Blair 413
    E. Or accepted substitution
4. Glands color coded: Black

I. Fabrication
1. Joints
    A. Except as indicated on Drawings
        i) Bells in wall pipe or casting: Mechanical with tapped holes for follower bolts or extended minimum 6 inches beyond wall
        ii) Exposed: Flanged or grooved
    B. 12 inch and smaller branch outlets where main line is at least twice the diameter of the branch, tee or a tapping saddle is acceptable
    C. Tie rods may be required as indicated on Drawings
    D. Mark the centerline of each flange and mechanical joint piece

E. Screw flanges onto screwed-on flanged pipe so that pipe extends completely through and flush with the flange
F. Finish machine pipe ends and flange faces flat and perpendicular to pipe centerline in a single operation

2. Shop coating and lining
   A. Shop prime exterior surfaces of pipe and fittings to be installed in exposed interior or exterior locations
   B. Shop coat flange faces with rust preventive compound
      i) Shall be vitreous material which is hard, smooth, continuous and formulated to prevent the adherence of grease in sludge and scum lines and to resist the adherence of crystalline metal salt deposits
      ii) Pipe interior shall be prepared by blasting
      iii) Minimum number of two (2) coats that shall be separately applied and separately fired. Each coating shall be applied in controlled thickness after the inside surface of pipe has been prepared as required to assure a continuous unbroken bond of the coating to the pipe. Items shall be exposed to a maturing temperature of approximately 1400°F at which point the vitreous and inorganic materials metal and fuse to base metal forming an integral molecular bond with the base metal surface. Subsequent coatings shall be process in a similar manner forcing an integral molecular bond with base coat.
      iv) Total finished coating minimum thickness shall be 10 mils as tested with a micro test or other acceptable dry film thickness gauge. Finished lining shall be able to withstand a strain of 0.001 inch/inch (yield point of base metal) without damage to the glass
      v) Lining shall be of a light, bright color to allow visual detection of defects more easily prior to electronic holiday detection testing
      vi) Surface of glass shall have a dense, glazed finish non-adherent to grease, scum, wax or other sticky substances found in sludge
      vii) Finish coating shall be free from carters, porosity, crazing, scaling or pinholes evident from visual inspection.
      viii) Finish coating shall be resistant to attacks from acids equivalent to a weight loss no greater than 3 milligrams per square inch as determined by the procedure for testing against citric acid, ASTM C283. Coating shall protect against etching or loss of gloss when subjected to cleaning procedures employing a 200°F water-steam mixture

2.4 POLYVINYL CHLORIDE (PVC) PRESSURE PIPING

A. The following piping shall be pressure PVC pipe as indicated on the drawings and as specified herein:
   1. As indicated in Piping Schedule below

B. Manufacturers:
   1. Cresline Plastic Pipe Co.
   2. North American Pipe Corp.
   3. Spears Manufacturing Co.
   4. Or accepted substitution

C. Pipe and fittings:
   1. 18 inch to 20 inch, ASTM D1785
   2. Schedule 40 or 80
   3. Fittings: Comply with ASTM D2466 (Schedule 40) or ASTM D2467 (Schedule 80)

D. Joints:
   1. Shall be bell and spigot, push-on type suitable for solvent welding, threading, or flanging
   2. Designed to hold pipe in alignment, provide flexibility, separate the ends of pipe lengths, resist applied earth pressures, and provide fluid tightness
   3. Solvent welding: ASTM D2672
      A. Use recommended solvent primer and cement for the application of fluid to be conveyed in pipeline
   4. Provide for sleeves or couplings where indicated.
      A. Furnish pipe ends suitable for receiving style of sleeve or coupling indicated or specified.
         i) Provide anchoring where restraint is required to withstand specified operating or hydrostatic test pressure and where indicated

2.5 PVC GRAVITY PIPE (NON-PRESSURE)

A. The following piping shall be non-pressure PVC pipe as indicated on the drawings and as specified herein:
   1. As indicated in Piping Schedule below

B. Manufacturers:
   1. CertainTeed
   2. Diamond Plastics Corp.
   3. JM Eagle Manufacturing Co.
   4. Or accepted substitution

C. Pipe and fittings:
   A. 4 inch to 48 inch, ASTM D3034 or ASTM F679, Type PSM, SDR 35
   B. Cell Classification: ASTM D1784, 12454-B, 12454-C, or 12364, 13364-B
   C. Pipe length: 20 feet standard length

D. Joints:
   1. Shall be bell and spigot, push-on type with elastomeric gaskets conforming to ASTM D3212 and F477
   2. Designed to hold pipe in alignment, provide flexibility, separate the ends of pipe lengths, resist applied earth pressures, and provide fluid tightness
   3. Rubber rings: ASTM D3132 and F477
      A. Sleeved or Coupled
   4. Provide for sleeves or couplings where indicated.
      A. Furnish pipe ends suitable for receiving style of sleeve or coupling indicated or specified.
         i) Provide anchored couplings where restraint is required to withstand specified operating or hydrostatic test pressure and where indicated

2.6 COPPER TUBING – 3 INCHES OR LESS

A. Manufacturers:
   1. Mueller
   2. Or accepted substitution

B. Copper Tube: ASTM B88; Type K, soft-annealed temper with flared connections.
   1. Fittings: Wrought-copper solder-joint fittings, ANSI B16.22; soldered joints, pressure type. Compression fitting will not be accepted.

2.7 POLYETHYLENE TUBING

A. Manufacturers:
   1. Centennial Plastics, Inc.
   2. Or accepted substitution

B. Service lines shall be Polyethylene (PE) Copper Tube Size (CTS) potable water tubing
   1. Service line pipe sizes are indicated on Drawings.
   2. Resin formulation: PE 3608
   3. Cell Classification of 4345464C per ASTM D2239 and ASTM D2737
   4. Hydrostatic Design Basis (HDB)
      A. HDB: 1600 psi @ 73.4 °F
      B. HDB: 800 psi @ 140 °F

C. Joining:
   1. Shall be by butt-fusion
   2. All personnel conducting butt-fusion should be experienced and follow guidelines published by the pipe manufacturer or by PPI in TR-33

D. Installing:
   1. To be direct buried
   2. Buried pipe must be supported by proper embedment material as shown on Drawings
   3. Refer to PPI's "Handbook of Polyethylene Pipe" and follow all local, state, and/or federal guidelines

E. Safe Handling:
   1. To safely handle and store PE pipe, refer to PPI's "Material Handling Guide"

F. Disinfection:
   1. Disinfection of service line should follow specifications herein

G. Testing:
   1. All pipe shall be hydrostatically tested after installation as specified herein.

2.8 GATE VALVES – 3" TO 12" AND ACCESSORIES

A. Manufacturers:
   1. Mueller
   2. American AVK

3. American Flow Control
4. Clow
5. Kennedy
6. Or accepted substitution

B. AWWA C509, Iron body, bronze trim, two O-ring stem seals, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, extension stem, and extension valve box, pressure rating of 250 psi. For installation in horizontal or near horizontal pipe lines
   1. Non-adjustable elastomeric stem seals
      A. Adjustable packing glands are not permitted
   2. Direct operation of stem from above via 2-inch square nut
      A. No gear box provided
   3. Rotation: Counterclockwise to open with the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut

C. Rotation: Contractor to verify the operating direction with the jurisdictional water district or department
   1. Provide the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut.
   2. Contractor to confirm nut size with the jurisdictional water district or department

D. Valve stem material: ASTM B763, UNS alloy C99500 minimum yield strength of 40,000 psi
   1. Valve stem extensions: Provide valve stem extensions as necessary for proper valve operation with a 7 foot key with tee handle
   2. Provide one (1) key to Owner prior to project closeout

E. Extension stems
   1. Provide for buried valves with operating nuts more than 4.5 feet below grade
   2. Non-rising stems
      A. Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
      B. Connected to the valve by a flexible socket coupling
      C. All other connections pinned
      D. Extend stem to within 6-inch of grade
      E. Provide spacers to center stem in valve box
      F. Provide wrench nut

F. Coating
   1. AWWA C550 and NSF 61 certified
   2. Minimum 8 mils dry film thickness
   3. Fusion bonded epoxy applied to all ferrous metal surfaces after cleaning surfaces of grease, dirt and moisture, and performing near-white blast cleaning following SSPC-SP10
   4. Do not coat fasteners or machined surfaces subject to contact and relative movement against other surfaces during operation of valve or other surfaces where such coating would compromise proper installation or functionality of valve

G. Valve boxes, depth as required for valve
   1. Three piece cast iron (complying with ASTM A48, Class 20A) adjustable screw type, 5.25-inch diameter, minimum thickness of 3/16 inch
   2. Box, cover, and base coated by dipping in asphalt varnish.
   3. Cover marked with word, “WATER.”
   4. Provide extension piece to permit 6-inch adjustment above finish grade
   5. Manufacturers:
      A. Tyler Pipe Company "Series 6860 with #160 oval base"
      B. East Jordan Iron Works "8560 Series"
      C. Tyler Union "6860 Series"
      D. Or accepted substitution

2.9 BUTTERFLY VALVES – 16" TO 36" (DIRECT BURY) AND ACCESSORIES

A. Manufacturers:
   1. Pratt
   2. Milliken
   3. Or accepted substitution.

B. AWWA C504 Class 150B for direct bury service
   1. Valve body shall be constructed of cast iron ASTM A126 Class B and conform to AWWA C504 in terms of laying lengths and minimum body shell thickness
   2. Mechanical joint ends following AWWA C111
   3. Valve disc shall be cast iron or ductile iron furnished with Type 316 stainless steel seating edge to mate with rubber seat on body
      A. Valve disc shall seat in position at 90 degrees to pipe axis and shall rotate 90 degrees between full-open and tight-closed position. Install valves with valve shafts horizontal and convex side of disc facing anticipated direction of flow
      B. Disc shall not creep or flutter under service conditions
   4. Seat: Buna-N-Rubber
      A. 16-inch to 18-inch: Bonded seats that meet ASTM D429 Method B
      B. 24-inch and larger: Seats retained in the valve body by mechanical means without metal retainers or other devices located in the flow stream
      C. Retaining hardware for seats: type 304 or 316 stainless steel. Nuts and screws used with clamps and discs for rubber seats shall be held securely with locktight, or other approved method, to prevent loosening by vibration or cavitation effects
   5. Valve Shaft: type 304 SS, ASTM A276
      A. Shaft bearings: stainless steel in accordance with AWWA C504. Design valve shaft to withstand 3 times amount of torque necessary to open valve
      B. Packing: Standard self adjusting and wear compensating, split-V type, and replaceable without removing actuator assembly
   6. Actuators:
      A. Provide manual actuators for single project, from same manufacturer
      B. Shaft connecting actuator to valve body must be fully enclosed. Bonnet and extension to be fully enclosed and water tight
      C. Provide bonnet extensions, as required, between valve body and actuator. Space between actuator housing and valve body shall be completely enclosed so that no moving parts are exposed to soil or elements

D. Provide actuators for valves with size based on line velocity of 12 feet per second and unidirectional service.
    i) Equip with gear manual actuator
    ii) Fully enclosed, traveling-nut type. Traveling nut shall engage alignment grooves in the housing
    iii) Traveling nut actuator shall be self-locking and designed to transmit twice the required actuator torque without damages to faces of gear teeth or contact faces of nut
E. Oil-tight and watertight actuator housing for valves, specifically designed for buried service and factory packed with suitable grease
F. Equipped with 2-inch actuator nut
G. Rotation: Counterclockwise to open with the word "OPEN" and an arrow indicating the direction to open cast on valve body or operating nut
H. Valve operating key: Provide one (1) for project, 7 foot length with tee handle

7. Coating
    A. Follow AWWA C550 and NSF 61
    B. Coat interior and exterior ferrous surfaces of valve with epoxy suitable for potable water conditions: in accordance with AWWA C550 and coating manufacturer's recommendations
    C. Provide three coats of two component, high-build epoxy with minimum dry film thickness of 12 mils

C. Extension stems
1. Provide as specified for buried valves with operating nuts more than 4.5 feet below grade
2. Non-rising stems
    A. Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
    B. Connected to the valve by a flexible socket coupling
    C. All other connections pinned
    D. Extend stem to within 6-inch of grade
    E. Provide spacers to center stem in valve box
    F. Provide wrench nut

D. Valve boxes, depth as required for valve
1. Three piece cast iron (complying with ASTM A48, Class 20A) adjustable screw type, 5.25-inch diameter, minimum thickness of 3/16 inch
2. Box, cover, and base coated by dipping in asphalt varnish.
3. Cover marked with word, “WATER.”
4. Provide extension piece to permit 6-inch adjustment above finish grade
5. Manufacturers:
    A. Tyler Pipe Company "Series 6860 with #160 oval base"
    B. East Jordan Iron Works "8560 Series"
    C. Tyler Union "6860 Series"
    D. Or accepted substitution

2.10 ECCENTRIC PLUG VALVES

A. Provide plug valves as indicated in Valve Schedule below and on Drawings

B. Approved manufacturers:
   1. DeZurik
   2. Henry Pratt Company
   3. Milliken
   4. Val-Matic Valve and Manufacturing Corp.
   5. Or accepted substitution

C. General
   1. Quarter-turn non-lubricated eccentric plug valves
   2. Resilient faced plug
   3. Tight shut-off up to scheduled rating with pressure in reverse direction where scheduled
   4. Valves with vane type seat rings are not acceptable
   5. Valve ends to match connecting piping
      A. Buried: Mechanical joint, ANSI A21.11/AWWA C111
      B. Flanged: 125 lb, ANSI B16.1
      C. Screwed valve ends shall be to the NPT standard
      D. Grooved ends shall conform to AWWA C606 rigid joint specifications
   6. Minimum Working Pressure Rating:
      A. 175 psi, 4 inch through 12 inch
   7. Opening motion eccentric, lifting plug away from body seat
   8. Valve alignment
      A. Valve shall be installed so that the plug is horizontal and rotates upward as the valve opens
      B. Valve shall be installed with seat on low pressure side of valve
   9. Provided with fully adjustable plug position stops
   10. Plugs shall be eccentric type with no backing ring or frame
   11. Valve body cavity shall be smooth without protrusions or baffles
   12. Valve body plainly marked to indicate seat end
   13. Valve packing adjustment accessible without removing actuator from valve

D. Valve Materials
   1. Plug and body: Cast iron, ASTM A126, Class B
   2. Resilient plug facing or replaceable style body seats shall be synthetic rubber, neoprene, or Buna N compound suitable for use with water and wastewater applications
   3. Seat rings shall be threaded, or welded of corrosion-resistant stainless steel (18-8), nickel, or Monel conforming to AWWA C504
   4. Sprayed or plated mating seat surfaces are not acceptable
   5. Bearings shall be replaceable. Sleeve type and thrust bearings in the upper and lower journals shall be corrosion-resistant stainless steel or bronze
   6. Shaft seals shall be multiple O-ring, self-adjusting U-cup or chevron type packing conforming to AWWA C504
   7. Pull-down packing is not acceptable

8. Shaft seals shall be field adjustable or replaceable without valve disassembly
9. Plug seat: Chloroprene (Neoprene)
10. Packing: Acrylonitrile Butadiene V-Type Cup
    A. Dual U-cup
11. Upper thrust bearing: TFE
12. Body seat: Welded-in overlay seat of no less than 90% nickel
13. Upper and lower trunnion bearings: Sleeve type, 18-8 stainless steel
14. Valves complete with epoxy coating on the interior and exterior, manufacturer's standard corrosion resistant coating shall be acceptable

E. Testing
1. Each valve shall be in accordance with AWWA C540 subjected to cycle life and pressure leak test (1,034 kPa) and a valve body hydrostatic test (2,068 kPa) by the manufacturer at their facilities prior to shipping
2. Valves shall be capable of drip-tight shut-off up to the full leak test rating
    A. Test and certify pressure capacity in the reverse direction

2.11 PRECAST MANHOLES

A. Refer to Section 02530

2.12 CLEANOUTS

A. Exposed metal cleanouts:
1. Manufacturers:
    A. Smith, Jay R. Mfg. Co.
    B. Tyler Pipe; Wade Div
    C. Watts Drainage Products Inc.
    D. Zurn Plumbing Products Group
    E. Or accepted substitution
2. Standard: ASME A112.36.2M for cast iron for cleanout test tee
3. Size: Same as connected piping
4. Body material: hub-and-spigot, cast-iron soi pipe T-branch as required to match connected piping
5. Closure: Countersunk, brass, cast-iron, or plastic plug
6. Closure plug size: same as or not more than one size smaller than cleanout size

2.13 MATERIALS

A. Plugs and Caps: Use pipe plugs or caps provided by the pipe manufacturer and approved by the Engineer for pipe stubouts

B. Cleanouts and Pressure Cleanouts: Provide as indicated on Drawings, pipe extension to grade with ferrule and countersink cleanout plug. Provide round cast-iron access frame over cleanout, with heavy duty secured scoriated cover with lifting device cast with the following words associated with the following pipe:
1. "DRAIN" – D piping

C. Reinforcement:
   1. Reinforcing Steel: ASTM A615 Grade 60
   2. Welded Wire Fabric: ASTM A185

D. Concrete: Refer to Division 3 specifications
   1. Minimum compressive strength: 4000 psi at 28 days
   2. Cement: ASTM C150, Portland Cement, Type II
   3. Aggregates: ASTM C33, free of deleterious substances

E. Gaskets: ASTM C923
   1. Mastic: FS SS-S-210A, "RAM-NEK" or accepted substitution
   2. Rubber: Neoprene, 40+ 5 hardness when measured by ASTM D2240, Type A durometer

F. Inlet Gratings and Manhole Rings and Covers
   1. Cast iron, heavy duty traffic type, ASTM A48, Class 35B. Grind bearing surfaces to ensure flat, true surfaces
   2. Provide bike/pedestrian-safe grates where such traffic is anticipated
   3. Set grate on frame such that openings maximize inlet intake
   4. Covers to seat at all points on ring

G. Rock Subbase: 1-1/2 inch minus, well-graded gravel over compacted subgrade

H. Water: Clean and free of deleterious substances

I. Grout:
   1. Non-Shrink, Non-Metallic Grout: Factory premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 4000 psi in one day and 8000 psi in 7 days
   2. Epoxy Grout: Three Component Epoxy Resin System
      A. Two liquid epoxy components
      B. One inert aggregate filtered component
      C. Each component furnished in separate package for mixing at job site

2.14 SOIL MATERIALS

A. Furnish pipe bedding and cover as specified in Section 02300

2.15 ACCESSORIES

A. Concrete for Thrust Blocks: constructed of “Class B” Concrete as defined by Colorado Dept of Transporation (CDOT) standards, with maximum water to cement ratio of 0.63 by weight and 28-day compressive strength of 2500 psi minimum

B. Anchorages: Provide anchorages for tees, wyes, crosses, plugs, caps, bends, and valves. After installation, apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of ferrous anchorages
   1. Clamps, straps and washers: Steel, ASTM A506

2. Rods: Steel, ASTM A575
3. Rod Couplings: Malleable-iron, ASTM A197
4. Bolts: Steel, ASTM A307
5. Cast-Iron Washers: Gray-iron, ASTM A126

C. Pipe Accessories
   1. Underground Type Plastic Line Identification Marker
      A. Manufacturer's standard permanent, continuous-printed plastic tape with metallic core, intended for direct-burial service; not less than 6-inch wide x 4 mils thick. Provide colored (green/blue/yellow) tape with black printing reading "CAUTION RAW WATER LINE BURIED BELOW." Provide identification markers of one of the following:
         i) Allen Systems, Inc.
         ii) Emed Co., Inc.
         iii) Seton Name Plate Corp.
         iv) Or accepted substitution
   2. Tracer Wire for Buried Pipe
      A. Provide tracer wire for all HDPE pipe and PVC pipe manhole to manhole and cleanout to cleanout
      B. All tracer wire shall be 12 AWG solid copper wire coated with 45 mil Type HMW - PE blue insulation compliant with ASTM D1351 specifically designed for direct burial in corrosive soil or water
      C. UL listed
   3. Tracer Wire for Horizontal Directional Drilling
      A. Non-UL listed tracer wire specifically developed for Horizontal Directional Drilling application
      B. 1/4-inch 304 Stainless Steel tracer wire
         i) Performance Wire & Cable Inc.: "Tracer wire, Stranded SS/45 mil HMW-HDPE, 30 Volt, HDD direct bury use only"
      C. #12 AWG Solid Carbon Clad Steel Extra High Strength tracer wire
         i) Copperhead Industries, LLC: "Direct Burial #12 AWG Solid (.0808" diameter), 21% conductivity copper-clad hard drawn high carbon steel extra high strength horizontal directional drill tracer wire, 1150# average tensile break load, 45 mil high molecular weight-high density polyethylene jacket complying with ASTM-D-1248, 30 volt rating"
         ii) Pro-Line Safety Products Co.: "Pro-Trace HDD-CCS PE45"
   4. Tracer Wire Test Stations
      A. 4-inch with locking lid
      B. Manufacturers:
         i) CP Test Services
         ii) Glenn Series "Glenn-4"
         iii) Or accepted substitution
      C. Test stations to be spaced at a maximum of 1,000 feet

D. Valve Accessories
   1. Extension stems

A. Provide where indicated on drawings, specified, or required for proper operation and for buried valves.
B. Non-rising stems
   i) Solid steel shafting with O.D. not less than O.D. of valve stem or galvanized steel pipe with I.D. not less than O.D. of valve stem
   ii) Connected to the valve by a flexible socket coupling
   iii) All other connections pinned, keyed, or socket
C. Stem guides
   i) Cast iron, bronze brushed, adjustable in two (2) directions
   ii) If extension stem length exceeds 10 feet or the weight exceeds 50 lbs., design top guide to carry the stem weight and provide a collar on the stem to bear against the thrust guide
   iii) Max spacing:
   Non-rising stems: 100 times stem O.D.
   Rising stems: 60 times stem O.D.
   Ten foot maximum
D. Buried valves
   i) Extend stem to within 1.0 foot of grade.
   ii) Provide spaces to center stem in valve box
   iii) Provide wrench nut

2. Valve boxes
A. Provide for all buried valves
B. Boxes shall consist of a cast iron cover, lid, and base castings. No slip type boxes shall be allowed
C. Type: Cast iron or ductile iron, extension sleeve (screw) type
D. Minimum thickness: 3/16 inch at any point
E. Coating: Bituminous varnish
F. Cast appropriate name designation of service in cover.
G. Shaft shall be ductile iron and minimum diameter of 5-1/4"
H. An appropriate word designating the valve service type on the cover
I. Manufacturer:
   i) Neenah Foundry Company
   ii) Tyler Company
   iii) Mueller Company
   iv) Or accepted substitution

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing conditions under provisions of Division 1 specifications

B. Verify locations and inverts or tops of pipe are as indicated

C. Carefully examine pipe and fittings for cracks, damage to linings, and other defects prior to installation

D. Remove all defective pipe from site and replace

E. Examine areas for weak or structural defects or deviations beyond allowable tolerances for piping clearances that adversely affect excavation and quality of Work.

F. Start installation only when conditions are satisfactory

3.2 PERFORMANCE - GENERAL

A. Perform work in a safe and proper manner with appropriate precautions against hazard

B. Provide adequate working space and clearances for work performed within excavations and for installation and removal of utilities

C. Contain all construction activity on the designated site and within the limits of work. Cost of restoration of site will be the responsibility of the Contractor

D. Contractor to verify quantities to perform all earthwork required according to Drawings, including but not limited to, additional import or export required to handle compaction, pavement subgrade preparation, and pipe bedding

E. Contractor shall take precautions to limit the removal of or damage to existing pavements, multi-use paths sidewalks, curbs, lawns, shrubbery, trees, hedges, walls, fences, buildings, or other existing improvements to the least practicable amounts and shall replace or restore such improvements to their original location and condition after the excavation has been backfilled and compacted

3.3 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

A. Excavation and backfill operations shall be performed in such a manner to prevent cave-ins of excavations or the undermining, damage or disturbing of existing utilities and structures or of new work

B. Backfill shall be placed and compacted so as to prevent future settlement or damage to existing utilities and structures and new work

C. Any excavations improperly backfilled or where settlement occurs shall be reopened to the depth required then refilled with approved materials and compacted, and the surface restored to the required grade and condition, at no additional costs to the Owner

D. Any damage due to excavation, backfilling, or settlement of the backfill, or injury to persons or damage to property occurring as a result of such damage shall be the responsibility of the Contractor. All costs to repair such damage, in a manner satisfactory to the Engineer, shall be borne by the Contractor at no additional expense to the Owner

3.4 SITE PREPARATION

A. Clear all site areas within the limits of work of grasses, roots, brush, and other objectionable material and debris

B. Remove all waste materials from site and dispose. Stockpile all acceptable grubbings for reuse in revegetation areas.

C. Remove debris including all demolished trees, underbrush, stumps, roots and other combustible materials from site and dispose of off-site; on-site burning is not permitted

3.5 DEWATERING

A. Comply with CDPHE Dewatering Requirements

B. Dewatering discharge to surface waterways requires CDPHE dewatering permit. Contractor must obtain dewatering permit and comply with discharge requirements therein, if necessary

3.6 PREPARATION

A. Thoroughly clean pipe and fittings of foreign matter before installation. Remove scale and dirt, on inside and outside, before assembly

B. Ream pipe and tube ends and remove burrs

C. Prepare pipe connections to equipment with flanges or unions. Clean joint contact surfaces with wire brush is necessary, wipe clean, and keep clean until jointing is complete.

D. Cut ends of metallic pipe, recoat with manufacturer's coatings

E. Shape trench and place bedding as specified in Section 02300 and as shown on the drawings. Do not disturb trench bottom during excavation. Hand trim excavation for accurate placement of pipe to elevations indicated
   1. Dig bell or coupling holes
   2. Do not support pipe on blocks or mounds of earth
   3. Provide uniform and continuous bearing and support for full length of pipe between bell holes
   4. Minor disturbance over a maximum length of 18 inches near the middle of each length of pipe will be permissible by the withdrawal of pipe slings or other lifting tackle
   5. Place bedding material at trench bottom, level fill materials in one continuous layer not exceeding 6 inches compacted depth, compact to 95 percent
   6. Backfill in accordance with Section 02300

F. Alignment and Grade
   1. Except as indicated on the Drawings, lay all pipe straight and at a uniform grade
   2. Use batter boards to determine and check pipe subgrades
   3. Other methods of maintaining alignment and grade may be acceptable if approved by the Engineer

3.7 PIPE INSTALLATION

A. Inspect pipe and accessories for defects before lowering into trench

B. Replace any defective, damaged or unsound pipe

C. Cutting Pipe
   1. Cut pipe to measurement taken at the site, not from the drawings
   2. Cut pipe neatly without damage to pipe or cement lining
   3. Cut smooth, straight, and at right angles to pipe axis
   4. Dress and bevel end of cut pipe to remove roughness and sharp corners
   5. Cut pipe with saw, abrasive wheel or pipe cutter designed specifically for the pipe material

D. Group piping with other site piping work whenever practical

E. Install pipe to indicated elevations. Adjust to maintain minimum 4.5 feet depth of bury and maintain minimum grade for drainage and also allow for all air to be released at high points

F. Comply with Grand Junction standards and specifications. Use the manufacturer's recommendations if the Grand Junction standards do not specifically apply.

G. Install PVC Pipe in accordance with AWWA M23 and AWWA C605

H. Install Ductile Iron Pipe in accordance with AWWA C600

I. Install Ductile Iron Fittings in accordance with AWWA M41

J. Route pipe as indicated on plan and profile drawings

K. Install pipe to allow for expansion and contraction without stressing pipe or joints

L. Protect from lateral displacement by placing embedment evenly on both sides of pipe

M. Make changes in horizontal, vertical, and curved alignment shown on drawings by using joint deflections in the amount permissible by manufacturer and shown on drawings

N. Do not bend pipe

O. Deflect pipe at joints

P. Do not deflect PVC pipe at connection to ductile iron fittings

Q. Slope pipe and position drain at low points

R. Protect from lateral displacement by placing embedment evenly on both sides of pipe as specified in Section 02300

S. Do not lay pipe in water. Maintain groundwater level a minimum of 12 inches below pipe to be installed. Do not lay pipe under unsuitable weather or trench conditions

T. Lay pipe with bell ends facing the direction of laying except when Engineer authorizes reverse laying

U. Form and place concrete for thrust blocks at each elbow or change of direction of pipe main

V. Install tracer wire continuous over top of pipe. Tracer wire shall be Type THHN, AWG size #12, UL listed with a single copper conductor, PVC insulation, and nylon jacket. Test stations at post hydrants shall be CP Test Services, Glenn Series Glenn-4 with locking lid, or approved equal. Install pipeline marker strip (tape) in trench above all pipelines

W. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system

X. Carefully lower pipe, fittings, and accessories into the trench with slings, ropes, and other suitable equipment to prevent damage. Do not dump or drop pipe or accessories into trench

Y. Joint to form true and smooth line

Z. Remove any pipe not making a good fit

AA. Begin pipe laying at the lowest point unless reverse laying is accepted by Engineer

BB. Utilize implements, tools and facilities as recommended by the manufacturer if required to remove debris

CC. During construction, close all open ends with watertight expandable type plugs
1. At the end of each day's operations
2. Whenever pipe ends are left unattended
3. Deposit adequate backfill on pipe to prevent flotation
4. Do not use wood, burlap or other similar temporary plugs

DD. Utility crossings
1. Whenever possible, lay water mains over sanitary and storm sewers to provide vertical separation of at least 18-inch between invert of water main and crown of sewer
2. If standard crossing detail is not available and above separation cannot be met, provide one continuous length of watertight sewer pipe 20' long centered on water main with joints between different pipes encased in 6-inch minimum of concrete and extending 6-inch either side of joint or encase sewer pipe in 6-inch of concrete completely around pipe, for not less than 10' either side of water main
3. Water Mains Passing Under Sanitary Sewers: If vertical separation is less than 18-inch, provide structural support for sewer. Provide concrete encasement where water lines pass under sanitary sewer line. Reference detail shown on Drawings

EE. Maintain a minimum 10 feet of horizontal separation and 18 inches of vertical separation between water main and storm or sanitary sewer lines in accordance with the CDPHE
1. Provide concrete encasement if these clearances cannot be achieved and when water line is below sanitary sewer line

FF. Tracer wire and marker tape
1. Install tracer wire continuous over top of pipe

2. Install tracer wire test stations at maximum 500 LF of water line per Grand Junction requirements. Locate test station at fire hydrants, gate valves, or special test station locations in a valve box
3. Terminate tracer wire following drawing details
4. Tape tracer wire to top of pipe using PVC tape every 4 feet along the pipe, and on each side of fitting
   A. Tape: minimum 2 inches wide and wrapping full circumference of pipe
5. Install identification /warning marker tape in fill area of trench above all water lines

GG. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system

HH. Install access fittings to permit disinfection of water system, subject to approval by Engineer

II. Backfill trench in accordance to specifications herein

JJ. Protect pipe from floatation or movement until completely backfilled and put into service

KK. Remove and re-lay any pipe which has floated

3.8 JOINTS

A. Make pipe joints carefully and neatly

B. Connect piping in accordance with manufacturer's recommendations

C. Push-on Joints
1. Lubricate joint surfaces immediately before completing the joint
2. Bevel spigot ends of field cut piping
3. Groove spigot ends of field cut restrained joint piping if required by joint system

D. Mechanical Joints
1. Thoroughly lubricate gaskets and install in accordance with manufacturer’s instructions
2. If an effective seal is not obtained, disassemble joint, clean thoroughly, and reassemble
3. Do not over tighten bolts to compensate for poor installation
4. Carefully align holes in mechanical joints with restraint device to permit installation of the harness bolts
5. Install flange and mechanical joint pieces so the mechanical jointholes, as well as the flange holes, straddle the top centerline for horizontal piping, or the side centerline for vertical piping

3.9 PROTECTIVE COATING

A. Provide polyethylene tube encasement on all buried ductile iron fittings, valves, and fire hydrant extensions

1. Encase ductile iron fittings and valves in polyethylene per AWWA C105, Method A, secured with polyethylene compatible adhesive tape. Overlap polyethylene onto PVC pipe a minimum of 6 inches
2. Before backfilling, inspect polyethylene for rips, punctures and other damage and repair following AWWA C105

B. Coat exposed ferrous metal surfaces of joints, couplings, and uncoated steel with primer and tape coating system after installation. Do not coat stainless steel or high strength low alloy steel nuts and bolts
   1. Surface Preparation: Clean surfaces of rust, scale, soil, mud, oil, grease, and other contaminants by hand or power tool following SSPC-SP2 or SP3 and other appropriate means as recommended by coating manufacturer Remove excess moisture and provide surface dryness as recommended by coating manufacturer
   2. Application: Apply primer in uniform manner to clean and dry surfaces following coating manufacturer's recommendations
      A. Fill complex and irregular surfaces with appropriate mastic or filler tape to eliminate bridging; then apply tape/wrap to primed and filled surfaces following coating manufacturer's recommendations.
      B. When coating restraining rods or strapping, apply tape wrap longitudinally
      C. Where metal being coated enters concrete, overlap coating onto concrete by minimum of 2 inches after placement of concrete
   3. Inspection: After field coating of specified items, conduct visual inspection to verify complete coverage has been accomplished.
      A. Repair damaged or incompletely coated surfaces following coating manufacturer's recommendations

C. Metal Surfaces not Protected by Poly Wrap
   1. Coat all steel clamp rods, bolts, and other metal accessories used in tapping saddles, anchorages, cut ends of pipe, follower rings and bolts or joint harnesses subject to submergence or contract with the earth and not concrete encased, but including pipe fittings and bolts in polyethylene tube protection
   2. Apply 2 coats of coal tar paint to clean, dry metal surfaces, allow first coat to dry before applying second coat

D. Metal Harness Rods
   1. Provide field applied primer and Polyken tape wrap

3.10 CONCRETE ENCASEMENT

A. Provide where indicated on the Drawings

B. Suitably support and block pipe and anchor against flotation

3.11 INSTALLATION – BURIED VALVES

A. Install valves and accessories in accordance with the manufacturer's recommendations and in accordance with referenced standards and specifications

B. Set valves on solid bearing

C. Center and plumb valve box over valve. Set box cover flush with finished grade. Evenly fill around box and thoroughly compact on all sides

D. Extend stem to within 6 inches of final grade. Provide spacers to center stem in valve box

E. Carefully inspect valve before installation. Clean interior. Operate valve to determine parts in proper working order, with valves seating and drain valve operating properly. Set plumb and center stem in valve box and securely brace into place. Comply with AWWA C600 and referenced standards

F. Provide an isolation or shutoff valve and union at the water connections to each fixture and unit of equipment, whether shown on the drawings or not

3.12 THRUST BLOCKS

A. Installation:
   1. Thrust blocks shall be constructed at bends and fittings that require support due to unbalanced line thrust. Care shall be taken to ensure that outlets, cover bolts, nuts, clamps, and other fittings are accessible. A bond breaker shall be placed between the pipe and the thrust block to aid in future removal. If a large thrust block is to be placed, it shall be separated into sections by a suitable material. Bearing surface areas are minimum areas to bear against the undisturbed trench wall. If the soil bearing capacity is insufficient to provide adequate support based on minimum bearing areas established by Drawing Details, then the minimum bearing area shall be increased to a size that shall ensure support restraint. In every instance, the thrust block shall bear against undisturbed earth
   2. Before placing concrete, equipment used in the mixing and transport shall be cleaned. Debris, water, or ice shall be removed from the area to be occupied by concrete. Concrete shall not be placed on frozen subgrade. Concrete shall be placed only in the presence of the Owner or Engineer unless inspection is waived prior to the placement

B. Formwork for Thrust blocks:
   1. Forming for concrete thrust blocks and anchors shall be done by bulkheading around the shape of the thrust block or anchor with wood, burlap sacks, or reinforced paper sacks that are filled with sand or earth. Sacks shall be constructed of a size easily handled when full and left in place in the trench. Wood forms shall be removed before backfilling.
   2. Horizontal struts or braces required for trench shoring shall not remain in concrete thrust blocks. Prior to placing concrete, the forms and ditch bank will be inspected and approved by Owner or Engineer
   3. When concrete is deposited against the ground without the use of forms, the ground shall be thoroughly moistened or other provisions made to prevent the ground from drawing water in from the concrete

C. Thrust block Curing Time:
   1. Newly placed concrete shall be allowed to set undisturbed for a minimum of 24 hours

D. Compaction of Fill Over Thrust blocks
   1. Backfill may be placed over thrust blocks once the surface has set sufficiently and they are able to resist the weight of the backfill. However, tamping or compacting shall not be allowed above the thrust block for a minimum of 24 hours after placement

E. Hydrostatic testing shall not be conducted until thrust blocks have fully cured, a minimum of 7 days

3.13 ABANDONMENT

A. Cap ends of main as shown. Place required concrete blocking as shown on drawing details

B. Where mains are to be abandoned and removed to a fitting or valve, cut and plug main at fitting or valve
   1. When shown on drawings, remove fire hydrants and valves, including lead joint tees when encountered; salvage and deliver removed fire hydrants and valves to the Grand Junction
   2. Pipe, fittings, and other appurtenances that are removed, but are not required to be salvaged become property of Contractor
      A. Remove and dispose of offsite

3.14 GROUT

A. PREPARATION
   1. Non-Shrink, Non-Metallic Grout, General Use
      A. Clean concrete surface to receive grout
      B. Saturate concrete with water for 24 hrs prior to grouting and remove excess water just prior to placing grout
      C. Cold weather conditions
         i) Warm concrete, substrate and base plate to 40 deg F, or above; store grout in warm area
         ii) Follow manufacturer's recommendations for cold weather application
      D. Hot weather conditions
         i) Use cold mixing water and cool base plate if possible; store grout in cool area
         ii) Follow manufacturer's recommendations for hot weather application
      E. Apply to clean, sound surface
      F. Apply latex bonding agent to hardened concrete, mix-in-grout, or as directed by Engineer
   2. Epoxy Grout: Apply only to clean, dry, sound surface
      A. Patching cavities in concrete including, but not limited to, tie holes, and structural and equipment support

B. APPLICATION
   1. Non-Shrink, Non-Metallic Grout
      A. Mix in a mechanical mixer
      B. Use no more water than necessary to produce flowable grout

C. Provide air vents where necessary to eliminate air pockets
D. Place in accordance with manufacturer's instructions
E. Where exposed to view finish grout edges smooth
F. Protect against rapid moisture loss by immediately covering with wet rags and polyethylene sheets or curing compound
G. Wet cure grout for 7 days, minimum
H. Maintain the temperature at a minimum of 40 deg F until grout reaches 3000 psi
I. After placement of grout, eliminate excessive external vibration

2. Epoxy Grout
   A. Mix and place in accordance with manufacturer's instructions
   B. Completely fill all cavities and spaces around dowels and anchors without voids
   C. Obtain manufacturer's technical assistance as required to insure proper placement

3.15 ERECTION TOLERANCES

A. Establish invert elevations and slopes as shown on Drawings

B. Respect pipe manufacturer’s tolerances of horizontal and vertical deflection

3.16 FIELD QUALITY CONTROL

A. General
   1. Utilize pressures, media and pressure test durations as specified on Piping Schedules
   2. Isolate equipment which may be damaged by the specified pressure test conditions
   3. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates. Select each gauge so that the specified test pressure falls within the upper half of the gauge's range. Notify Engineer 24 hours prior to each test
   4. Completely assemble and test new piping systems prior to connection to existing pipe systems
   5. Acknowledge satisfactory performance of tests and inspections in writing to Engineer prior to final acceptance
   6. Provide all necessary equipment and perform all work required in connection with the tests and inspections
   7. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination

B. Testing methods and criteria
   1. Ductile iron pipe systems: Test ductile iron pipe in accordance with the latest version of AWWA C600. Per AWWA C600, the allowable leakage in gallons per hour from buried ductile iron pipe systems shall be less than the length of pipeline tested in feet, times the nominal diameter of the pipe in inches, times the square root of the average test pressure during the leakage test in pounds per square inch (gauge), divided by 133,200. The duration of each leakage test shall be two hours. The equation for computing the allowable leakage is:

      i) $L = (SDP^{0.5})/133{,}200$
      Where:

L = allowable leakage, in gallons per hour
S = length of the pipe tested, in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the leakage test, in psi

2. Polyethylene (PE) pressure pipe systems: Test PE pressure pipe in accordance with the latest version of ASTM F2164. For PE pipe, pressurize the test section to the system test pressure and maintain this pressure for four hours by adding make-up water. After this initial expansion phase, reduce the test pressure by 10 PSI and stop adding make-up water. If the test pressure remains steady (within 5% of the target value) for one hour, no leakage is indicated
3. Unless otherwise specified, the allowable leakage in gallons per hour from other buried liquid piping systems shall be less than the length of pipeline tested in feet, times the nominal diameter of the pipe in inches, times the square root of the average test pressure during the leakage test in pounds per square inch (gauge), divided by 133,200. The duration of each leakage test shall be two hours. The equation for computing the allowable leakage is:

    i) $L = (SDP^{0.5})/133{,}200$

    Where:
    L = allowable leakage, in gallons per hour
    S = length of the pipe tested, in feet
    D = nominal diameter of the pipe, in inches
    P = average test pressure during the leakage test, in psi

4. The following liquid piping systems shall have zero allowable leakage at the specified test pressure throughout the specified duration:
    A. Exposed piping
    B. Buried insulated piping
    C. Buried or exposed piping carrying liquid chemicals
5. Hydrostatic pressure testing
    A. For buried piping: Perform testing after backfill and proper compaction of trenches. Where lines are installed under roadways and parking areas, perform tests after completion of final grade preparation and prior to application of surface courses. Notify Engineer at least 48 hours prior to testing. Provide temporary restraints for expansion joints for additional pressure load under test. Isolate equipment in piping system with rated pressure lower than pipe test pressure by valves or blind flanges
6. Low pressure air test
    A. Check pneumatic plugs for proper sealing
    B. Place plugs in line at each manhole and inflate to 25 PSIG
    C. Introduce low pressure air into sealed line segment until air pressure reaches 4 PSIG greater than ground water that may be over the pipe. Use test gauge conforming to ANSI B40.1 with 0 to 15 PSI scale and accuracy of 1 percent of full range
    D. Allow 2 minutes for air pressure to stabilize
    E. After stabilization period (3.5 PSIG minimum pressure in pipe) discontinue air supply to line segment

F. Acceptable time for loss of 0.5 PSIG of air pressure in plastic pipe shall be:

	Minimum Time for 0.5 PSIG Loss in Plastic Pipe (minutes: seconds)								
Pipe Size	≤100 Feet	150 Feet	200 Feet	250 Feet	300 Feet	350 Feet	400 Feet	450 Feet	500 Feet
4 Inch	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53	1:53
6 Inch	2:50	2:50	2:50	2:50	2:50	2:50	2:51	3:12	3:34
8 Inch	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42	6:20
10 Inch	4:43	4:43	4:43	4:57	5:56	6:55	7:54	8:54	9:53
12 Inch	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50	14:14
15 Inch	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02	22:16
18 Inch	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51	32:03
21 Inch	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16	43:38
24 Inch	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17	56:59
27 Inch	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54	72:07
30 Inch	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07	89:02

NOTE: If there has been no (zero psi) drop after 1 hour of testing, the test section shall be accepted and the test completed

H. For pipe lengths not shown in the above table, use the two nearest pipe lengths to estimate the minimum time necessary for a 0.5 PSIG loss
I. For concrete pipe 24" and smaller refer to ASTM C-924 for acceptable test procedures and times
J. For concrete pipe 24" and larger refer to ASTM C-1103 for acceptable test procedures and times

7. Hydrostatic Exfiltration/Infiltration Test
   A. Hydrostatic Exfiltration Test (groundwater level is below the top of pipe)
      i) Allowable Leakage rate: 50 gallons per IN diameter per mile of pipe per day
   B. Hydrostatic Infiltration Test (groundwater level is above the top of pipe)
      i) Allowable leakage rate: 50 gallons per IN diameter per mile of pipe per day
8. Notify Engineer of the date and time for each pipe test 1 week prior to actual testing

C. Dielectric Testing Methods and Criteria
   1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained
   2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition
   3. Check the integrity of each cadwelding connection using a light hammer blow at a 45 degree angle

D. Pipe Deflection Test
   1. No sooner than 30 days after placement and compaction of backfill, but prior to placement of permanent surface materials, clean and mandrel each line to detect obstructions (deflections, joint offsets, lateral pipe intrusions, etc.)
   2. Use a rigid mandrel with diameter of at least 95 percent of the pipes specified average inside diameter and a length of the mandrel circular portion at least equal to the nominal pipe diameter

3. Maximum allowable deflection is 5 percent of the base internal diameter. Mandrel outside diameters in inches are as follows:

Pipe Size	Base I.D.	Mandrel O.D.
6	5.792	5.50
8	7.764	7.38
10	9.711	9.23
12	11.558	10.98

4. Pull the mandrel through the pipe by hand
5. Relay or replace all pipe exceeding the 5 percent deflection at no additional cost to the Owner
6. Retest repaired sections
7. Maximum allowable deflection at end of one year correction period, 7-1/2 percent of the base internal diameter tested in the same manner. Uncover and repair sections exceeding the allowable deflection

E. All sewer lines shall be inspected visually to verify accuracy of alignment and freedom from debris and obstructions. The full diameter of the pipe should be visible when viewed between consecutive manholes. The method of test can be photography, closed circuit television or visually lamping with mirrors and lights.

F. Lamp Test
1. Each section between manholes will be lamped by Contractor in the presence of engineer
2. A true circle will be required in the lamp tests to indicate a properly constructed sewer line
3. Repair any sections not passing the lamp test at Contractor's expense.

G. TV Inspection and Video Recording
1. Each section between manholes will be TV inspected by Engineer.
2. Each pipe line is to be cleaned or flushed prior to inspection.
3. Contractor shall furnish suitable assistants to help Engineer.
4. No deformed circle, pipeline sags, unseated joints or gaskets, visible leaks will be allowed in the TV inspection test that indicates an improperly constructed sewer or drain line.
5. Repair any sections not passing the TV inspection test.
6. Create a digital video file of the inspection, date, time, pipeline station and manhole number, and observations for Owners record.

3.17 CLEANING AND DRAINING

A. The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand, and dirt when connected

B. Wire brush, if necessary, wipe clean and keep joint contact surfaces clean until connection is complete

3.18 SITE PIPING SCHEDULE

A. Install pipes as scheduled in the pipe schedule provided below
   1. AM: Air Method
   2. B&SP: Bell and spigot
   3. BF: Butt Fusion Weld
   4. CI: Cast iron
   5. CISP: Cast iron soil pipe
   6. CL: Class, followed by the designation
   7. CM: Cement mortar
   8. CTP: Coal tar pitch
   9. DIP: Ductile iron piping
   10. EPP: Epoxy polyurethane coating
   11. FL: Flange
   12. GA: Gauge, preceded by the designation
   13. GE: Grooved end joint
   14. GL: Glass lined
   15. GR: Gravity Method
   16. GSP: Galvanized steel pipe
   17. HH: High Head Method
   18. LH: Low Head Method
   19. MJ: Mechanical joint
   20. NPS: Nominal pipe size, followed by the number in inches
   21. psi: pounds per square inch
   22. psig: pounds per square inch gauge
   23. PE: Polyethylene
   24. PEE: Polyethylene encasement
   25. PTW: Polyethylene tape wrap
   26. PVC: Polyvinyl Chloride
   27. SC: Special Case
   28. SCH: Schedule, followed by the designation
   29. SCRD: Screwed-On
   30. SDR: Standard Dimension Ratio
   31. SLR: Solids removal
   32. SST: Stainless steel
   33. SW: Solvent welded
   34. VCP: Vitrified clay piping
   35. WLD: Weld

PIPING SCHEDULE									
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**
D	**Drain**								
	Underground	18	PVC	SDR 35	02616	B&SP	15 feet/GR	None	None
W	**Raw Water**								
	Underground	20	PVC	DR 18	02616	B&SP	235 psi/HH	None	None
OF	**Overflow**								
	Underground	18	PVC	SDR 35	02616	B&SP	15 feet/GR	None	None

3.19 VALVE SCHEDULE, VALVES LARGER THAN 4-INCHES

A. Valves smaller than 4-inches may not be indicated in the Valve Schedule and are the responsibility of the Contractor to purchase and install

B. Install valves as scheduled in the valve schedule provided below
   1. FLG: Flanged Joints
   2. MJ: Mechanical Joints
   3. PV: Plug Valve
   4. GV: Gate Valve
   5. CV: Check Valve
   6. ECV: Elastomeric Check Valve
   7. BFV: Butterfly Valve
   8. PRV: Pressure Reducing Valve
   9. DAP: Diffuser Air Purge Valve
   10. EA: Electrically Actuated
   11. PNEA: Pneumatically Actuated
   12. HW: Hand Wheel
   13. VBNO: Valve Box and Nut Operation
   14. SO: Solenoid
   15. NPW: Non-Potable Water
   16. PSE: Pre-Selected Equipment to be included in Manufacturer's scope of supply
   17. C: Contractor to provide valve
   18. O: Owner to provide valve

Item No.	Type	Size (inches)	Area Location	Type of Installation	Service	Valve End Connection	Actuator/ Operator	Supplied by
1	BFV	18	Drain Pipe Exiting Concrete Tank	Direct Bury	Drain	MJ	VBNO	C
2	BFV	20	Draw Line Connection to Raw Water Lines	Direct Bury	Raw Water	MJ & MJ	VBNO	C
3	BFV	20	Raw Water Line Connection to Feed Line	Direct Bury	Raw Water	MJ & MJ	VBNO	C

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Cast-in-place concrete

B. Reinforcing steel

C. Forms

D. Concrete accessories

1.2 RELATED SECTIONS

A. 03600 - Grout

1.3 REFERENCE STANDARDS AND GUIDES

A. Comply with the following except as modified by supplementary requirements of this Project Specification.

B. American Concrete Institute – ACI:
1. 117 – Standard Specifications for Tolerances for Concrete Construction and Materials
2. 214R – Guide to Evaluation of Strength Test Results of Concrete
3. 301 – Specifications for Concrete Construction
4. 302.1R Guide to Concrete Floor and Slab Construction
5. 304 – Guide for Measuring, Mixing, Transporting, and Placing Concrete
6. 304.2R – Guide to Placing Concrete by Pumping Methods
7. 305.1 – Specification for Hot Weather Concreting
8. 306.1 – Standard Specification for Cold Weather Concreting
9. 308.1 – Specification for Curing Concrete
10. 309 – Guide for Consolidation of Concrete
11. 318 – Building Code Requirements for Structural Concrete
12. 347 – Guide to Formwork for Concrete
13. 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary

C. American Standards and Testing Materials (ASTM)
1. A615 – Deformed and Plain Carbon Steel Bars for Concrete Reinforcement
2. C31 – Practice for Making and Curing Concrete Test Specimens in the Field
3. C33 – Concrete Aggregates
4. C39 – Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
5. C94 – Specification for Ready-Mixed Concrete

6. C115 – Length Change of Hardened Hydraulic-Cement Mortar and Concrete
7. C143 – Standard Test Method for Slump of Hydraulic-Cement Concrete
8. C150 – Specification for Portland Cement
9. C173 or C231 – Test Methods for Air Content of Freshly Mixed Concrete
10. C260 – Air Entraining Admixtures for Concrete
11. C309 – Liquid Membrane-Forming Compounds for Curing Concrete
12. C452 – Standard Test Method for Potential Expansion of Portland-Cement Mortars Exposed to Sulfate
13. C494 – Chemical Admixtures for Concrete
14. C595 – Standard Specification for Blended Hydraulic Cements
15. C618 – Coal Fly Ash and Raw or Calcined Natural Pozzolan for use in Concrete
16. C989 – Standard Specification for Slag Cement for Use in Concrete and Mortars
17. C1157 – Performance Specification for Hydraulic Cement
18. C1602 – Mixing Water Used in the Production of Hydraulic Cement Concrete
19. D1751 – Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

D. Concrete Reinforcing Steel Institute (CRSI)
1. Manual of Standard Practice

E. National Institute of Standards and Technology (NIST)
1. PS 1 – Structural Plywood

1.4 PERFORMANCE TOLERANCES

A. Confirm to ACI 117, ACI 301, ACI 347 and ACI 350 as modified herein. In case of conflict, ACI 117 governs. ACI 350 governs where ACI 117 does not apply.

B. Shrinkage Test Procedure:
1. Testing and reporting shall conform to ASTM C157-17 with the following modifications:
   a. Wet cure specimens for a period of 7 days (including the period of time the specimens are in the mold). Wet cure may be achieved either through storage in a moist cabinet or room in accordance with ASTM C 511, or through storage in lime saturated water. Drying age zero (0) shall be deemed after the specimen has completed its wetting period.
   b. Slump of concrete for testing shall match job requirements and need not be limited to restrictions as stated in ASTM C 157.
   c. Report results in accordance with ASTM C 157 at 0, 7, 14 & 28 days of drying.

1.5 SUBMITTALS

A. Submit under provisions of Division 1 specifications

B. Shop Drawings: Reinforcing bar lists, fabrication and placement drawings
1. Indicated bar sizes, spacing, locations, and quantities of reinforcing steel. Bending and cutting schedules shall be included in all shop drawings.

2. Indicate pertinent dimensions, materials, bracing, arrangement of joints and ties, and exact location of openings, framing, and special conditions affecting work
3. All shop drawings shall be original drawings produced by the supplier and shall not be reproductions of the Contract Documents

C. Product Data: Provide sufficient information on products specified to verify compliance with specifications. Provide data on
1. Joint devices
2. Attachment accessories
3. Admixtures and mixes
4. Curing Compounds
5. Sealers
6. Waterstops
    a. Product data for all waterstop to be used
    b. Product data for waterstop splicing iron, showing compliance with manufacturer's recommendations
    c. Installation procedures to be followed, showing compliance with manufacturer's recommendations

D. Test Reports
1. Submit reports of tentative concrete mix designs and testing prior to placing any concrete, including
    a. Slump range on which the design is based
    b. Total gal of water per cu yd
    c. Brand, type, composition, and quantity of cement with manufacturer and plant location identified
    d. Brand, type, composition and quantity of fly ash
    e. Specific gravity and gradation of each aggregate
    f. Ratio of fine to total aggregates
    g. Surface-dry weight of each aggregate per cu yd
    h. Brand, type ASTM designation, active chemical ingredients and quantity of each admixture
    i. Air content and tolerance
    j. Water/cementitious material ratio and tolerance
    k. Compressive strength based at 7- and 28-day compression tests
    l. Submit reports of field quality control testing
    m. Time of initial set
2. Submit suppliers certified fly ash test reports for each shipment delivered to concrete supplier
    a. Physical and chemical characteristics
    b. Certification of compliance with the specifications
    c. Signed by Contractor and concrete supplier
3. Existing data on proposed design mixes are acceptable if certified and complete

E. Construction Joint Locations: Submit all proposed construction joint locations in slabs and walls to Engineer two (2) weeks prior to placing any concrete.

1.6 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301 and ACI 350. Maintain one copy of each document on site.

B. Follow recommendations of ACI 305.1 when concreting in hot weather.

C. Follow recommendations of ACI 306.1 when concreting in cold weather.

D. Acquire cement and aggregate from same source for all work

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle materials under provisions of Division 1 Specifications

B. Cement, fly ash, and other cementitious materials: Store in moisture proof enclosures, do not use if caked or lumpy

C. Aggregate: Store to prevent segregation and inclusion of foreign materials, do not use the bottom 6-inch of piles in contact with the ground

D. Reinforcing steel
   1. Store on supports 6” minimum off of ground, which will keep it from contact with ground and protected from oil or other materials detrimental to steel or bonding capability. Cover to prevent unacceptable surface corrosion and contamination.
   2. Tag bundles of reinforcing bars and wire spirals with metal tag showing specification, grade, size, quantity and suitable identification to permit checking, sorting and placing.

E. Rubber and plastic materials: Store in a cool place, do not expose to direct sunlight

F. Prepare a delivery ticket for each load of ready-mixed concrete

G. Truck operator shall hand ticket to Geotechnical Engineer or Third Party Inspector at the time of delivery with ticket to show:
   1. Quantity delivered
   2. Actual quantity of each material in batch
   3. Outdoor temp in the shade
   4. Time at which cement was added
   5. Numerical sequence of the delivery
   6. Quantity of water that can be added in the field based on mix design
   7. Free moisture in fine and coarse aggregate in percent by weight
   8. Temperature of batch

PART 2 PRODUCTS

2.1 FORMS

A. Prefabricated: Symons "Steel-Ply" or accepted substitution

B. Plywood: PS 1, waterproof resin-bonded, exterior type Douglas Fir; face adjacent to concrete Grade B or better

C. Lumber: Straight, uniform width and thickness; free from knots, offsets, holes, dents, and other surface defects

D. Chamfer strips: Clear, white pine, surface against concrete planed

E. Form coating: Colorless biodegradable oil or water based release agent that will not stain concrete and is VOC compliant. Acceptable products: Nox-Crete "Nox-Crete Form Coating", L & M "Debond", or accepted substitution

F. Form Coating where exposed to potable water: Meets NSF Standard 61, Dayton Superior “Clean Strip J1EF”, Hill and Griffith Company “Grifcote LV-50-Plus”

G. Form ties: Removable end, permanently embedded body types with waterstops not requiring auxiliary spreaders, with cones on both ends, embedded portion 1-inch minimum back from concrete face. If not provided with threaded ends, constructed for breaking off ends without damage to concrete.

2.2 REINFORCING STEEL

A. Bars: ASTM A615, Grade 60

B. Bars to be field bent: ASTM A706, grade 60

C. Bar supports: CRSI Class 1, fabricated from galvanized wire having PVC coated legs

D. Tie wire: 16 ½ gage or heavier, black annealed wire

E. Form and fabricate reinforcing steel in accordance with ACI 315 and 318 and CRSI DA4 except as specified or indicated on Drawings, free from rust, scale and contaminants which will reduce bond.

F. Dowel Adhesive: Hilti “HIT-RE 500 V3”, Powers “PE 1000+”, Simpson “SET-XP”, or accepted substitution.

2.3 CONCRETE

A. Cement: ASTM C150, Type I/II modified cement tested to meet type V for sulfate resistance per ASTM C150 Table 4 and ASTM C452. Cement should have a tricalcium aluminate (C_3A) content of not more than 5 percent or testing in accordance with

ASTM C452 that reports that the cement meets the Type V maximum limit of 0.040% expansion.

B. Blended Hydraulic Cement: ASTM C595 Type IL(HS), Type IP(HS), Type IS(HS), or IT(HS). Blended Hydraulic Cements not allowed: Type IS≥70 and Type IT(S≥70)

C. Fly ash: ASTM C618, Class F

D. Blast Furnace Slag: ASTM C989, Grade 100 or 120

E. Fine aggregate: Clean, natural sand, ASTM C33; no manufactured or artificial sand

F. Coarse aggregate: Crushed rock, natural gravel, or other inert granular material, ASTM C33 except clay and shale particles no more than 1%.
   1. Alkali Silica Reactivity: Aggregate shall be considered non-reactive with a documented satisfactory service record for a minimum ten year period used in concrete with similar cementitious material or with an alkali (Na_2O eq.) content in concrete equal or higher than that in the proposed mixture. In the absence of service record the aggregate shall be tested and will be considered non-reactive if it complies with a) or b)
      a. ASTM C1260 14-day expansion less than or equal to 0.1%, or
      b. ASTM C1293 1-year expansion less than or equal to 0.040%

G. Water: ASTM 1602

H. Admixtures
   1. Air entraining agent: ASTM C260; Grace "Darex AEA", Master Builders "VR-10", Sika Chemical "AEA", or accepted substitution
   2. Chemical Admixtures: ASTM C494, non-corrosive and chloride free.
   3. Shrinkage reducing admixture: Dosage 1% of weight of cement and fly ash; “Eclipse 4500” by GCP Applied Technologies (Grace) “SikaControl-75” by Sika
   4. Bid Alternate #2: Waterproofing admixture: Dosage as recommended by manufacturer; “C-500, C-500NF, C-1000, or C-1000NF” by Xypex

2.4 WATERSTOPS

A. Hydrophilic Waterstop
   1. 3/4” inch wide by 3/8 inch thick, Adeka “MC-2010MN”, Sika Hydrotite CJ-1020-2K, Kryton “Krytonite Swelling Waterstop”, or accepted substitution
   2. Waterstop shall be treated to not expand when in contact with fresh concrete.

B. Non-swelling gasket type waterstop or low swell pressure waterstop
   1. Sika “Lockstop”, Adeka “KBA-1510FP”, or accepted substitution

C. Alternate Waterstop
   1. PVC: Ribbed or serrated,
      a. 6 inch wide by 3/8 inch thick, Vinylex "R6-38," Sika Greenstreak "679", or accepted substitution

b. For concrete section less than 8 inch thick or as indicated on the drawings: 4 inches wide by 3/16 inch thick ribbed or serrated
c. Provide factory made waterstop fabrications for all changes of direction, intersections, and transitions leaving only straight butt joint splices for the field
d. Provide hog rings or grommets spaced at 12 inches on center along length of waterstop
e. Provide Teflon coated waterstop splicing irons approved by manufacturer for field butt splices.

2.5 ACCESSORIES

A. Membrane Forming Curing Compound: ASTM C309, L&M Construction Materials "Dress & Seal WB30", BASF "MasterKure CC 200WB", Euclid "Super Diamond Clear VOX", Dayton Superior "Cure & Seal 1315 EF", W.R. Meadows "VOCOMP-20", or accepted substitution.

B. Curing Compound for surfaces in contact with potable water: Meets NSF Standard 61, Dayton Superior "Clear Cure VOC J7WB", Atlas Tech Products "Atlas Quantum-Cure NSF".

C. Epoxy Bonding Agent: ASTM C881, Sika "Sikadur 32 Hi-Mod", Dayton Superior "Sure Bond J58", L&M Construction Materials "Epobond", or accepted substitution. Use when joining new to existing concrete.

D. Non-Epoxy Bonding Agent: ASTM C1059 Type II, Larson Products "Weld-Crete", BASF "MasterEmaco A 660", L&M Construction Materials "Everbond", Dayton Superior "Acrylic Bonding Agent J40", or accepted substitution. Use when joining new to existing concrete when bonding agent cannot be placed immediately prior to placement of new concrete.

E. Patching Mortar: Sika "Sikatop", L&M Construction Materials "Durapatch VOH", or accepted substitution.

2.6 CONCRETE MIX DESIGN

A. Concrete Mix: Measure and combine cement, aggregate, water, and admixtures in accordance with ASTM C94 and ACI 211.1.
1. Cementitious materials: When used in exposed concrete shall be one brand from one source. Do not mix different cements in same element of Work unless used in accordance with ASTM C595.
2. Water-Cement Ratio (if fly ash used, water-cement plus fly ash ratio): 0.42 maximum for 4500 psi, 0.45 for 4000 psi concrete
3. Air-Entrainment: Air-entrain concrete exposed to exterior or exposed to liquids. See Table below for requirements.
4. Chemical Admixtures: Use is optional to aid concrete properties and allow for efficient placement. Manner of use and amount shall be in accordance with manufacturer's written recommendations and as approved by Engineer. Do not use admixtures that increase early shrinkage or negatively affect finishing.

5. Fly Ash: Use is optional unless otherwise noted. Combine fly ash with cement at a rate of 1 pound fly ash for each pound reduction of cement. Amount of fly ash shall not be less than 15% or more than 25% of weight of cement plus fly ash. When fly ash used, minimum amount of cement designated may be proportionately reduced.
6. Blast Furnace Slag: Use is optional unless otherwise noted. Combine blast furnace slag with cement at a rate of 1 pound of blast furnace slag for each pound reduction of cement. When blast furnace slag is used a cement replacement, blast furnace slag shall comprise 40-65 percent of the cementitious materials.
7. Shrinkage requirement: For location identified to include shrinkage reducing admixture concrete shall be proportioned such that the results of shrinkage test as defined in Part 1 of this section do not exceed 0.030% at 28 days of drying for laboratory cast specimens
8. Provide shrinkage reducing admixture in the following areas:
   a. Tank lid
9. Use no admixtures other than specified, unless approved by Engineer.

B. Class of Concrete:
1. Furnish in accordance with table. Cement contents listed are minimum values and shall be increased as required to attain other specified characteristics.
2. Slumps listed are maximum, except when high range water reducer is used. Maximum slump when high-range water reducer is used, 10 inches.
3. Chloride ion content shall not exceed values listed in ACI 318, Table 19.3.2.1

Use	28-Day Compressive Strength (psi)	Coarse Aggregate (size no.)	Water to Cement ration	Air Content (%)
Walls	4500	67	0.45	6±1.5
Base Slab	4000	67	0.45	3±1.5
Elevated Slab	4500	67	0.45	6±1.5

2.7 FABRICATION

A. Reinforcing Steel: Accurately formed, fabricated in accordance with ACI 315 and 318 except as specified or indicated on drawings, free from rust, scale and contaminants which will reduce bond

2.8 SOURCE QUALITY CONTROL

A. Test the proposed concrete mix for each size and gradation of aggregates and each consistency intended for use in the project

B. Aggregates
1. Sample and test according to ASTM C33
2. Determine bulk specific gravity in accordance with ASTM C127 and C128

C. Fly Ash and Blast Furnace Slag: Supplier's chemical composition and physical analysis test

D. Initial set test
   1. In accordance with ASTM C403
   2. Test at 70 degrees F and 90 degrees ambient
   3. Test at 70 degrees F on mix including specific plasticizing and entraining admixtures
   4. Test at 90 degrees F on mix including specified retarding and air entraining admixtures
   5. Fly ash and Blast Furnace Slag: Supplier's chemical composition and physical analysis test

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify site conditions in field or under provisions of Division 1 Specifications

B. Verify requirements for concrete cover over reinforcement

C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete

3.2 PREPARATION

A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions

B. Subgrade and bedding shall be compacted and free of frost. If placement occurs at temperatures below freezing, provide temporary heat and protection to remove frost. Do not place concrete on frozen material.

C. Provide mud slabs where noted, where necessary, and when required by the Engineer to obtain a dry and stable working platform for placement of concrete. Unless otherwise approved by Engineer, 2 inch thick mud slabs shall be provided between free-draining fill and concrete as detailed.

D. Remove standing water, ice, mud, and foreign matter before placing concrete

E. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels with dowel adhesive system.

3.3 FORMS

A. Formwork design, detailing, and installation shall be Contractor’s responsibility and shall conform to ACI 347.

B. Type of forms used is Contractor's option, except as otherwise indicated or shown. Plywood and other wood forms shall have smooth level surfaces treated with form oil or sealer to produce clean release of concrete from forms.
   1. Where wall remain exposed use plywood, prefabricated metal or wood forms; do not use boards. Lay forms out in a uniform pattern with the long dimension of the form placed vertically and joints aligned.
   2. Form ties shall be plastic cone snap ties. Cone shall be min ¾ inch diameter by 1 inch deep. Ties for liquid holding structures or dry structures below grade shall have integral waterstop. Taper tie through-bolt form ties may be used as an alternate to plastic cone snap ties; conform to details shown. Do not use wire ties on exposed concrete.
   3. Provide ¾ inch chamfer on external corners of exposed concrete walls, beams, columns, equipment bases and exposed edges of construction joints. Do not chamfer edges flush with concrete walls.

C. Coat plywood and wood forms with non-staining form release agent. Apply release agent before reinforcement is placed.

D. Clean, patch, and repair form material before reuse.

E. Formwork shall prevent leakage of mortar, shall not deflect under weight of concrete and workmen, and shall withstand fluid pressure of concrete. Maximum deviation from a true plane: 1/8 inch within 6 feet

F. Brace or tie forms to maintain desired position, shape, and alignment during and after concrete placement

G. Design to produce hardened concrete to the shape, lines, and dimensions indicated on the drawings

H. Plywood or lined forms are not required for surface normally submerged or not normally exposed to view

I. Other type of forms may be used for surfaces not restricted to plywood or lined forms as backing for form lining

J. Flat segmental forms, 2 foot maximum width, may be used for curved surfaces 25 feet minimum diameter

K. Provide polyethylene film to protect concrete from water loss when placing concrete against gravel or crushed rock not containing 25 percent minimum material passing a No. 4 sieve, lap joint 4 inches

L. When placing concrete against rock, remove all loose pieces of rock and clean exposed surface with high pressure hose

M. Size and space wailers, studs, internal ties and other form supports so proper working stresses are not exceeded

N. Locations to be finished to a specified elevation, slope, or contour, bring form to true line and grade and provide a wooden guide strip at the proper location in the forms for finishing the top surface with a screed or template

O. At horizontal construction joints in walls, stop the forms on one side not more than 2 feet above the joint

P. Provide temporary opening at the bottom of columns and wall forms and wherever necessary for cleaning and inspection

Q. Install form ties on exposed surfaces in uniformly spaced vertical and horizontal rows

R. Do not remove or disturb until concrete has attained sufficient strength to safely support all dead and live loads

S. Leave shoring beneath beams and slabs in place and reinforce as required for construction equipment and materials

T. Maintain forms in place for a minimum of 40 hours for length of curing time in accordance with ACI 306 when temperature is 45 deg F and below

U. Remove forms carefully to prevent surface gouging, corner or edge breakage and other damage

3.4 REINFORCING STEEL

A. Accurately position reinforcing steel on supports, spacers, hangers, or other reinforcing steel at maximum intervals of 4 feet on center

B. Secure with wire ties or suitable clips. Tie 50 percent of all reinforcement and reinforcement at intersections for wall and floor construction

C. Except at contact splices, minimum clear distances between bars, the greater of
   1. Nominal diameter of bars
   2. 1.5 times max size of coarse aggregate

D. Splices
   1. As specified or indicated on the drawings
   2. Splices at other locations will be acceptable, if approved by the Engineer
   3. Do not weld or tack weld reinforcing steel
   4. Remove and replace steel upon which any unauthorized welding has been performed

3.5 EMBEDMENTS

A. Accurately position and securely anchor in forms, anchor bolts, steel shapes, conduit, sleeves, masonry anchorages, and other materials to be embedded in concrete

B. Cast pipe and other embedded items into concrete as placement progresses. Do not provide blockouts.

C. Do not place ducts, conduit, and pipes in slabs on grade. Place minimum 4 inches below slab

D. Place items constructed of dissimilar metals to avoid physical contact with reinforcing. Secure item and reinforcing to ensure they will not shift and come into contact during concrete placement. Contact between reinforcing steel and other metal, other than bare, coated, or plated carbon steel not permitted.

E. The following restrictions shall be adhered to, unless otherwise noted
   1. No duct, conduit, pipe, or fitting placed vertically shall be larger in cross-sectional area than 4% oc column into which it is placed.
   2. Duct, conduit, pipe, and fittings, when placed within slabs or walls
      a. Shall not be larger than 1/3 thickness of slab or wall
      b. Shall be placed within the middle 1/3 of slab or wall where possible
      c. Shall not be placed closer than 3 outside diameters clear from each other when parallel
      d. Shall cross each other at right angles
      e. Shall be secured to prevent shifting of “floating” during concrete placement
      f. Multiple conduits shall not cross each other at the same location
      g. Except for conduits that must run up a column, keep conduits a minimum of 2 to 3 feet away from columns
      h. Where conditions require conduit to be tied to the inside face of the reinforcing mat, the conduit shall be galvanized steel or PVC, shall be placed 3 outside diameter clear away from the parallel reinforcement bar.
   3. Reinforcing steel shall be in place before embedded items placed and reinforcing cut or removed shall be replaced with additional reinforcing as indicated.
   4. Do not pass sleeves through columns or beams without Engineer’s approval.

F. Anchor bolts
   1. Unless installed in pipe sleeves, provide sufficient threads on anchor bolts to permit a nut on the concrete side of the form or template
   2. Install a second nut on the other side of the form or template
   3. Adjust the nuts to hold the bolt rigidly in the proper position

G. Clean embedments before installation

3.6 TRANSPORTING MIXED CONCRETE

A. Transporting of mixed concrete shall conform to ACI 304R.

B. Maximum delivery time from batch plant is 90 minutes unless stated otherwise by the supplier and approved by the Owner/Engineer.

C. Mix concrete in accordance with ASTM C94.

D. Do not exceed manufacturer's guaranteed capacity of truck agitators. Maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

E. Additional mixing water is permitted as long as the specified water cement ratio of the mix is not exceeded. Batched water quantities and added water quantities must be accurately recorded for verification. If additional water is to be incorporated into the concrete, revolve the drum not less than 30 revolutions at mixing speed after the water is added and before placing concrete. Addition of water is not permitted after concrete testing has occurred.

F. Notify Special Inspector of any water added to the concrete mixture

G. A water measuring device in good working condition, mounted on each transit mix truck, shall be used for measuring the water added to the mix on site or in transit.

H. Provide delivery ticket to Special Inspector or Owner and comply with delivery requirements of this section

3.7 PLACING CONCRETE

A. Place concrete in accordance with ACI 304, ACI 301, and ACI 318

B. Schedule and attend pre-pour meeting with Owner at least 7 days before first pour to review requirements of this specification

C. Notify Engineer and Owner not less than 48 hours in advance of the times and places at which contractor intends to place concrete

D. Predetermine limits at each pour and place all concrete within limits of pour in one continuous operation

E. Construction joint locations shall be approved by the Engineer

F. Rigidly secure forms, reinforcing steel, embedment, and anchor bolts in proper position

G. Remove all mud, water, ice, snow, frozen material, and debris from space to be occupied by concrete

H. Clean surfaces encrusted with dried concrete from previous concrete operations

I. Convey to the point of final deposit by methods which will prevent separation or loss of ingredients

J. Place concrete in final position without being moved laterally more than 5 feet

K. Place concrete in horizontal layers not more than 2 feet of depth to allow for proper consolidation

L. Place subsequent layer while the preceding layer is still plastic

M. Top finish concrete when thoroughly settled

N. Remove all laitance, debris, and surplus water from the tops of the forms by screeding, scraping or other effective means

O. Overfill the forms for walls whose tops will be exposed to the weather and screed off the excess after the concrete has settled

P. Provide vertical construction joints as required to comply with these requirements

Q. Limit portions of columns and walls poured monolithically with floor or roof slabs to 6 feet of vertical height

R. Allow concrete in walls and columns to settle at least 2 hours before concrete is placed in structural systems to be supported by the walls and columns

S. Clean concrete spatter and other foreign substances from surfaces not in contact with concrete.

3.8 BONDING TO HARDENED CONCRETE

A. Place new concrete on rough, clean, damp faces of existing concrete

B. Roughen concrete to be bonded to future concrete to 1/4 inch amplitude

C. Remove surface mortar of smooth surfaces to expose aggregate

D. Clean hardened concrete of all foreign substances, including curing compound, washed with clean water, and keep saturated for 24 hrs preceding placement of fresh concrete

E. Apply epoxy bonding agent for bonding to hardened concrete

3.9 CONSOLIDATION

A. Thoroughly consolidate concrete during and immediately after placement

B. Work concrete around all reinforcements and embedments and into the corners of the forms

C. Use mechanical vibrators which will maintain 9,000 cycles per minutes when immersed in the concrete, 1 ½ hp motor minimum

3.10 COLD WEATHER CONCRETING

A. Conform to ACI 306.1, except as modified herein

B. Minimum concrete temp at the time of mixing: Refer to Table 5.1 of ACI 306R-10

Outdoor Temp at Placement (in shade)	Minimum Concrete Temp at Mixing (Concrete sections 12” or Greater)
Below 0°F	65°F

Between 0°F & 30°F	60°F
Above 30°F	55°F

C. Do not place heated concrete which is warmer than 80 degrees F

D. If freezing temp are expected during curing, maintain the concrete temperatures in accordance with ACI 306R-10, Table 7.1

E. Do not allow concrete to cool suddenly.

3.11 HOT WEATHER CONCRETING

A. Conform to ACI 305.1, except as modified herein

B. At air temp of 90 degrees F and above keep concrete as cool as possible during placement and curing

C. Do not allow concrete temperature to exceed 85 deg F at placement

D. Prevent plastic shrinkage cracking due to rapid evaporation of moisture

E. Do not place concrete when the actual or anticipated evaporation rate equals or exceeds 0.2 lbs per sq ft per hr as determined from ACI 305R-10, Fig 4.2

3.12 CONSTRUCTION JOINTS

A. Unless otherwise noted, construction joints shown are optional. Joints not shown on Drawings shall be approved by Engineer. Locate to miss splices in reinforcement.

B. Limit size on concrete pours. Maximum length of wall and slab pours shall not exceed 80 feet.

C. Before concrete placed, construction joints shall be cleaned, laitance removed, and surface wetted. Remove standing water.

D. Construction joints shall have keys or roughened surfaces. Where roughened surfaces are used, surface shall have amplitude of ¼ inch minimum.

3.13 WATERTIGHT JOINTS

A. Provide waterstop in construction joints at the following locations:
   1. Walls and slabs separating dry interior from earth or liquid.
   2. Exterior walls and slabs of liquid holding tanks.
   3. Slabs above occupied areas
   4. Other locations shown on Drawings.

B. Hydrophilic and non-swelling gasket type waterstops
   1. Follow all manufacturer's recommendations and instructions for installation.
   2. Provide a smooth even surface to ensure good bond between waterstop and substrate.

3. Locate waterstops in center of construction joints.
4. Splice waterstops in accordance with manufacturer's recommendations.
5. Prior to application of waterstop remove all dust, oil, or other contaminants from the concrete surface prior to adhering the waterstop.
6. Secure waterstop sufficiently to substrate to prohibit movement of waterstop during placement of fresh concrete.

C. Alternate PVC Waterstops
1. Follow all manufacturer's recommendations and instructions for installation.
2. Protect and maintain clean and free of dirt and coatings which would weaken the bond with concrete. Sandblast or power-wash waterstop prior to placing concrete if any dirt, concrete, cement paste, or other deleterious material is found or remains from previous concrete placements.
3. Provide continuous through the length of the construction joint
4. Any waterstop punctured or damaged shall be repaired or replaced
5. Do not wrap waterstop around corners. Use factory-formed joints at all changes of direction, intersections, and transitions.
6. Field butt splices shall be heat fused welded using a Teflon coated waterstop splicing iron approved by waterstop manufacturer. Follow manufacturer recommendations for splicing procedures. Lapping of waterstop, use of adhesives, or solvents shall not be allowed
7. Center waterstop in joint and secure waterstop in correct position using hog rings or grommets spaced at 12 inches on center along the length of the waterstop and wire tie to adjacent reinforcing steel. Protect and maintain in proper position until surrounding concrete is deposited and consolidated.
8. Waterstop splicing defects which are unacceptable include, but are not limited to the following: Tensile strength less than 80 percent of parent section; misalignment of ribs greater than 1/16 inch; bond failure at joint deeper than 1/16 inch or 15 percent of material thickness; misalignment that reduces waterstop cross section more than 15 percent; visible porosity in the weld; bubbles or inadequate bonding; visible signs of splice separation when cooled splice is bent by hand at a sharp angle; charred or burnt material.

3.14 FINISHING SLABS AND FLATWORK

A. Slab Finishes:

Description	Concrete Finish
Submerged and Buried Slabs	Float
Exterior Exposed Slabs	Float and Broom Finish

B. After placement, screed concrete with straightedges, power strike-offs or vibrating screeds.

C. After screeding, bull float or darby surfaces to eliminate ridges and to fill in voids left by screeding.

D. Float:
1. Use magnesium or aluminum hand floats or power floats with slip on float shoes.

2. Float finish shall result in uniform smooth granular texture.

E. Broom Finish: Use fine, soft-bristled broom and broom at right angles to direction of traffic to give nonskid finish approved by Engineer.

F. Tolerances:
1. Concrete slabs shall be within 3/16 inch of 10 foot straightedge in all directions except where slabs are dished for drains. Deviations from elevation indicated shall not exceed 3/4 inch.
2. Pitch floor to floor drains minimum 1/8 inch per foot or as shown. Pitch bottom of slab or beam to match top slope to maintain thickness or depth indicated. As an alternate, bottom of slab or beam may be placed level provided that min thickness or depth is maintained.

3.15 FINISHING FORMED SURFACES

A. Remove fins and other surface projections from all formed surfaces except exterior surfaces that will be in contact with earth backfill and are not specified to be dampproofed

B. Use a power grinder, if necessary, to remove projections and provide a flush surface

C. Remove fins and fill all tie holes on surfaces exposed to view
1. Clean, dry and fill plastic cone snap tie holes with Patching Mortar. Fill taper tie through-bolt form tie holes with Non-Shrink Grout.
2. Finish flush to match the texture of adjacent concrete

D. Surface finishes shall meet requirements noted below.
1. All formed surfaces exposed to view and surfaces not exposed to view, but resisting hydrostatic pressure shall have a surface finish of 2.0 as defined in section 5 of ACI 301.
   a. Patch voids larger than ¾ inches wide or ½” deep.
   b. Remove projections larger than 1/4 inch.
   c. Tie holes shall be patched
   d. Surface tolerance Class B as specified ACI 117
   e. Grout clean surfaces exposed to view to produce a smooth uniform surface free of marks, voids, surface glaze and cement dust
2. All surfaces exposed to view shall have grout cleaned rubbed finish
   a. Use non-shrink grout mix with bonding agent.
   b. Wet surface and scrub grout into voids and remove excess material.
   c. Finished surface shall have smooth appearance free of marks, voids, surface glaze, and cement dust.

3.16 CURING AND PROTECTION

A. Protect concrete from frost and keep moist for min curing period of 7 days after placement in accordance with ACI 308.
1. Formed Surfaces:

a. Wet cure by spraying surfaces as frequently as drying conditions may require to keep concrete surfaces moist.
b. Surfaces may be cured by leaving forms in-place. For vertical surfaces, apply water to run down inside of forms, if necessary, to keep concrete moist.
c. After forms are removed, wet cure for remainder of curing period or apply curing compound.
d. Do not use curing compound where mortar, grout, concrete, or other coatings or adhesives will be applied.

B. Flatwork:
1. Cure using curing compound or wet cure.
2. Do not use curing compound where mortar, grout, concrete, or other coatings or adhesives will be applied.

C. Curing Compound:
1. Apply curing compound at uniform rate sufficient to comply with requirements for water retention as specified and as measured in accordance with ASTM C156.
2. Cover areas subjected to direct sunlight with ambient temperature expected to exceed 80°F with white pigmented compound, other surfaces may be covered with fugitive dye compound.

D. Water curing
1. Begin water saturation as quickly as possible after initial set
2. Regulate water application to provide complete surface coverage with minimum runoff
3. Interrupt the application of water to walls for grout cleaning only over the area being cleaned at the time and do not permit the surface to become dry during such an interruption

E. Protect from damaging mechanical disturbances, load stresses, heavy shock, and excessive vibration.

F. Protect finished concrete surfaces from damage caused by construction equipment, materials, and methods, and from rain or running water.

G. Do not load self-supporting structures to overstress concrete.

3.17 REMOVAL OF FORMING AND SHORING

A. Do not remove forming or shoring until member supported has acquired sufficient strength to safely support own weight and any imposed loads. Forming shall remain in place for at least min time recommended by ACI 347R. In addition, forming for horizontal members shall remain in place minimum 7 days. In no case shall forming for horizontal members be removed before concrete has reached 70% of specified design strength.

B. Reshore areas as required to carry additional imposed loads.

3.18 DEFECTIVE CONCRETE

A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.

B. General:
   1. Prior to starting repair work, obtain Engineer's approval of proposed repair techniques and materials.
   2. Method of repair shall not adversely affect the appearance of the finished structure.
   3. Develop repair techniques on portion of as-cast surface selected by Engineer. Surface of repair remaining exposed to view shall match color and texture of adjacent surfaces.
   4. Prepare surfaces, apply and install materials, and cure as recommended by material manufacturers.

C. Defective Areas:
   1. Remove honeycombing, stone packets, spalls, and other defective concrete down to sound concrete. If chipping required, make edges perpendicular to surface. Do not feather edges.
   2. Fill defective area with patching mortar

D. Leaks or wet spots:
   1. Inject, patch and repair areas where leaks or wet spots have occurred inside dry structures.
   2. Inject, patch and repair areas where leaks or wet spots have occurred in wet wells, basins, tanks, and other structures which are to hold water and exceed the allowable leakage rate specified in this section.

3.19 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed in accordance with ACI 301 under provisions of Section 01400

B. Owner's geotechnical consultant provide field and compressive strength tests to determine compliance of concrete materials in accordance with the specifications except as indicated otherwise under provisions of Section 01400

C. The Owner shall pay for compressive strength tests to determine compliance of concrete material in accordance with the specifications

D. Concrete Field Tests
   1. Tests by ACI certified technician
   2. Concrete Test Samples: Samples for acceptance tests on concrete shall be obtained in accordance with ASTM C172 at the point of placement or discharge.
   3. Provide all equipment, supplies, and the services of one or more employees, as required
   4. The test frequencies specified are minimum. Additional tests may be performed as required by the job conditions

E. Slump: Provide a sample from each truck load in accordance with ASTM C143 if requested by Engineer and when making test cylinders

F. Air Content: Provide a sample from each truck load if requested by Engineer and when making test cylinders

G. Compression Tests
1. Provide one set of 6 cylinders each day when up to 50 cu yds have been placed
2. Make one additional set of 6 cylinders for each additional 50 cu yds or each major pour placed in one day
3. Test two cylinders in each set at 7 days
4. Test two cylinders in each set at 28 days
5. The other two cylinders to be used as directed by Engineer at any time
6. Engineer will evaluate in accordance with ACI 214 and 318
7. Make, cure, store, and deliver cylinders in accordance with ASTM C31
8. Test in accordance with ASTM C39
9. Mark or tag each set of test cylinders with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the delivery truck or batch number, the air content, and the slump

H. Storage Facilities for Concrete Test Cylinders
1. Including water necessary, a specially prepared box with high-low thermometer and thermostatically controlled heating devices in accordance with ASTM C31

I. Failure of Test Cylinder Results: Evaluation of concrete structures where laboratory-cured cylinders fail to meet 28-day concrete strength requirements of the contract documents will be subject to, but not limited to, the following measures.
1. Upon failure of 28-day test cylinder results, the Engineer may require the Contractor, at his expense, to obtain and test at least three 4-inch diameter cored samples from area in question
2. Concrete will be considered adequate if average of three core tests is at least 85 percent of, and if no single core is less than 75 percent of, the specified 28-day strength. Where concrete durability is a concern due to freeze thaw or sulfate exposure the Engineer may reject concrete that passes ACI 318 core testing criteria for strength, but fails to meet acceptance criteria for cylinder testing.
3. In the event an area is found to be structurally unsound, the Engineer may order removal and replacement of concrete as required. The cost of the core tests and removal and replacement of defective concrete shall be borne by the Contractor
4. Fill all core holes as specified for repairing defective concrete
5. Additional measures may be required at the direction of the Engineer in accordance with ACI 350

3.20 LEAKAGE TESTING OF WATER HOLDING STRUCTURES

A. Structures shall be subjected to leakage tests after concrete has obtained specified design strength, and before backfilling or other Work which will cover faces of walls is begun

B. Tanks laterally restrained or supported by cross-walls, beams or slabs shall not be tested until such restraining or supporting construction is placed and has obtained its specified design strength

C. Fill structure with water to elevation given in the Table 1. After structure has been full for 24 hrs, it will be assumed for purposes of test that absorption of moisture by concrete in structure is complete. Measure change in water level after 24 hours have elapsed.

D. Fill container with water and place next to or in structure being tested. Locate container so it experiences environmental conditions as close as possible to those experienced by structure. Container shall be used as an indicator to measure loss of water due to evaporation. Level of water in container shall be measured and recorded over same period as structure.

E. If drop in water level, adjusted for evaporation in 24-hr period, exceeds 1/32 of an inch leakage shall be considered excessive

F. During test period, examine structure and mark visible leaks or damp spots

G. Damp spots on the exterior wall faces or footings shall be qualified as leaks. All leaks shall be repaired.

H. Drain structure to 2-ft minimum below leaks and damp spots and repair. Method of repair shall be Contractor's option, subject to requirements of these Contract Documents and review by Engineer.

I. If leakage was determined to be excessive, refill structure to specified level and retest

J. Continue this process until drop in water level in 24-hr period is less than 1/32 of an inch

K. Repairs and additional tests shall be made by Contractor, in acceptable manner, at no additional cost to Owner

TABLE 1
LEAKAGE TEST ELEVATIONS

Structure	Test Elevation
Concrete Water Storage Tank	5390.10

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Patching cavities in concrete

B. Other grouting specified or indicated on Drawings

1.2 RELATED SECTIONS

A. Section 03300 – Concrete

1.3 REFERENCES

A. ASTM C109 – Test Method for Compressive Strength of Hydraulic Cement Mortar

B. ASTM C157 – Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete

C. ASTM C191 – Time of Setting of Hydraulic Cement by Vicat Needle

1.4 SUBMITTALS

A. Submit under provisions of Section 01340

B. Product Data: Provide manufacturer's catalog sheet for material indicating test data and physical properties

1.5 QUALITY ASSURANCE

A. Conform to applicable industry standard, Corps of Engineers, Specification CRD-C 621 - Specification for non-shrink grout

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Non-Shrink, Non-Metallic Grout
   1. Master Builders - Masterflow 928
   2. M.R. Meadows - Sealtight 588
   3. Sonneborn - Sonogrout 10K
   4. Euclid - Tammsgrout Supreme
   5. Sika - SikaGrout 212
   6. Or accepted substitution

B. Epoxy Grout
   1. L&M Inc. - Epogrout
   2. Sika - Sikadur 42, Grout Pack
   3. Or accepted substitution

2.2 MATERIALS

A. Non-Shrink, Non-Metallic Grout: Factory premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents, capable of developing minimum compressive strength of 4000 psi in one day and 8000 psi in 7 days

B. Epoxy Grout: Three Component Epoxy Resin System
   1. Two liquid epoxy components
   2. One inert aggregate filtered component
   3. Each component furnished in separate package for mixing at job site

C. Water: Clean and free from deleterious substances

PART 3 EXECUTION

3.1 PREPARATION

A. Non-Shrink, Non-Metallic Grout
   1. Clean concrete surface to receive grout
   2. Saturate concrete with water for 24 hrs prior to grouting and remove excess water just prior to placing grout
   3. Cold weather conditions
      a. Warm concrete, substrate and base plate to 40 deg F, or above; store grout in warm area
      b. Follow manufacturer's recommendations for cold weather application
   4. Hot weather conditions
      a. Use cold mixing water and cool base plate if possible; store grout in cool area
      b. Follow manufacturer's recommendations for hot weather application
   5. Apply to clean, sound surface
   6. Apply latex bonding agent to hardened concrete, mix-in-grout, or as directed by Engineer

B. Epoxy Grout: Apply only to clean, dry, sound surface

3.2 APPLICATION

A. Non-Shrink, Non-Metallic Grout
   1. Mix in a mechanical mixer
   2. Use no more water than necessary to produce flowable grout
   3. Provide air vents where necessary to eliminate air pockets
   4. Place in accordance with manufacturer's instructions
   5. Where exposed to view finish grout edges smooth

6. Protect against rapid moisture loss by immediately covering with wet rags and polyethylene sheets or curing compound
7. Wet cure grout for 7 days, minimum
8. Maintain the temperature at a minimum of 40 deg F until grout reaches 3000 psi
9. After placement of grout, eliminate excessive external vibration

B. Epoxy Grout
1. Mix and place in accordance with manufacturer's instructions
2. Completely fill all cavities and spaces around dowels and anchors without voids
3. Obtain manufacturer's technical assistance as required to insure proper placement

3.3 SCHEDULE

A. Non-Shrink, Non-Metallic Grout: General Use
1. Grouting of manhole covers, pipe inlets, and precast manholes and vaults

B. Epoxy Grout
1. Patching cavities in concrete including, but not limited to, tie holes, and structural and equipment support

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Provide miscellaneous metal work shown on the Drawings, as specified herein, and as needed for a complete and proper installation.

B. Section Includes:
   1. Concrete anchors
   2. Aluminum handrail
   3. Ladders
   4. Access hatches
   5. Miscellaneous items

1.2 RELATED SECTIONS

A. Section 09900 – Coatings

1.3 DEFINITIONS

A. Submerged: At or below level 1 foot 6 inches above maximum water level in water holding structures

1.4 REFERENCES AND STANDARDS

A. AISC: American Institute of Steel Construction

B. AA: Aluminum Association

C. AWS: American Welding Society

D. ASTM: American Society for Testing and Materials

E. AISI: American Iron and Steel Institute

F. OSHA: Occupational Safety and Health Administration

1.5 SUBMITTALS

A. Shop Drawings:
   1. Indicate materials, sizes, connections, anchors, and finishes.

B. Product Data

1. Manufacturer’s catalog sheets and premanufactured items.

C. Miscellaneous Submittals:
   1. Floor access hatch warranty.

D. Submit in accordance with Section 01340.

1.6 QUALITY ASSURANCE

A. Perform shop and/or field welding required in connection with the work of this Section by certified welders in strict accordance with pertinent recommendation of AWS.

B. Conform to AISC and AA standards.

C. Provide periodic shop inspection and final inspection prior to shipment of welds for railing systems.

PART 2 GENERAL

2.1 MATERIALS

A. In fabricating items which will be exposed to view, limit materials to those which are free from surface blemishes, pitting, and roughness.

B. Comply with following standards, as pertinent.
   1. Pipe: ASTM A53, Grade B
   2. Stainless Steel:
      a. Exterior and submerged uses: AISI, Type 316
   3. Aluminum shapes and plates: Alloy 6061-T6 or 6063-T6
   4. Connection Bolts:
      a. For aluminum and galvanized steel members: Stainless steel
   5. Cast-in-place anchor bolts:
      a. ½ inch minimum diameter
      b. Nonsubmerged: ASTM A307, galvanized
      c. Submerged: Stainless steel

2.2 CONCRETE ANCHORS

A. Expansion Anchors:
   1. Manufacturers:
      a. Kwik Bolt 3 or Kwik Bolt TZ by Hilti
      b. Power-Stud+ SD1 or SD2 by Powers Fasteners
      c. Strong-Bolt or Strong-Bolt 2 by Simpson Strong-Tie Co., Inc.
      d. Red Head Trubolt+ or Trubolt Wedge Anchor by ITW Commercial Construction
   2. Usage: In concrete
      a. 316 Stainless Steel
      b. Do not use when submerged or subjected to dynamic loads.

B. Adhesive Anchors:
   1. Manufacturers:
      a. HIT RE-500-V3 or HIT-HY 200-A by Hilti Corp.
      b. AC100+ Gold or PE 1000+ by Powers Fasteners
      c. AT or SET-XP Epoxy Adhesive System by Simpson Strong-Tie Co., Inc.
      d. Red Head Epcon S7, A7, G5 or C6 Adhesives by ITW Commercial Construction
   2. Epoxy adhesive with 316 Stainless steel stud assembly.
   3. Usage:
      a. In concrete, submerged
      b. Do not use in overhead applications

C. Screw Anchors:
   1. Manufacturers:
      a. Kwik-Con II or Kwik HUS / HUS-EZ by Hilti Corp.
      b. Wedge-Bolt+ or Tapper+ by Powers Fasteners
      c. Titen or Titen HD by Simpson Strong-Tie CO., Inc.
      d. Red Head Tapcon or Large Tapcon (LDT) anchors by ITW Commercial Construction
   2. Stainless steel concrete screw with hex head.
   3. Usage:
      a. In concrete, only where noted

2.3 FINISHES

A. Galvanizing Repair Paint: High zinc-dust content paint complying with MIL-P-21035

2.4 FABRICATION

A. Except as otherwise shown on the Drawings or the approved Shop Drawings, use materials of size, thickness, and type required to produce reasonable strength and durability in the work of this Section.

B. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection.

C. Fabricate with accurate angles and surfaces which are true to the required lines and levels, with projecting corners clipped, grinding exposed welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.

D. Weld shop connection and bolt or weld field connections.

E. Prior to shop painting or priming, properly clean metal surfaces as required for the applied finish and for the proposed use of the item. Conform to Section 09900.
   1. Do not coat ferrous metal surfaces embedded in concrete.
   2. Coating of cast iron or ductile iron floor access hatches and pressure relief valves not required.

3. On surfaces inaccessible after assembly or erection, apply two coats of the specified primer. Change color of second coat to distinguish it from the first.
4. Coat aluminum surfaces in contact with concrete in accordance with AA and Section 09900. Under no circumstances shall aluminum contact dissimilar metal.

F. Galvanizing:
1. Galvanize after fabrication.
2. Galvanize by hot-dip process conforming to ASTM A123 and AHDGA specifications.

2.5 ALUMINUM HANDRAIL

A. Handrail and railing shall meet requirements of OSHA and local building code

B. Provide end products of one manufacturer to achieve standardization of appearance

C. Materials:
1. Rails, posts, and formed elbows: 1-1/2 inch diameter schedule 40 aluminum pipe (1.90 inch outside diameter, 0.145 inch wall thickness) allow 6063-T6
2. Fittings:
   a. Riveted type fabricated from material similar to rails and posts
   b. Connections shall be continuous type to permit sliding of hands.
   c. Fittings for open railing extensions shall be welded construction and welded to posts to comply with OSHA loading requirements. Welds shall be ground smooth and finished to match adjacent finish.
   d. Base plates and side mounted flanges shall be aluminum or stainless steel.
3. Toe Plate shall be ¼ inch by 4 inch flat aluminum plate or manufacturer's standard z-type toe plate, alloy 6063-T6
4. Mechanical fasteners shall be stainless steel.

D. Finishes:
1. Clear satin anodized finish
   a. Extruded components: 0.7 mil
   b. Cast components: 0.4 mil

E. Fabrication
1. Use materials of size thickness, and type required to produce required strength and durability.
2. Fabricate with accurate angles and surfaces which are true to the required lines and levels, grinding welds smooth and flush, forming exposed connections with hairline joints, and using concealed fasteners wherever possible.
3. Form connections and changes in direction by using prefabricated fittings or radius bends.
4. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces
5. Remove burrs from exposed cut edges
6. Close pipe ends using prefabricated fittings

7. Fabricate joints of exterior units to exclude water or provide weep holes where water may accumulate
8. Provide base flange or side mounted base plate.
9. Coat surfaces to be in contact with concrete with bituminous paint

2.6 LADDERS

A. Ladders shall conform to OSHA and local building code safety requirements

B. Construct from stainless steel or hot dip galvanized steel as noted on Drawings
   1. Stringers: 3-1/2 inch by 3/8 inch bar
   2. Rungs: 1 inch diameter rod.
   3. Other materials shall be minimum ¼ inch thick
   4. Weld rungs to stringers
   5. Fabricate brackets for fastening ladders to wall, weld to ladder.

C. Safety Devices:
   1. Unless otherwise noted, equip ladders over 10 feet tall with aluminum safety climbing devices as manufactured by TS Products, Inc.
      a. Safety rail shall be TS rail
      b. 2 TS trolleys at each ladder
      c. 10TS safety belts, Verify size with Owner
      d. 1 TS ice guard for each exterior ladder
      e. TS removable extension safety rail extensions on ladders accessible from top. Where permanent installation not possible, provide removable extension. Position extension on brackets near top of ladder so climber can readily install extension.
      f. Safety rail climbing devices shall allow worker to operate freely in normal climbing position during ascent or descent. Device shall enable worker to be attached to device during climb without having to remove hands from ladder to operate system effectively, and be able to easily pivot onto and off work platforms or landings while safely attached to device.

D. Where noted on Drawings provide retractable safety post extension at top of ladder
   1. Bilco LadderUP model LU-3 or accepted substitution.

2.7 ACCESS HATCHES

A. Prefabricated Surface Mount Type:
   1. Manufacturers:
      a. Bilco type SM
      b. Halliday Series F-R
   2. Provide aluminum access hatches and frames of type and size shown on Drawings
   3. Door leaves shall be 1/8 inch minimum diamond pattern plate with reinforcing on underside to withstand live load of 105 pounds per square foot and shall have 90 degree return flange around perimeter

4. Frames shall be ¼ inch minimum thick raised style for surface mounting flange set in sealant.
5. Equip hatches with stainless steel hinges
6. Equip hatches with hold-open arm with positive locking device with conveniently positioned release handle for easy and controlled closing
7. Provide exterior 316 stainless steel pad lock lug and pressure locks
8. Provide ¼ inch neoprene compression gasket at underside of cover.
9. Hardware shall be stainless steel
10. Factory finish on aluminum surfaces shall be mill finish with bituminous coating applied to surfaces in contact with concrete
11. Manufacturer shall warranty in writing against defects in material and workmanship for 5 years

2.8 MISCELLANEOUS ITEMS

A. Fabricate miscellaneous framing, supports, and items of structural shapes, plates, bars, and tubing or sizes and arrangements indicated and as required.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Set work accurately into position, plumb, level, true and free from rack.
   2. Tolerance: 1/8 inch in 10 feet
   3. Anchor firmly into position
   4. Where field welding is required, comply with AWS recommended procedures for appearance and quality of weld and for methods to be used in correction welding work.
   5. Grind exposed welds smooth, and touchup shop prime coats.
   6. Do not cut, weld, or abrade surfaces which have been hot-dip galvanized after fabrication and which are intended for proper installation. Drill field holes for bolts, for not burn holes.
   7. Perform cutting, drilling, and fitting as required for proper installation. Drill field holes for bolts, do not burn holes.
   8. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint the exposed areas with same material used for shop priming.

B. Concrete Anchors:
   1. Do not install until concrete or masonry has reached design strength.

2. Do not install closer than 6 bolt diameters to edge of concrete or masonry, or closer than 12 bolt diameters to another anchor unless noted otherwise.
3. Minimum embedment shall be 8 bolt diameters unless noted otherwise.
4. Install in accordance with manufacturer's recommendations.

3.3 ALUMINUM HANDRAIL AND RAILING

A. Assemble and install in accordance with manufacturer's written instructions.

B. Set posts plumb and align in each direction to within 1/8 inch in 10 feet

C. Provide expansion joints in rails and toe plate at 30 feet maximum on center. Locate within 12 inches of post

D. Support handrail on brackets having 2 inch clearance between handrail and wall spaced not more than 5 feet on center and within 12 inches of each end of rail. Return handrail ends to within ½ inch of wall.

E. Provide toe plate except on stairs where concrete curb provided, and on top of walls that project above grade where foot traffic is not feasible.

F. Bolt to top of concrete or stair stringers. Bolt to side of platform framing.

3.4 ADJUSTING AND CLEANING

A. Clean exposed surfaces, removing dirt, dust, and other foreign matter.

B. Prepare surfaces for finished painting as specified in Section 09900

C. Field repair of damaged galvanized coatings:
1. Repair surfaces damaged during shipping, erection, or construction operations.
2. Use zinc rich paint
3. Prepare surfaces and apply in accordance with ASTM A780, Annex A2.

END OF SECTION

SECTION 07920

JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY

A. Preparation of joint substrates and installation of joint sealants, joint backer materials and accessories needed to ensure a complete and durable weathertight seal at locations indicated.

1.2 REFERENCES

A. ASTM: American Society for Testing and Materials

B. NSF: National Sanitation Foundation

C. USDA: United States Department of Agriculture

1.3 SUBMITTALS

A. Product Data:
   1. Manufacturer's specifications and other data needed to prove compliance with the specified requirements.
   2. Manufacturer's recommended installation procedures.
   3. Catalog illustrations in sufficient detail to show installation and interface of the Work of this Section with the Work of adjacent trades.
   4. Standard color card showing full range of colors available for each product exposed to view.

B. Miscellaneous:
   1. Written documentation of applicator's qualifications, including reference projects of similar scope and complexity, with current phone contacts of engineers and owners for verification.
   2. Certification from sealant manufacturers that their products are suitable for the use indicated and comply with specification requirements.

C. Submit in accordance with Section 01340.

1.4 QUALITY ASSURANCE

A. Applicator shall be approved by sealant manufacturer and shall have at least three years' experience in installing materials of types specified and shall have successfully completed at least three projects of similar scope and complexity.

B. Obtain joint sealants from single manufacturer for each different product required to ensure compatibility.

1. Provide joint sealants, joint fillers and accessory joint materials that are compatible with one another and with joint substrates under Project conditions.
2. Provide joint sealants, joint fillers and related joint materials that are nonstaining to visible joint surfaces and surrounding substrate surfaces.
3. Manufacturer shall instruct applicator in procedures for intersecting sealants.

C. Perform Work in accordance with ASTM C-1193 guidelines except where more stringent requirements are indicated or specified.

D. Schedule applications of waterproofing, water repellents, and preservative finishes after sealant installation unless sealant manufacturer approves otherwise in writing. Ensure that installed sealant is allowed to cure sufficiently prior to subsequent applications.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver the materials to Site in the manufacturer's unopened containers with all labels intact and legible at time of use.

B. Maintain the products in a dry condition during delivery, storage, handling, installation, and concealment.

1.6 SUBSTRATE CONDITIONS

A. Surfaces shall be broom clean, dry, sound, and free of voids, bugholes, rockpockets, honeycombs, protrusions, excessive roughness, foreign matter, frost, ice, and other contaminants which may inhibit application or performance of the sealant system.

B. Provide joints properly dimensioned to receive the approved sealant system.

1.7 WARRANTY

A. Furnish written warranties against adhesive and cohesive failure of the sealant and against infiltration of water and air through the sealed joint for a period of 3 years from date of substantial completion.
1. Manufacturer's standard warranty covering materials.
2. Installing Subcontractor's standard warranty covering workmanship.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sika.

B. Or Equal.

2.2 SEALANTS

A. The sealant products listed are set as a standard of quality. Sealants of other manufacturers shall meet or exceed the characteristics of the products listed.

B. Sealant must be NSF 61 certified.

C. Provide colors selected by Engineer from manufacturer's standard color range.

D. Sealant Type A:
   1. For interior and exterior joints in vertical surfaces and horizontal surfaces in concrete tanks containing potable water.
   2. Acceptable Systems:
      a. Sika - 1a

2.3 ACCESSORIES

A. Joint Cleaner: As recommended by sealant manufacturer for substrates indicated.

B. Joint Primer: As recommended by sealant manufacturer for substrates, conditions and exposures indicated.

C. Bond Breaker: Polyethylene tape or other adhesive faced tape as recommended by sealant manufacturer to prevent sealant contact where it would be detrimental to sealant performance.

D. Joint Backer: Polyethylene foam rod or other compatible non-waxing, non-extruding, non-staining resilient material in dimension 25% to 50% wider than joint width as recommended by sealant manufacturer for substrates, conditions and exposures indicated.

E. Masking Tape: Non-staining, non-absorbent tape product compatible with joint sealants and adjacent joint surfaces that is suitable for masking.

2.4 2.04 OTHER MATERIALS

A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor and approved by the sealant manufacturer as compatible, subject to the approval of the Engineer.

PART 3 EXECUTION

3.1 SURFACE CONDITIONS

A. Examine the areas and conditions under which Work of this Section will be performed.
   1. Verify conformance with manufacturer's requirements.
   2. Report unsatisfactory conditions in writing to Engineer.
   3. Correct conditions detrimental to timely and proper completion of the Work.
   4. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Prepare surfaces to receive sealants in accordance with sealant manufacturer's instructions and recommendations except where more stringent requirements are indicated.

B. Thoroughly clean joint surfaces using cleaners approved by sealant manufacturer whether primers are required or not.
   1. Remove all traces of previous sealant and joint backer by mechanical methods, such as by cutting, grinding and wire brushing, in manner not damaging to surrounding surfaces.
   2. Remove paints from joint surfaces except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer.
   3. Remove wax, oil, grease, dirt, film residues, temporary protective coatings and other residues by wiping with cleaner recommended for that purpose. Use clean, white, lint-free cloths and change cloths frequently.
   4. Remove dust by blowing clean with oil-free, compressed air.

C. Provide joint backer material to depth required by sealant manufacturer for proper joint design.
   1. Fit securely by compressing backer material 25% to 50% so no displacement occurs during tooling.
   2. Avoid stretching or twisting joint backer.

D. Provide bond-breaker where indicated or recommended by sealant manufacturer, adhering strictly to the manufacturer's installation requirements.

E. Prime joint substrates where required.
   1. Use and apply primer according to sealant manufacturer's recommendations.
   2. Confine primers to sealant bond surfaces; do not allow spillage or migration onto adjoining surfaces.

F. Taping:
   1. Use masking tape where required to prevent sealant or primer contact with adjoining surfaces that would be permanently stained or otherwise damaged by such contact or the cleaning methods required for removal.
   2. Apply tape so as not to shift readily and remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION

A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the Work of this Section.

B. Provide the approved sealant system where shown on the Drawings, and in strict accordance with the manufacturer's recommendations as approved by Engineer.

C. Install sealants immediately after joint preparation.

D. Mix and apply multi-component sealants in accordance with manufacturer's printed instructions.

E. Install sealants to fill joints completely from the back, without voids or entrapped air, using proven techniques, proper nozzles and sufficient force that result in sealants directly contacting and fully wetting joint surfaces.

F. Install sealants to uniform cross-sectional shapes with depths relative to joint widths that allow optimum sealant movement capability as recommended by sealant manufacturer.

G. Tool sealants in manner that forces sealant against back of joint, ensures firm, full contact at joint interfaces and leaves a finish that is smooth, uniform and free of ridges, wrinkles, sags, air pockets and embedded impurities.
   1. Dry tooling is preferred; tooling liquids that are non-staining, non-damaging to adjacent surfaces and approved by sealant manufacturer may be used if necessary when care is taken to ensure that the liquid does not contact joint surfaces before the sealant.
   2. Provide concave tooled joints unless otherwise indicated to provide flush tooling or recessed tooling.
   3. Provide recessed tooled joints where the outer face of substrate is irregular.

H. Remove sealant from adjacent surfaces in accordance with sealant and substrate manufacturer's recommendations as work progresses.

I. Protect joint sealants from contact with contaminating substances and from damages. Cut out, remove and replace contaminated or damaged sealants, immediately, so that they are without contamination or damage at time of Substantial Completion.

END OF SECTION

SECTION 09900

COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Coating of surfaces as specified herein, including:
   1. Exposed interior and exterior ferrous metal, ductile iron, or cast iron piping, regardless of factory-applied finish.
   2. Exterior and interior equipment, pumps, valves, motors, etc. and all appurtenances.

B. Do not coat the following unless specifically noted otherwise:
   1. Factory-finished electrical motor control panels (MCC), main instrument panels (MIP), flow indicators, and related equipment.
   2. Moving parts of operating units, electrical parts, linkages, sensing devices, and motor shafts.
   3. Buried equipment and piping.
   4. Surfaces above ceilings.
   5. Factory-finished trim.
   6. Stainless steel, chrome plate, copper, bronze, galvanized surfaces, and similar finished materials.
   7. Aluminum louvers and trim.
   8. Concrete tanks.
   9. Plastic and FRP piping, equipment, and ductwork.

C. Do not coat over any code-required labels such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.

D. Equipment manufacturers are responsible for surface preparation and coating of equipment, motors, and appurtenances. Equipment to be coated and coating system is identified in the equipment specification sections.

1.2 DEFINITIONS

A. Definitions as used in Coating Schedule included herein.
   1. Coatings: Paint or heavy duty finishes for use on surfaces subject to interior and exterior exposure, submergence, high moisture, splash, or chemical environment, including primers, sealers, fillers, and intermediate and finished coats.
   2. Submerged P: Surfaces submerged in potable water plus 1 foot-6 inches above high water level.
   3. First Coat: Field primer, factory primer, or shop primer. When only one coat is required, first coat is the finished coat.
   4. Second, Third, or Intermediate Coats: Successive finished coats applied over first coat.
   5. DFT: Dry film thickness (mils/coat).

6. sfpg: Square feet per gallon (per coat).

1.3 REFERENCES

A. MSDS: Material Safety Data Sheets

B. ASTM: American Society for Testing and Materials

C. SSPC: The Society for Protective Coatings

D. OSHA: Occupational Safety and Health Administration

E. NSF: National Sanitation Foundation

1.4 SUBMITTALS

A. Product Data:
   1. Manufacturer's literature including application recommendations and generic makeup for each coating scheduled.
   2. Factory or shop-applied primer manufacturer's literature including application recommendations and generic makeup shall be submitted with all material and equipment submittals. All primers shall conform to the requirements of this Section.

B. Samples:
   1. Actual color samples available for each coating scheduled.

C. Miscellaneous:
   1. Schedules:
      a. Schedule of proposed coating systems within 60 days after Notice to Proceed.
      b. Schedule of proposed coating systems shall contain all information as indicated in Coating Schedule included herein.
   2. Submit one copy of manufacturer's MSDS, for each type of coating, to Engineer's field office for information. Contractor shall post copy of MSDS on Site at all times coating is in progress.

D. Submit in accordance with Section 01340.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. All coatings shall conform to OSHA requirements for allowable exposure to lead and other hazardous substances.
   2. All coatings in contact with potable water or within potable water reservoirs shall be NSF 61 approved.

B. Applicator Qualifications:
   1. Engage an experienced field applicator with a minimum of 5 yrs successful experience and who has successfully completed coating system applications similar in material and extent to those indicated.

C. Single-Scource Responsibility:
   1. Provide coating material produced by same manufacturer for each system.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be delivered to site in original containers with labels intact and seals unbroken.

B. Protect and heat or cool material storage location to maintain temperature ranges recommended by coating manufacturers, but not less than 55° F.

C. Avoid danger of fire. Oily rags and waste must be removed from buildings each night or kept in appropriate metal containers. Provide fire extinguishers of type recommended by coating manufacturer's in areas of storage and where finishing is occurring. Allow no smoking or open containers of solvent.

D. Empty containers shall have labels canceled and clearly marked as to use.

1.7 PROJECT / SITE CONDITIONS

A. Environmental Requirements:
   1. Dry-heat and ventilate areas to obtain conditions recommended by coating manufacturer.
   2. Relative humidity conditions as specified by coating manufacturer shall be adhered to.
   3. No unprotected, unheated exterior coating shall be undertaken when cold, damp, foggy, or rainy weather appears probable, nor when the temperature of the substrate is below 55° F, unless approved in writing by coating manufacturer.
   4. Maintain manufacturer's environmental requirements until coating is fully cured.
   5. Apply no coating in areas where dust is being generated.
   6. Testing and disposal of any waste and coating shall be the responsibility of the Contactor.

B. Protection:
   1. Drop cloths shall be provided in all areas where coating is done to fully protect other surfaces.
   2. Remove hardware, accessories, plates, lighting fixtures, and similar items or provide protection by masking. Upon completion, replace items or remove protection and clean.

C. It is the intent of this Section that all ferrous metal items scheduled for coating be shop-primed. If items are not shop-primed, surfaces shall be prepared and coated in the field as specified.

D. Upon Substantial Completion, remaining unused material will become property of Owner. Seal material as required for storage, mark contents with color (name and color code), type, location, and shelf life, and store on Site where required by Owner. Provide minimum of two gallons of each system component and color used.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Tnemec.

B. Sherwin Williams.

2.2 MATERIALS

A. Coatings shall meet surface burning characteristics as required by code and established by ASTM E84.

B. Coating products of Tnemec or Sherwin Williams, listed in the Coating Schedule, are set as a standard of quality. Coatings of substitute manufacturers shall meet or exceed the characteristics of the products listed as established by the following ASTM standards; B117, C307, C413, C579, C580, C868, D870, D1014, D1653, D2047, D2240, D2370, D2794, D3363, D4060, D4141, D4541, D4585, D4587, and G85.

C. If the Contractor wishes to offer a substitute to the Tnemec or Sherwin Williams products specified, the request for a substitute shall conform to the requirements of Section 01615.

D. The Contractor and top coat coating manufacturer shall verify the compatibility of their products with the various primers used on shop primed materials and equipment.

2.3 COLORS

A. Color shall be formed of pigments free of lead, lead compounds, or other materials which might be affected by presence of hydrogen sulfide or other gases likely to be present at Site.

B. Colors shall be as selected by Owner.

C. Coat access doors of electrical distribution panels and grilles to match color of adjacent wall or ceiling surfaces.

D. In areas scheduled for finishing, coat exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding.

E. In areas where existing surfaces are finished, coat new exposed piping, conduit, and ducts to match color of adjacent or near surfaces, except for color-coding.

F. Equipment Colors:
   1. Equipment includes pumps, blowers, valves, flow meters, etc, and associated motors, structural supports, hangers, and attached portions of electrical conduit, and other associated components.
   2. Color of non-submerged equipment, including equipment with a manufacturer-applied finish coat, shall be same color as piping equipment serves.

3. Color of submerged equipment can be manufacturer's standard color.

2.4 THINNING, MIXING, AND TINTING

A. Where thinning is necessary, only the products of the manufacturer furnishing the coating will be allowed. All such thinning shall be done in strict accordance with coating manufacturer's recommendations.

B. Mix in accordance with manufacturer's recommendations.

C. Each coat shall be slightly darker than preceding coat, unless otherwise noted. Tint undercoats similar to finish coat.

PART 3 PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine the areas and conditions under which Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Materials removed and replaced to correct defects due to Work placed on unsuitable surfaces shall be at Contractor's expense.

3.2 SURFACE PREPARATION

A. All surfaces to be coated shall be prepared as specified herein and in accordance with coating manufacturer's recommendations. The object shall be to obtain a uniform, clean, and dry surface.

B. Quality of surface preparation described herein is considered a minimum. If coating manufacturer requires a higher degree of preparation, comply with coating manufacturer's recommendations.

C. Where surface dryness is questioned, test with dampness indicating instrument. Do not apply coatings over surfaces where moisture content exceeds that permitted by coating manufacturer.

D. Shop primed surfaces shall be scarified before applying top coats. Conform to top coat manufacturers recommendations.

E. If recoat time between application of primer and second coat or between top coats is exceeded, scarify surface before applying coatings. Conform to top coat manufacturers recommendations.

F. Workmanship for surface preparation shall conform to the following SSPC specifications:
   a. Solvent Clean: SP-1.
   b. Hand Tool Cleaning: SP-2.
   c. Power Tool Cleaning: SP-3.

d. White Metal Blast Cleaning: SP-5.
e. Commercial Blast Cleaning: SP-6.
f. Brush-Off Blast Cleaning: SP-7.
g. Near-White Blast Cleaning: SP-10.

G. Ferrous Metal:
1. Ferrous metal primed in the shop shall have all rust, dust, scale, and other foreign substances removed by abrasive cleaning conforming to SSPC SP-10. Cleaned metal shall be primed or pretreated immediately after cleaning to prevent new rusting.
2. Ferrous metal not primed in the shop shall be abrasive blast cleaned in the field prior to application of primer, pretreatment, or coating. Blast cleaning shall conform to SSPC
SP-10 for submerged service. Blast cleaning shall conform to SSPC SP-6 for non-submerged service.
3. Prior to finish coating, primed areas that are damaged shall be cleaned and spot primed.

3.3 APPLICATION

A. Surfaces shall be dry at time of application.

B. The minimum surface temperature shall be 55°F and rising. Some coatings are modified so that they may be applied at lower temperatures, conform to manufacturer's recommendations.

C. Apply in strict accordance with manufacturer's recommendations by brush, roller, spray, or other application method. The number of coats and thickness required is the same regardless of application method.

D. Each coat shall be allowed to dry in accordance with manufacturer's requirements. Drying time shall be construed to mean "under normal conditions". Where conditions other than normal exist, because of weather or because of confined space, longer times will be necessary. Units shall not be put in service until coatings are thoroughly dry and cured.

E. Surfaces to be coated that will be inaccessible in the completed work shall receive the final coat before enclosure.

F. Coatings shall be applied to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable. Areas cut-in by brush prior to rolling shall have uniform appearance in comparison with adjoining surfaces.

G. Make edges of coating adjoining other materials or colors sharp and clean without overlapping.

H. Crevices and other hard-to-apply areas shall be back-rolled/back-brushed in conjunction with application of field applied prime coat or intermediate coat. This includes, but is not

limited to: between pipe flanges, pipe flange/barrel joints, equipment fittings, and other narrow openings.

I. Manufacturer-Applied Coatings:
   1. Repair abraded areas on factory-finished items in accordance with equipment manufacturer's recommendations.
   2. Blend repaired areas into original finish.

3.4 FIELD QUALITY CONTROL

A. Examination of Work on Site by coating manufacturer's representative shall be performed when requested by Engineer.

B. Sampling of Materials:
   1. Engineer reserves the right to select unopened containers of materials furnished for the Project and have the materials tested at an independent laboratory. Owner will pay for first tests.
   2. Retests of rejected materials and tests of replacement materials shall be paid for by Contractor.
   3. Remainder of contents of containers not required for testing will be returned to Contractor.

C. Coverage:
   1. 1. Before beginning Work, finish one complete room, space, surface, and item of each color scheme required, showing selected colors, finished texture, material, and workmanship. After approval, sample room, space, surface, and item shall serve as standard for similar Work.
   2. 2. If coverage is not acceptable to Engineer, Engineer reserves the right to require additional application of coating at no extra cost to Owner.

D. Where coatings are to be applied at the Site, Engineer reserves the right to observe the Work. After surface has been prepared and before application of specified prime coat and each succeeding finish coat, Contractor shall provide three days notice to Engineer to allow the Engineer time to observe the Work. If notification is not provided, no credit for applied coat will be given and Contractor automatically assumes responsibility to recoat Work in question. Surfaces coated without notification shall be abrasive blast cleaned, re-prepared, and recoated at no addition cost to Owner.

3.5 FINAL TOUCH-UP AND CLEANING

A. Prior to Substantial completion, examine coated surfaces and retouch or refinish surfaces to leave in condition acceptable to Engineer.

B. Remove masking, coatings, and other material from floors, glass, and other surfaces not scheduled to be coated.

3.6 COATING SCHEDULE

A. Scheduled thickness or coverage rate is minimum as recommended by Tnemec. If other manufacturer is used, manufacturer's recommendations shall be followed, but in no case shall the thickness or coverage rate be less than scheduled.

B. Coatings shall conform to the following schedule and coating manufacturer's recommendations. Examples of surfaces to be coated may not be all inclusive.

COATINGS SCHEDULE

System No.	Application	Tnemec Coating System	Sherwin Williams Coating System
9	Ferrous Metal, Cast Iron, Ductile Iron / Exterior Non-Submerged / Gloss	First Coat – Series 1 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Series V69 @ 5 mils DFT Third Coat – Series 1094U @ 3 mils DFT	First Coat – Macropoxy 646 @ 3 mils DFT, touch-up primer prior to second coat Second Coat – Macropoxy 646 @ 5 mils DFT Third Coat – Hi-Solids Polyurethane 250 Gloss @ 3 mils DFT
20	Dissimilar Metal Protection / Semi-Gloss	Scarify the Surface, SP-1 First Coat – Series 46H-413 @ 16 mils DFT	Scarify the Surface, SP-1 First Coat – TarGuard @ 16 mils DFT
32	Steel/ Submerged P/ Interior	**Interior Overhead Structural Steel and Ceiling Primer to High Water Level**: Apply 1 coat of Tnemec 91-H20 Hydro-Zinc at 2.5-3.5 mils DFT. **Interior Wet Area Primer:** Apply 1 coat of Tnemec FC20HS-1255/20HS-1255 (Beige) Pota-Pox at 4.0- 6.0 mils DFT. **Overhead 2nd Coat:** Apply 1 coat of Tnemec FC20HS-1255/20HS-1255 (Beige) Pota-Pox at 4.0- 6.0 mils DFT. **Finish Coat, All areas:** Apply 1 coat of Tnemec FC20HS-15BL/20HS-15BL (Tank White) Pota-Pox at 4.0-6.0 mils DFT. Total Dry Film Thickness Interior OH: 10.5-15.5 mils Total Dry Film Thickness Interior Wet Areas: 8.0-12.0 mils	**Primer:** Corothane I Galvapac Zinc-rich Primer at 2.0-4.0 mils DFT **2nd Coat:** Macropoxy 5500LT Potable Water Epoxy with Opti-Check OAP pigment Technology at 4.0-8.0 mils DFT **Finish Coat:** Macropoxy 5500LT Potable Water Epoxy at 4.0-8.0 mils DFT

Foot Notes:

1. Tnemec Series N66HS may be substituted for Series 1.

END OF SECTION

SECTION 13210

GLASS LINED BOLTED STEEL TANK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. If Bid Alternate tank is selected, furnish and erect a glass lined, bolted steel tank and appurtenances, including cast-in place concrete foundation, as designed by manufacturer and specified herein.

B. Tank shall be designed for long-term storage of raw water.

1.2 REFERENCES

A. ASCE: American Society of Civil Engineers

B. ACI: American Concrete Institute

C. AISC: American Institute of Steel Construction

D. AWWA: American Architectural Manufacture's Association

E. ASTM: American Society for Testing and Materials

F. NSF: National Sanitation Foundation

G. OSHA: Occupational Safety and Health Administration

H. SSPC: Society for Protective Coatings

1.3 RELATED SECTIONS

A. Section 01340 – Shop Drawings, Product Data, and Samples

1.4 SUBMITTALS

A. General:
   1. Submit Product Data and Shop Drawings in sufficient detail to confirm compliance with requirements of this Section. Submit Product Data and Shop Drawings in one complete submittal package. Partial submittals will not be reviewed.

B. Shop Drawings and Product Data:

   1. Submit shop drawings and product data for foundation and all tank system components. Shop drawings and product data shall include the following features:

a. Manufacturer's specification data, descriptive literature, and construction drawings.
b. Tank capacity and dimensions as specified.
c. Structural calculations for tank structure and foundation.
d. Penetrations and attachment locations as specified as specified and shown on Drawings.
e. Proposed coatings and compatibility with liquid stored.
f. Statement that fabrication is in accordance with these Specifications.
g. Recommended procedures for job site storage, handling, installation, and start-up.
h. Detailed layout and other drawings required for proper installation.
i. Procedures for proper installation.
j. Manufacturer's warranty.
k. Location of parts-supply facilities, service crews, and repair facilities.
l. Shop Drawings and calculations shall be sealed by a professional engineer registered in the State of Colorado.

C. Submit above in accordance with Section 01340.

D. Operation and Maintenance (O&M) Data:
1. Submit in accordance with Section 01730.
2. Operation and maintenance manual submittal shall be complete in one comprehensive submittal. Individual submittals for components of systems will not be reviewed.
3. Start-up of system will not be permitted until O&M Data has been submitted and approved by Engineer. The submittal shall include any field modifications.

1.5 DESIGN REQUIREMENTS

A. Tank Dimensions:
1. Nominal Tank Volume: 30,000 gallons
a. High water level (operational range max): 5388.50
b. Low water level (operational range min): 5380.00
c. Minimum water depth: 3 feet
2. Nominal Tank Diameter: 24 feet
1. Nominal Liquid Depth: 11 feet 6 inches
2. Nominal Freeboard: 2 feet

B. Design Loads:
1. Specific Gravity: 1.05
2. Process Load: 62.4 per cubic feet
3. Snow Load: ASCE 7
a. Ground Snow Load: 30 pounds per square foot
b. Ce: 0.9
c. Ct: 1.0
d. Snow Importance Factor: 1.1
4. Wind Load: ASCE 7
a. Vult (3-second gust): 109 miles per hour
5. Platform Live Load: 100 pounds per square foot or 1,000 pounds concentrated.

6. Seismic Load: ASCE 7
    a. Soil Site Class: D
    b. Seismic Importance Factor: 1.25
    c. S_S: 0.249g
    d. S_{DS}: 0.265g
    e. S_1: 0.066g
    f. S_D: 0.105g

C. Tank Foundation:
    1. The tank manufacturer shall design the tank foundation to conform to ACI 350 requirements and to safely sustain the structure and its live loads.
    2. The dimensions and reinforcement shown on the drawings shall be considered the minimum required.
    3. Net Allowable Soil Bearing Pressure: 1,500 pounds per square foot. (assumed)

D. Design Criteria:
    1. Tank design shall conform to AISC and AWWA D103 requirements.
    2. The annealing effect created from the glass coated firing process shall be considered in determining ultimate steel strength. In no event shall a yield strength greater than 50,000 pounds per square inch be used for calculations detailed in AWWA D103.
    3. Multiple vertical bolt line holes in sheets and plates of high strength steel shall be manufactured such that the holes are staggered in the vertical bolt lines and that no two adjacent holes are in line horizontally, except at the center of the sheet or plate.
    4. Intermediate horizontal wind stiffeners shall be hot dipped galvanized steel of "web-truss" design. Rolled steel shape intermediate horizontal stiffeners are not permitted.
    5. Tank shall be designed to accept and support manufactured knuckle style roof system.

1.6 QUALITY ASSURANCE

A. Supplied by tank manufacturer specializing in the design, fabrication, and erection of factory applied glass-fused-to-steel, bolted together tank systems.

B. Tank materials, fabrication, and erection shall conform to AWWA D103.

C. Tank shall be erected by tank supplier or Subcontractor approved by tank manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Heavy paper or plastic foam sheets shall be placed between each tank panel to eliminate sheet to sheet abrasion during shipment.

B. Individual stacks of tank panels shall be wrapped in heavy black plastic and steel banded to special wood pallets built to the roll-radius of the rank panels.

C. Unload and handle in accordance with manufacturer's instructions.

D. Store on site on suitable blocking above ground.

1.8 WARRANTY

A. Manufacturer shall warranty in writing the glass coating system against chips, cracks, spalls, or undercuts and against defects in material and workmanship for a period of 5 years from substantial completion.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Aquastore Tank as Manufactured by CST Storage.

B. No Substitutes

2.2 MATERIALS

A. Plates and Sheets:
   1. Shall conform to AISC and AWWA D103 requirements.
   2. Minimum thickness: 1/4 inch.
   3. Mild Steel: ASTM A570, Grade 30, maximum allowable tensile stress 18,000 pounds per square inch.
   4. High-Strength Steel: ASTM A607, Grade 50, max allowable tensile stress 30,000 pounds per square inch.
   5. The annealing effect created from the glass coated firing process shall be considered in determining ultimate steel strength. In no event shall a yield strength greater than 50,000 pounds per square inch be used for calculations detailed in AWWA D103 Sections 3.4 and 3.5.
   6. When multiple vertical bolt line sheets and plates of ASTM A607, Grade 50 are used, the effective net cross section area shall not be taken as greater than 85% of the gross area.

B. Structural Shapes: ASTM A36 or A992.

C. Coating:
   1. Manufacturer's standard fusion bonded glass lining.
   2. Tank coating system shall conform solely to AWWA D103 Section 10.4.
   3. Finished interior color: White.
   4. Finished exterior color: Colors shall be as selected by Owner

D. Bolts/Nuts/Washers:
   1. Bolts used in tank lap joints shall be minimum 1/2 inch 13 UNC-2A rolled threaded, and shall meet AWWA D103, Section 2.2.
   2. SAE Grade 2 (1 inch length):
      a. Min Tensile Strength: 74,000 pounds per square inch.
      b. Min Proof Load: 55,000 pounds per square inch.
      c. Allowable Shear Stress: 18,164 pounds per square inch.
   3. SAE J429 (1 ¼ inch length):

a. Heat treated.
b. Min Tensile Strength: 120,000 pounds per square inch.
c. Min Proof Load: 85,000 pounds per square inch.
d. Allowable Shear Stress: 36,818 pounds per square inch.

4. SAE J429 (>1 1/4 inch length):
   a. Heat treated.
   b. Min Tensile Strength: 150,000 pounds per square inch.
   c. Min Proof Load: 120,000 pounds per square inch.
   d. Allowable Shear Stress: 29,454 pounds per square inch.
5. Bolts, nuts, and washers shall have 2.0 mil minimum mechanically deposited zinc coating. Coating shall be under bolt heads, on shank, and on heads.
6. Bolt heads shall be encapsulated with high impact polypropylene copolymer resin up to the splines on the bolt shank. Resin shall be stabilized with an ultraviolet light resistant material such that the color shall appear black. Bolt head encapsulation shall be certified to meet ANSI/NSF Standard 61 for indirect additives.
7. Lap joints shall be selected so that the threaded portions will not be exposed to the "shear plane" between tank sheets.
8. Lap joint bolts shall include a minimum of 4 splines on underside of bolt head at shank to resist rotation during torquing.
   a. .0005 in. on threads.
   b. Iridite #3 bronze color coat.

E. Sealant:
1. As recommended by tank manufacturer.
2. One component polyurethane, suitable for contact with wastewater and meeting applicable ANSI/NSF Title 61 requirements.
3. Shall be use to seal lap joints, bolt connections, and edge fillets for sheet notches and starter sheets.
4. Shall cure to rubber like consistency, have excellent adhesion to glass coating, have low shrinkage, and shall be suitable for interior and exterior exposure.
5. Neoprene gasket or tape type sealer shall not be used.
6. Sealant Curing Rate at 70oF and 50% relative humidity:
   a. Tack-free time: 6 to 8 hours
   b. Final cure time: 10 to 12 days

F. Concrete foundation shall conform to requirements of Section 03300.

G. Roof shall be knuckle style roof designed by the tank manufacturer with coatings and fasteners meeting the requirements for the wall panels.

H. Access ladders shall be constructed of aluminum members and access hatch in accordance with OSHA requirements.

I. Provide access manway as shown on drawings and in accordance to AWWA D103. Manway opening shall be a minimum of 36 inches in diameter.

J. Provide pipe penetrations as shown on drawings. Tank shell reinforcing around penetration shall comply with AWWA D103.

K. Provide cathodic protection consisting of sacrificial magnesium anodes. Electrical continuity shall be the responsibility of the tank manufacturer. The design life shall be a minimum of 10 years.

L. Nameplate shall list the tank serial number, tank dimensions, maximum design capacity, intended use, and date of installation.

2.3 FABRICATION

A. Fabricate tank plates and sheets to conform to approved Shop Drawings and AWWA D103 requirements.

B. Following the decoiling and shearing process, plates and sheets shall be steel grit blasted on both sides and all edges to SSPC SP-10.

C. Plates and sheets shall be evenly oiled to protect them from corrosion during the remainder of the fabrication process.

D. Mechanically rounded wall sheets to appropriate diameter. Apply 316 stainless steel coating to exposed sheet edges by an ARC thermal spray to a thickness of 1.5-5.0 mils. The coating shall have an adhesion tensile strength greater than 1,500 psi per ASTM C633. The process shall be equal to EDGECOAT by Engineered Storage Products Co.

E. Sheets shall be fabricated with proper dimension, rolled to proper diameter, bolt seam holes, and manways prior to coating.

F. Prior to application of coating, plates and sheets shall be thoroughly cleaned by caustic wash and hot rinse process followed immediately by hot air drying.

G. After cleaning, plates and sheets shall be examined for traces of debris or rust. Any debris or rust shall be removed by re-cleaning or re-blasting as specified.

H. Plates and sheets shall be shop coated.
   1. One coat of catalytic nickel-oxide glass precoat on both sides and all edges, then air dried.
   2. One coat milled cobalt blue glass on both sides.
   3. A final coat of titanium dioxide reinforced mixture on interior surfaces bottom of bottom plate and all edges.
   4. Fired at a minimum temperature of 1500°F in strict accordance with manufacturer's recommendations.
   5. Dry film interior coating thickness shall be 10.0 to 16.0 mils.
   6. Dry film exterior coating thickness shall be 6.0 to 11.0 mils.

2.4 SOURCE QUALITY CONTROL

A. Coated plates and sheets shall be tested for chemical resistance.

B. Coated plates and sheets shall be tested by low voltage wet sponge holiday test. Inside sheet surfaces shall be holiday free. Any sheet registering discontinuity shall be rejected.

C. Coated plates and sheets shall be inspected for mil thickness.

D. Coated plates and sheets shall be checked for color uniformity by electronic colorimeter.

E. Impact adherence test shall be performed on one sheet per every lot in accordance to ASTM B916-01.

F. Perform fishscale test on one sheet per lot.

G. Notify Engineer sufficiently in advance of testing so that Engineer or Engineer's representative may be present during testing.

PART 3 EXECUTION

3.1 GENERAL

A. Erect tank components in accordance with tank manufacturer's instructions. Take special care in handling and bolting of the tank panels and members to avoid damaging the coating.

B. Select bolts such that the threads are not in the shear plane between the plates and sheets. Provide uniform bolt lengths to achieve a neat appearance, excessive bolt length beyond the nut will not be permitted.

C. Install sealant in accordance with tank manufacturer's recommendations.

D. Install roof structure in accordance with tank manufacturer's recommendations

E. Where pipe connections are shown to pass through tank panels, they shall be field located, sawcut in the panel, and shall have an interior and exterior flange assembly. All edges of sawcut openings in panels and bolt connections shall be sealed as recommended by tank manufacturer. Torch cutting will not be allowed.

F. Install access ladders or stairs and platforms as shown on drawings.

G. Install bolted manway where shown on drawings.

H. Install nameplate on the exterior of the tank approximately 5 feet above grade close to the base of the access ladder.

3.2 FOUNDATION

A. Place reinforced concrete foundation in conformance with the requirements of Section 03300.

B. Bolted steel bottom panels shall be placed over a 3-inch minimum compacted sand base contained by a concrete ring wall.

C. Install the base mounting plate and leveling assembly in accordance with tank manufacturer's recommendations. Provide elastomeric rubber waterstop on inside face below concrete floor line.

3.3 GLASS COATED BOLTED STEEL BOTTOM

A. A plastic encapsulated nut shall be used to cover the bolt threads exposed on the inside of the floor. The plastic encapsulation shall be Noryl GFN2-701 S.

B. Leveling of the starter ring shall be required and the maximum differential elevation within the ring shall not exceed 1/8 inch, and shall not exceed 1/16 inch within any 10 feet of length.

C. Place 6 inch layer of Class B fiber reinforced concrete over the bottom. Concrete shall conform to the requirements of Section 03300.

3.4 SIDE WALL STRUCTURE

A. Bolts shall be installed with the head on the inside of the tank.

B. Specialized erection jacks and building equipment developed and manufactured by the tank manufacturer shall be used to erect the tanks.

C. Particular care shall be taken in handling and bolting of the tank panels and members to avoid abrasion of the coating system. Prior to a liquid test, all surface areas shall be visually inspected by the Engineer.

D. No backfill shall be placed against the tank sidewall without prior written approval and design review of the tank manufacturer. Any backfill shall be placed according to the strict instructions of the tank manufacturer.

3.5 ROOF

A. Tank Roof
   1. Tanks with diameters of 14 to 31 feet (4267 to 9449 mm) shall include a radially sectioned roof fabricated from glass - coated, bolted steel panels, as produced by the tank manufacturer, and shall be assembled in a similar manner as the sidewall panels utilizing the same sealant and bolting techniques, to assure a weather tight assembly. The roof shall be clear - span and self-supporting. Both live and dead loads shall be

carried by the tank walls. The roof shall be of a rolled knuckle design, with no rolled angle connection between sidewall and roof panels.

2. The manufacturer shall furnish a roof opening which shall be placed near the outside tank ladder and which shall be provided with a hinged cover and a hasp for locking. The opening shall have a clear dimension of at least 24 inches (610 mm) in one direction and 15 inches (381 mm) in the other direction. The opening shall have a curb at least 4 inches (102 mm) in height, and the cover shall have a downward overlap of at least 2 inches (51 mm), or a gasketed weather-tight cover in lieu of the 4 inch (102 mm) curb and 2 inch (51 mm) overlap.

B. Roof Vent
   1. A properly sized vent assembly in accordance with AWWA D103 shall be furnished and installed above the maximum water level of sufficient capacity so that at maximum design rate of water fill or withdrawal, the resulting interior pressure or vacuum will not exceed ½ inch (13 mm) water column.
   2. The overflow pipe shall not be considered to be a tank vent.
   3. The vent shall be constructed of aluminum such that the hood can be unbolted and used as a secondary roof access.
   4. The vent shall be so designed in construction as to prevent the entrance of birds and/or animals by including an expanded aluminum screen (½ inch [13 mm]) opening. An insect screen of 23 to 25 mesh polyester monofilament shall be provided and designed to open should the screen become plugged by ice formation.

C. Appurtenances (per AWWA D103)
   1. Pipe Connections
      a. Where pipe connections are shown to pass through tank panels, they shall be field located, saw cut, (acetylene torch cutting or welding is not permitted), and utilize an interior and exterior flange assembly. Tank shell reinforcing shall comply with AWWA D103 latest edition. A single component urethane sealer shall be applied on any cut panel edges or bolt connections.
      b. Overflow piping shall be 20 inches diameter schedule 80 PVC, seamless aluminum tubing, or FRP.
   2. Outside Tank Ladder
      a. An outside tank ladder shall be furnished and installed as shown on the submittal drawings.
      b. Ladder shall be fabricated of aluminum and utilize grooved, skid-resistant rungs.
      c. Safety cage and step-off platforms shall be fabricated of galvanized steel. Ladders shall be equipped with a hinged lockable entry device.
   3. Inside Tank ladder
      a. An inside tank ladder shall be furnished and installed as shown on the submittal drawings.
      b. Ladder shall be fabricated of aluminum and utilize grooved, skid-resistant rungs.
   4. Access Doors
      a. One bottom access door shall be provided as shown on the submittal drawings in accordance with AWWA D103.

b. The manhole opening shall be a minimum of 24 inches (610 mm) in diameter. The access door (shell manhole) and the tank shell reinforcing shall comply with AWWA D103 latest edition, Sec. 5.1.

5. Identification Plate
   a. A manufacturer's nameplate shall list the tank serial number, tank diameter and height, and maximum design capacity. The nameplate shall be affixed to the tank exterior sidewall at a location approximately 5 feet (1524 mm) from grade elevation in a position of unobstructed view.

3.6 FIELD QUALITY CONTROL

A. After the tank erection is complete, the tank shall be inspected by the Engineer.

B. After the Engineer’s inspection is completed the tank shall be tested for leaks.

C. After the tank has been in operation for a period of not less than 6 months or more than 11 months, the tank manufacturer shall visually inspect the tank interior and exterior and appurtenances, and provide a written summary of the inspection.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

A. This section includes basic electrical requirements for materials and methods applicable to electrical equipment specified under this section and other related sections.
   1. Conduit
   2. Boxes
   3. Duct Bank
   4. Wire and Cable
   5. Wiring Devices and Device Plates
   6. Maintenance Materials
   7. Grounding Materials
   8. Luminaries
   9. Power Panels

B. Related Sections:
   1. Section 01340 – Shop Drawings and Product Data

1.2 REFERENCES

A. UL – All applicable standards

B. IEEE – All applicable standards

C. IPCEA – All applicable standards

D. NEMA – All applicable standards

E. ANSI/NFPA 70 – National Electrical Code

F. ANSI C2 – National Electrical Safety Code

G. ANSI/NEMA FB 1 – Fittings and Supports for Conduit and Cable Assemblies

H. ANSI/NEMA OS 1 – Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports

I. ANSI/NEMA OS 2 – Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

J. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum)

1.3 SUBMITTALS

A. Information covering all material that is to be used on this project shall be submitted.

B. Each sheet of descriptive literature shall be clearly marked to identify the material or equipment for which it pertains.

C. Equipment on submitted sheets that is not for this project shall be crossed out.

D. As a minimum the following information shall be submitted:
   1. Lamp fixture descriptive sheets identified by the fixture schedule letter
   2. Equipment sheets shall identify what the equipment refers to by calling out the name of the equipment on the sheet.
   3. Schematics and connection diagrams for all electrical equipment shall be submitted.
   4. Submit all types of conduit and cables with manufacturer and sizes as well as all appurtenances.

1.4 QUALITY ASSURANCE

A. Supplier's qualifications
   1. The entire system shall be designed, coordinated, and supplied by a qualified Electrical Contractor who is regularly engaged in the business of building electrical systems for water and wastewater projects. The Electrical Contractor shall provide a "Statement of Qualifications" indicating that they have successfully provided similar work for at least 5 years.

B. Coordination
   1. The electrical equipment shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufacturer and the manufacturer of related equipment.
   2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
   3. The Contractor shall provide coordination with other contractors and supervision of installation as required during construction.
   4. All service entrance work shall be in accordance with the local utility standards.
   5. The electrical contractor shall coordinate all service entrance work with the local utility. The local utility is Grand Valley Power.
   6. The electrical contractor shall NOT pay for the utility's work. That shall be billed directly to the owner.
   7. Accurately record actual locations of conduit, duct banks, panels, and accessories.

1.5 REGULATORY REQUIREMENTS

A. Conform to applicable Building Code.

B. Electrical: Conform to latest version of NFPA 70.

C. Coordinate, obtain and pay for all permits, inspections and approvals of authority having jurisdiction.

D. Comply with local electrical codes in force or in the absence of local electrical code, the latest edition of the National Electrical Code, ANSI C1.

1.6 WARRANTY

A. The electrical contractor shall warrant the supplied equipment and labor for a period of one year from the date of system acceptance.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. The work for this project is for a functioning city building. All new work shall be done in a way that allows the existing facility to maintain its operation.

B. All equipment furnished under this Section shall be selected by the Contractor for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged, and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
   1. Conduit
      a. Minimum Size: ¾ inch unless otherwise specified, or ½ inch for luminaries pendants.
      b. Underground Installations:
         i) Over 100V: More than five feet from foundation wall: Use thick wall nonmetallic conduit.
         ii) Within five feet from foundation wall: Use rigid steel conduit
         iii) Under 100V: Use rigid steel conduit
         iv) Minimum size: 1 inch.
      c. Outdoor Locations, Above Grade: Use rigid steel conduit.
      d. In Slab Above Grade:
         i) Use rigid steel conduit for circuits that are 24V or less.
         ii) Use rigid thick wall non-metallic conduit for 120V to 480V circuits.
         iii) Maximum Size Conduit in Slab: 2 inch, 1 inch for conduits that cross over each other, or with structural engineer's approval.
         iv) Conduits shall not be spaced closer than 3 conduit widths on center.
         v) Aluminum conduit shall not be embedded in concrete.
         vi) Conduits shall not pass through a structural concrete beam without the structural engineer's approval.
      e. In or under slab on grade:
         i) Use rigid steel conduit for circuits that are 24V or less.
         ii) Use rigid thick wall non-metallic conduit.

f. Wet and damp locations: Use rigid steel conduit or aluminum conduit.
g. Dry locations:
    i) Concealed: In walls or above ceilings, use rigid steel or aluminum conduit.
    ii) Exposed: Use rigid steel conduit or aluminum conduit.
h. Rigid Steel Conduit.
    i) Rigid steel conduit shall be heavy wall, hot-dipped galvanized, and shall conform to Fed Spec WW-C-581 and ANSI C80.1, and shall be manufactured in accordance with UL 6.
i. Rigid Nonmetallic Conduit (PVC).
    i) PVC conduit shall be heavy wall, schedule 40, shall be UL labeled for aboveground and underground uses.
j. PVC-Coated Rigid Steel Conduit.
    i) The conduit shall be rigid steel and before the PVC coating is applied, the hot-dipped galvanized surfaces shall be coated with a primer to ensure a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit at a thickness of at least 40 mils. A two part urethane chemically cured coating shall be applied at a nominal 2 mil thickness to the interior of all conduit and fittings.
    ii) Manufacturers: Ocal, PermaCote, or Robroy Industries.
k. Rigid Aluminum Conduit.
    i) Rigid aluminum conduit shall be heavy wall and shall conform to Fed Spec WW-C-581 and ANSI C80.1, and shall be manufactured in accordance with UL 6.
l. Flexible connections
    i) Conduit: Moisture proof vinyl jacketed, liquid-tight, hot-dipped galvanized flexible steel and shall be UL labeled.
    ii) Connectors: Watertight, Appleton Type ST or STB, Crouse-Hinds Type LT or LTC, or equal.

2. Outlet Boxes
    a. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1, Galvanized.
        i) Luminaries and equipment supporting boxes: rated for weight of equipment supported.
        ii) Concealed installations.
    b. Nonmetallic outlet boxes: ANSI/NEMA OS 2.
    c. Cast Boxes: NEMA FB 1, Type FD, Cast Ferroalloy.
        i) Provide gasketed cover by box manufacturer.
        ii) Provide threaded hubs.
        iii) Models VXF, GRFX as manufactured by Crouse-Hinds.
        iv) Models SEH, JBDX, with mounting lugs as manufactured by Appleton.

3. Pull and Junction
    a. Sheet Metal Boxes: NEMA OS 1, Galvanized Steel.
    b. Surface-Mounted Cast Metal Box: NEMA 250, Type 4 flat-flanged, surface-mounted junction box.
        i) Material: Galvanized cast iron Cast aluminum in corrosive areas.
        ii) Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

iii) Model: WCB as manufactured by Crouse-Hinds.

c. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting.
   i) Material: Galvanized cast iron.
   ii) Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
   iii) Cover Legend: ELECTRIC.
   iv) Model: WPD as manufactured by Crouse-Hinds.

4. Large Junction Boxes and Wiring Gutters
   a. Indoor Locations:
      i) Steel, NEMA 12.
   b. Outdoors:
      i) Stainless steel.
      ii) Weather-tight NEMA 4.
   c. Construction.
      i) Provide rigid handles for box covers larger than 9 sq. ft. or heavier than 25 lbs.
      ii) Provide split covers for covers larger than 12 sq. ft.
      iii) Aluminum boxes in concrete not allowed.
5. Seal Fittings
   a. Model ESU with Apelco sealing cement and fiber, as manufactured by Appleton.
   b. Model EZS with Chico X Fiber and Chico A compound as manufactured by Crouse-Hinds.
6. Deflection Fittings
   a. Locations:
      i) Underground conduit runs.
      ii) Runs between concrete sections subject to relative movement.
   b. Material:
      i) Ferroalloy hubs.
      ii) Neoprene outer jacket.
      iii) Stainless steel jacket clamps.
      iv) Molded plastic inner sleeve.
      v) Tinned copper braid grounding strap.
   c. Model XD as Manufactured by Crouse-Hinds.
7. Expansion Fittings
   a. Locations:
      i) In long conduit runs, to permit linear movement caused by thermal expansion and contraction.
      ii) In long conduit runs to prevent conduit from buckling.
      iii) Indoors and outdoors, where conduit expansion occurs or where there is a wide temperature range.
      iv) At structural expansion joints.
   b. Material:
      i) End fittings: Ferroalloy.
      ii) Body: Steel conduit.
   c. Provide Bonding Strap When Used Outdoors.
   d. Model XJ, as Manufactured by Appleton and Crouse-Hinds.
8. Flexible Sealing Compound

a. “Duxseal” as Manufactured by Johns-Manville.
b. “Permagum” as Manufactured by In mount.

9. Coal Tar Epoxy Paint
10. Wire and Cable
    a. 600 Volt Power Cable
        i) General Use:
            a) Conductors: Single, copper, 12 AWG minimum.
            b) All conductors shall be stranded.
            c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
            d) Suitability: Wet or dry locations at 75° C and 90° C copper temperature.
            e) Or as specified for service entrances.
        ii) Service entrance and 4 AWG and above:
            a) Conductors: Single, stranded, copper.
            b) Insulation: 600V cross-linked polyethylene, UL Type XHHW/USE or THHN.
            c) Suitability: Wet or dry locations at 75°C and 90° C copper temperature.
        iii) Terminations
            a) Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap standard cable around screw type terminals
    b. Lighting Circuits
        i) General Use:
            a) Conductors: Single, copper, 12 AWG minimum.
            b) Conductors may be solid or stranded.
            c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
            d) Suitability: Wet or dry locations at 75° C and 90° C copper temperature.
        ii) Terminations:
            a) Lugs, cup washers or pressure type; do not use wire nuts on stranded cable or wrap stranded cable around screw type terminals.
    c. Control circuits
        i) General Use:
            a) Conductors: Single, tinned copper, 14 AWG
            b) All conductors shall be stranded
            c) Insulation: 600V thermoplastic, UL Type THWN/THHN.
        ii) Millivolt or Milliampere Instrumentation and Control.
            a) Conductors: 18 AWG stranded copper, 2 or 3 as required.
            b) Insulation: 15 mils, minimum, 90°C PVC.
            c) Shield: Mylar aluminum tape with 20 AWG copper drain wire, fully covering conductors.
            d) Jacket: 20 mils, minimum, 80°C PVC.
            e) Suitability: Wet or dry steel conduit.
        iii) Manufacturers: Belden “UL Instrumentation Cable – 1032A”, Samuel Moore “Dekoron ICMX” No. 1852-686 and 1862-686, or equal.
    d. Telephone and Networking
        i) Cable.
            a) The cables shall be rated for use in communications circuits.
            b) The cables shall be rated for riser applications.
            c) The cables shall be rated for 75 degrees Celsius applications.

d) The cables shall be free of defects and splices.
e) The cables shall be rated for outdoor applications.
f) The cables shall be rated for P-MSHA applications.
g) The cables shall pass a -40 degree Celsius cold bend test per UL 1581.
h) The cables must be UL third party verified to ANSI/TIA/EIA-586-B.2 Category 5e.
i) The cable shall be ROHS compliant.
j) The cable shall be CE compliant.
k) Conductors
    1) The conductors shall be solid, bare copper per ASTM B-3.
    2) The conductors shall be #24 AWG (.20 sq mm).
l) Insulation
    1) The insulation shall be polyolefin.
    2) The insulation shall be free of defects and splices.
m) Pairs
    1) The cable shall contain four pairs.
    2) The insulated conductors shall be bonded together down the entire length of the pair.
    3) The pairs shall be marked with a permanent, extruded stripe identification of tip and ring insulated conductors.
    4) Each pair shall have a unique twist length to minimize pair to pair coupling.
n) Shielding
    1) Shielding shall be an aluminized foil with the foil facing inward, where required.
    2) Unshielded cables shall be acceptable except where shielding is required for the system.
o) Jacket.
    1) All cables shall have a continuous jacket of Polyvinyl Chloride (PVC).
    2) Jacket thickness: The jackets shall be .030" (.75 mm) nominal thickness.
    3) The jackets shall be ultraviolet (UV) radiation and sunlight resistant per UL 1581.
    4) The jackets shall be oil resistant per UL 1581 Class 43.
p) Manufacturer: Belden “Industrial Data Solutions – 7923A” or equal.

11. Wiring Devices
    a. General:
        i) Industrial Specification grade.
        ii) White.
    b. Receptacles:
        i) 120 V duplex outlets: NEMA 5-20R, 3 wire, grounding, 20A, 125 V, Leviton 5362, or approved equal.
        ii) 120 V duplex GFCI outlets: NEMA 5-20R, 3 wire, grounding, 20A, 125 V, Leviton 7899, or approved equal.

iii) 240 V duplex outlets: NEMA 6-20R, 3 wire, grounding, 20A, 250 V, Leviton 5462, or approved equal.
iv) Welding outlets: 50A, 125/250V, 3 pole, 4 wire, grounding, NEMA 14-50R, Leviton 55050, or approved equal.

c. Light Switches:
i) 277 V lighting circuits: 20 amp, 120/277 V, Leviton 1221-2W to 1224-2W, or approved equal.

12. Device Plates
a. General:
i) Mounting hardware countersunk and finished to match plate.
ii) Provide over-sized plates where standard plates do not cover wall opening.
iii) Provide engraving as indicated on drawings.
b. Indoors:
i) Surface mounted devices: Galvanized or cadmium-plated steel.
ii) Flush mounted devices in other finished areas: Phenolic plastic, white.
iii) All other flush mounted devices: Type 302 stainless steel.
c. Outdoors and Indoors when identified on Drawings as Weatherproof:
i) Weatherproof with spring doors for receptacles and with provisions for padlocking switches on and off.
ii) Provide an adaptor plate for flush mounted device plates, Crouse-Hinds FS031, or equal.

13. Grounding and Bonding
a. Provide rod electrodes, exothermic connections and mechanical connections.
b. Building perimeter ground cable shall be minimum of 4/0 AWG bare copper.
c. Duct bank ground cable shall be minimum of 4/0 AWG bare copper.
d. Other ground cable shall be as noted on the drawings.

14. Luminaries
a. Furnish products as specified on drawings.
b. Install ballasts, lamps, and specified accessories at factory.
c. Accessories:
i) Provide swivel-type box covers.
ii) Provide threaded conduit pendants.
d. Provide all lamps and required mounting hardware.

15. Power Panels
a. General:
i) Circuit breaker panel board.
ii) With neutral.
iii) Dead front.
b. Enclosure:
i) NEMA 12, surface in unfinished areas, NEMA 1 flush in finished areas or as indicated on the drawings.
ii) Door with latch and lock.
iii) Typewritten circuit directory.
iv) Ground stud bolt through cabinet with removable 1/0 AWG bond to the panel ground bus and an external clamp connector for a station ground conductor.
c. Circuit Breakers:
i) Molded case thermal magnetic.

ii) Multiple pole breakers shall be common trip.
iii) Bolt-in.
iv) Individually front replaceable.
v) Indicating “On”, “Off”, and “Tripped”.
vi) RMS symmetrical interrupting capacity shall be as indicated on the drawings.
vii) Breakers, trip ratings, and number of poles as indicated on the drawings.

d. Buses:
i) Three phase and neutral bus insulated from cabinet.
ii) Ground bus.
a) Connected to cabinet.
b) Clamp type lug for supply circuit and each load circuit.
c) Removable bond to neutral bus.
iii) Copper bussing.
iv) Ampere and voltage ratings as indicated on the drawings.
v) Bracing coordinated with circuit breakers interrupting capacity.

16. Lighting Panels
a. General:
i) Circuit breaker panel board.
ii) With neutral.
iii) Dead front.

b. Enclosure:
i) NEMA 1 or as indicated on the drawings.
ii) Door with latch and lock.
iii) Typewritten circuit directory.
iv) Ground stud bolt through cabinet with removable 1/0 AWG bond to the panel ground bus and an external clamp connector for a station ground conductor.

c. Circuit Breakers:
i) Molded case thermal magnetic.
ii) Multiple pole breakers shall be common trip.
iii) Bolt-in or plug-in.
iv) Individually front replaceable.
v) Indicating “On”, “Off”, and “Tripped”.
vi) 10,000 amp RMS symmetrical interrupting capacity at 240 V.
vii) Handle clips to prevent casual operation for circuit breakers indicated on drawings.
viii) Ground fault interrupting breakers with a sensitivity of 5mA for receptacle branch circuit and where indicated on drawings.
ix) Breakers, trip ratings, and number of poles as indicated on the drawings.

d. Buses:
i) Two phase and neutral bus insulated from cabinet.
ii) Ground bus.
a) Connected to cabinet.
b) Clamp type lug for supply circuit and each load circuit.
c) Removable bond to neutral bus.
iii) Copper.
iv) Ampere and voltage ratings as indicated on the drawings.
v) Bracing coordinated with circuit breakers interrupting capacity.

17. Dry-Type Specialty Transformers.
    a. Phase, voltage current ratings as indicated on drawings.
    b. Two 2½% full capacity taps below normal voltage.
    c. Dry type, wall floor or MCC mounted as indicated on the drawings, enclosed for wiring in conduit.
    d. Self air-cooled.
    e. Suitable for indoor NEMA 4.
    f. Insulation system and average winding temperature rise for rated KVA as follows:
        i) 1-15 KVA: Class 185 with 115°C rise.
        ii) 16-500 KVA: Class 220 with 115°C rise.
    g. Sound Levels: NEMA ST20.
    h. Ground core and coil assembly to enclose by means of a visible flexible copper grounding strap.
    i. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise
18. Control Stations.
    a. Enclosures:
        i) Indoors: NEMA 4X.
        ii) Outdoors: NEMA 4X
    b. Pilot Devices:
        i) Refer to specification section 16900.
    c. Nameplates:
        i) Pilot devices: Laminated plastic nameplates, white surface with a black core, engraved to identify controlled motor or equipment.
        ii) Control station: Laminated plastic nameplates, white surface with a black core, engraved to identify controlled motor or equipment.
19. Equipment Disconnects
    a. General:
        i) Heavy-duty safety switches.
        ii) Square D or Cutler-Hammer.
    b. Enclosure:
        i) Indoor dry areas: NEMA 12.
        ii) Outdoor: NEMA 4X.
        iii) Corrosive Areas: NEMA 4X.
        iv) Use above guidelines unless otherwise noted on drawings.
        v) Padlocked external operating handle.

    c. Switch:
        i) 25,000 amp symmetrical withstand.
        ii) Poles to match equipment served.
        iii) 600 VAC.
        iv) Continuous current rating not less than the serving branch circuit over current protection.
        v) Non-fusible except where fusing is required by the served equipment or as noted on the drawings.
20. Separately Enclosed Motor Starters.

a. General:
   i) Starters shall have a disconnecting means.
   ii) 3 phase: NEMA size 1 minimum size or as indicated on the drawings.
   iii) Dry type control power transformer for 120VAC control power sized to handle all loads simultaneously, both primary leads fused and one secondary lead fused and one secondary lead grounded.
   iv) Two spare NO and NC auxiliary contacts.
   v) Pilot devices.
   vi) Nameplates to identify the starter and all the items in the starter.
   vii) Square D or Cutler-Hammer.
b. Enclosure:
   i) Indoor dry areas: NEMA 12.
   ii) Outdoors & corrosive areas: NEMA 4X.
   iii) External operating handle to be interlocked with the door to prevent opening door when handle is in the closed position.
   iv) Padlocked external operating handle.
c. Contactor:
   i) 3 phase: NEMA size 1 minimum size or as indicated on the drawings.
   ii) 1 phase: NEMA size 0 minimum size or as indicated on the drawings.
   iii) Rated for the voltage being provided.
   iv) 120 VAC coils.
   v) Non-reversing NEMA rated magnetic starters.
d. Overloads:
   i) One solid state overload relay in each phase.
   ii) External manually reset push button for reset of the overload relay.
   iii) Overloads shall provide phase loss tripping capability.
e. Disconnecting Device:
   i) 3 phase: MCP type disconnect rated at 25KAIC minimum.
   ii) 1 phase: MCP or fused type disconnect rated at 10KAIC minimum.

21. Reduced Voltage Solid State Starters
   a. Starter shall be provided with:
      i) Phase loss, phase unbalance and phase reversal protection.
      ii) Shorted SCR protection.
      iii) Bypass contactor:
         a) Provide a bypass contactor to bypass the SCRs of the starter once the motor is up to speed.
         b) The bypass contactor may be built into the starter, or if it is not, there shall be an external bypass provided.
      iv) Diagnostic module shall be provided which shall include:
         a) Control power
         b) Shorted SCR
         c) Start inhibit
         d) Trip
         e) Phase loss
         f) Phase unbalance
         g) Phase reversal

v) Independently adjustable acceleration and deceleration current limit adjustable from 150 to 400 percent of motor full load current.
vi) Adjustable current ramp to provide breakaway torque to the motor adjustable from 0-150 percent of motor full load current.

b. Starter shall be rated for a minimum of 115 percent of the full load current of the motor that is installed.
c. Each starter shall be provided with a motor run contact and a starter fault contact.

22. Surge Protective Device (SPD).
a. General:
i) SPD units shall be installed as shown on the drawings.
ii) SPD units shall be appropriate for the voltages indicated on the drawings.
iii) Approved manufacturers: Cutler Hammer, Square D, LEA, or equal.
iv) SPD units shall comply with UL 1449 and 1283.
v) SPD units shall comply with IEEE C62.41 and IEEE C62.45.
vi) SPD units shall have a 30 amp disconnect directly before the TVSS unit.
vii) SPD units shall have indication for trouble alarms and surge count.
viii) For assembled equipment the SPD unit shall be of the same manufacturer as the assembled equipment.

b. Ratings:
i) Maximum let through voltage shall be:

Mode	120/208	277/480
L-N or L-G	400V	800V
L-L	800V	1800V

ii) Minimum total surge current capability:

Location	Per Phase	Per Mode
Switchgear	250 KA	125KA
MCC	160KA	80KA
Panelboards	120KA	60KA

2.2 SPARE PARTS

A. The Supplier shall furnish and deliver the following spare parts.

B. The following spare parts to be furnished as a minimum:
1. 25% replacement lamps for lighting fixtures.
2. 25% replacement lamps for pilot light.
3. Two (2) sets of each type of fuse used in the project.
4. Two (2) spare ballast of each type specified.

C. All of the above parts shall be provided as spare parts and shall be packaged new in the original manufacturer's packaging. A list of spare parts shall be provided.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General Requirements

1. The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers' instructions. The services of the system supplier's technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation.

B. Inspection
   1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.
      a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

C. Equipment Installation
   1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.
      a. Separate sheet metal junction boxes, equipment enclosures, sheet metal raceways, etc., mounted on water or earth-bearing walls or wall-mounted outdoors ¼" from wall be corrosion resistant spacer.
      b. Seal the base of all outdoor switchgear, motor control center, and similar equipment with grout.
      c. Screen or seal with flexible sealing compound all openings into outdoor equipment to prevent the entrance of rodents, wasps, and mud-daubers.
      d. Electrical work shall conform to the construction schedule and progress of other trades.
      e. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
      f. Perform all work in accordance with manufacturer's instructions.
         i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
         ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.
      g. Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section.

D. Identification:
   1. Conduit. All conduits shall be provided with identification tags. Tags shall be brass nameplates with 3/8" high lettering and attached to the conduits by means of stainless steel wire. Conduits shall be identified at both ends with the same identification number.
   2. Cable. Except for lighting and receptacle circuits, each individual wire in power, control, indication, and instrumentation circuits shall be provided with identification markers at the point of termination. Power wires without individualized identification numbers shall be color coded with electrical tape or colored wire jacket. The wire markers shall be of the heat-shrinkable tube type.
   3. Control Stations. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched

legends (“start”, “stop”, etc.) as indicated on the drawings. Nameplates shall be laminated plastic, with 1/8 inch engraved letters, and shall be securely fastened to the control stations.

4. Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated plastic, with 1/8 inch engraved letters, and shall be securely fastened to the circuit breakers.

E. Raceways:
   1. General:
      a. Except as otherwise indicated on drawings, conduit shall be concealed in finished areas and exposed in unfinished areas.
      b. Rigid steel conduit and aluminum conduit connections and terminations shall be reamed, de-burred, threaded and provided with bushings.
      c. Securely fasten conduit connections to sheet metal enclosures with locknuts inside and out. Conduit hubs outdoors and in wet locations.
      d. Provide deflection fittings across structural joints where structural movement is allowed.
      e. Keep conduit clear of structural openings and indicated future openings.
      f. Provide flashing and seal watertight conduits through roofs and metal walls.
      g. Neatly grout conduit into any opening cut into structure.
      h. Cap or plug conduits during construction to prevent the entrance of trash, dirt and water.
      i. Minimum conduit size shall be ¾”, except ½” for luminaries pendants or as noted on drawings.
      j. Seal conduits with flexible sealing compound forced to a minimum depth equal to the conduit diameter after cable is installed.
         i) At handholes, manholes, and vaults.
         ii) Building entrance junction boxes.
         iii) One inch or larger connections to equipment.
      k. Provide flexible conduit where flexible connections are necessary, including each motor without flexible cord.
         i) Keep length to a minimum, not to exceed 6’ maximum.
         ii) No sharp bends.
      l. Provide suitable pull string in each empty or spare conduit.
   2. Conduit exposed in structures:
      a. Install parallel to structural members and surface.
      b. Install conduits of the same general routing parallel with symmetrical bends.
      c. Arrange supports to prevent misalignment during wiring installation.
      d. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
      e. Group related conduits; support using conduit rack. Construct rack using steel channel provide space on each for 25 percent additional conduits.
      f. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inch size.
      g. Provide suitable pull string in each empty conduit except sleeves and nipples.
      h. Maintain 6” clearance to ducts, piping and flues.

i. Support rigidly with galvanized or cadmium-plated hardware and framing materials, including nuts and bolts.
j. Provide expansion fittings at 100’ centers outdoors, 200’ centers indoors; in each conduit run longer than 100’ outdoors, 200’ indoors.
k. Provide galvanized pipe caps on conduit stubs for future use.
l. Allow 7’ headroom for horizontal conduit runs, except along structures, piping equipment or where not possible.
m. Except as otherwise indicated, do not install exposed conduit in water chambers.
n. Where allowed, coat conduit exposed in water chambers with 2 coats of coal tar paint with paint injuries repaired or use PVC coated conduit.

3. Conduit concealed in structure:
   a. Install between reinforcing steel in slabs with reinforcing in both faces.
   b. Install under reinforcing steel in slabs where only a single layer is provided.
   c. Terminate conduit for future use in equipment or by galvanized couplings and conduit plugs flush with structural surfaces. Seal plugs with self-leveling caulk.
   d. Maximum of two conduits crossing each other in slab.
4. Underground:
   a. One inch minimum.
   b. Encased in concrete.
      i) Two inches between conduits.
      ii) Three inches over conduit where not reinforced.
      iii) Three inches over reinforcing.
      iv) Reinforced at and 5’ past portion on disturbed earth or subject to traffic.
      v) Reinforced within 5’ of a structure, manhole or vault.
      vi) Reinforced for entire length and 2’ beyond each adapter to steel conduit if non-metallic is used in duct bank.
      vii) Where capped underground, reinforce the last 2’ and extend steel and conduit 2’ past end of duct bank. Paint all un-encased metal with 2 coats of coal tar paint.
      viii) Continue encasement on outdoor risers to 3” above grade and crown and chamfer top.
   c. Two foot minimum bend radius at vertical risers, 3 foot elsewhere.
   d. Install underground conduit so that it does not drain to cable pulling access in buildings; where necessary, provide a handhole or manhole near or adjacent to building.
   e. Provide 3 foot minimum earth cover.
   f. Install underground conduits through buildings, manhole, handhole and vault walls in box outs as indicated on the drawings.
   g. All steel inside manholes, handholes and vaults shall be galvanized with bared spots treated with zinc rich paint.
   h. Provide ¾” galvanized steel pulling eyes on opposite walls below the centerline of each duct bank.
   i. Provide end bells at wall terminations and adapters for steel conduit continuations for non-metallic duct systems.
   j. Isolate intercommunication and milliampere level instrumentation circuits from all power wiring raceways, conduits, boxes, vaults, manhole and handhole.
   k. Provide a full-size extension for each underground conduit entering a building.

l. Rigid nonmetallic conduit (PVC) shall be fastened no less than every 4 feet.

5. Junction boxes and wiring gutters:
   a. Install electrical boxes as shown on drawings and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
   b. Install pull boxes and junction boxes to maintain headroom and to present neat mechanical appearance.
   c. Install level and plumb.
   d. Where indicated, provide a removable side opposite underground duct banks.
   e. At least code size including space for full size continuation of any conduit not originally continued.
   f. Arrange conduit for maximum space for future conduits.
   g. Support boxes independently of conduit except cast box that is connected to rigid metal conduits both supported within 12 inches of box.

F. Wire and Cable
   1. General:
      a. Protect the cable and avoid kinking conductors, cutting or puncturing jackets, contaminating by oil or grease or damaging in any manner.
      b. Terminate stranded cable with lugs, cup washers, or pressure type connectors; do not wrap stranded cable around screw type terminals.
      c. Splice stranded cable with pressure type connectors; do not use wire nut type connectors on stranded cable.
      d. Splice cables only at readily accessible locations.
      e. Do not pull cable tight against bushings or press heavily against enclosures.
      f. Use cable pulling lubricants as recommended by the cable manufacturer.
      g. Use swab to clean conduits and ducts before pulling cables.
      h. Install cable and accessories in accordance with manufacturer's instructions.
      i. Where necessary to prevent heavy loading of cable connectors due to cable weight, support cables in vertical risers with woven cable grips.
      j. Coil and tape spare cable ends.
      k. Support each 250 MCM or larger cable, and each conduit group of smaller cables from manholes, handholes or vault walls.
      l. Use Stranded conductor for feeders and branch circuits.
      m. Use stranded conductors for control circuits.
      n. Use conductor not smaller than 12 AWG for power and lighting circuits.
      o. Use conductor not smaller than 16 AWG for control circuits.
      p. Use 10 AWG conductors for 20 ampere, 120 Volt branch circuits longer than 100 feet.
      q. Pull all conductors into raceway at same time.
      r. Use suitable wire pulling lubricant for building wire 8 AWG and larger.
      s. Protect exposed cable from damage.
      t. Neatly train and lace wiring inside boxes, equipment, and panel boards.
      u. Clean conductor surfaces before installing lugs and connectors.
      v. Make splices, taps, and terminations to carry full ampacity of conductors.
   2. Special cables:

a. Isolate networking and milliampere level instrumentation cables from all power circuits.
b. Isolate telephone cables from all other circuits.

3. Conductor identification:
   a. Color code all service, feeder, and branch circuit conductors, 277/480 VAC and above as follow:
      i) Phase A: Brown
      ii) Phase B: Orange
      iii) Phase C: Yellow
      iv) Neutral: White
      v) Ground: Bare or Green
   b. Color code all feeder, and branch circuit conductors, 120/208 VAC as follows:
      i) Phase A: Red.
      ii) Phase B: Black.
      iii) Phase C: Blue.
      iv) Neutral: White.
      v) Ground: Bare or Green.
   c. Identify single control conductors by color coding orange and by labeling each end of conductors by color coding orange and by labeling each end of conductor with heat shrink-tube type wire markers.
   d. Identify multi-conductor instrumentation and control cables with heat shrink-tube type wire markers.
   e. Contractor shall establish a control and instrumentation conductor and cable identification system acceptable to Engineer.

G. Wiring Devices:
1. Flush mount wiring devices in concealed conduit system.
2. Surface mount wiring devices in exposed conduit systems.
3. Provide extension rings to bring outlet boxes flush with finished surface.
4. Clean debris from outlet boxes.
5. Install products in accordance with manufacturer's instructions.
6. Install devices plumb and level.
7. Install switches with OFF position down.
8. Install receptacles with grounding pole on bottom.
9. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
10. Connect wiring devices by wrapping conductor around screw terminal.
11. Use jumbo size plates for outlets installed in masonry walls.
12. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
13. Install wall switch 48 inches above finished floor.
14. Install convenience receptacle 24 inches above finished floor.
15. Inspect each wiring device for defects.
16. Operate each wall switch with circuit energized and verify proper operation.
17. Verify that each receptacle device is energized.
18. Test each receptacle device for proper polarity.
19. Test each GFCI receptacle device for proper operation.

20. Adjust devices and wall plates to be flush and level.

H. Grounding Materials:
   1. Coordinate installation with other disciplines.
   2. Verify that final backfill and compaction has been completed before driving rod electrodes.
   3. Install Products in accordance with manufacturer's instructions.
   4. Install rod electrodes at locations indicated. Install additional rod electrodes as required to achieve specified resistance to ground.
   5. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing.
   6. Provide bonding to meet Regulatory Requirements.
   7. Install ground cable through building walls within 3' below finish grade and prepare a water stop.
   8. Install ground rods and cables as deep in earth as possible and as far from structure as possible, not closer than 6".
   9. All branch circuit and feeder circuits to include a copper ground conductor in addition to the conduit ground connection.
   10. Connect ground conductors to equipment by ground lugs or clamps.
      a. If no ground bus or terminal is provided and enclosure is not explosion-proof or submersible provide a clamp type lug under a permanent assembly bolt or by grounding locknuts or bushings.
      b. If an explosion-proof or submersible enclosure is not provided with grounding means, provide an adjacent junction box with a ground lug.
      c. Bond grounding system to station piping by connection to the first flange inside the building on either a suction or discharge pipe which will form a good ground connection:
         i) Drill and tap the flange.
         ii) Provide a bolted connection.
         iii) Bond with a copper bar or strap.
      d. Form ground conductors on equipment to the contours of the equipment.
      e. Install main ground cables with encased underground conduit banks in earth at least 3" below 1 corner of the duct bank.
      f. Bond ground cables in underground circuits to main ground cables at each manhole, handhole, and vault.

I. Luminaries
   1. Install in the general locations and arrangement indicated on drawings.
   2. Align luminaries in rows vertically and horizontally except as otherwise required.
   3. Install clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.
   4. Adjust luminaries location as required by field conditions.
   5. Examine each luminaries to determine suitability for lamps specified.
   6. Install in accordance with manufacturer's instructions.
   7. Install suspended luminaries using pendants supported from swivel hangers. Provide pendant length required to suspend luminaries at indicated height.
   8. Support luminaries larger than 2x4 foot size independent of ceiling framing.

9. Locate recessed ceiling luminaries as indicated on reflected ceiling plan.
10. Install surface mounted luminaries and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.
11. Install recessed luminaries to permit removal from below.
12. Install accessories furnished with each luminaire.
13. Bond products and metal accessories to branch circuit equipment grounding conductor.
14. Install specified lamps in each luminaire emergency lighting unit and exit sign.
15. Operate each luminaire after installation and connection. Inspect for proper connection and operation.
16. Aim and adjust luminaries as directed.
17. Relamp luminaries that have failed lamps at Substantial Completion.
18. Clean electrical parts to remove conductive and deleterious materials.
19. Remove dirt and debris from enclosure.
20. Clean photometric control surfaces as recommended by manufacturer.
21. Clean finishes and touch-up damage.

J. Lighting Panel
1. Wall mount in unfinished areas, flush mount in finished areas.
2. Install lighting panel in accordance with NEMA PB 1.1.
3. Install lighting panel plumb. Provide supports. Height: 6 ft. to top of lighting panel; install lighting panel taller than 6 ft. (2M) with bottom no more than 4 in. above floor.
4. Provide filler plates for unused spaces in lighting panels.
5. Provide typed circuit directory for each branch circuit in lighting panel. Revise directory to reflect circuiting changes required to balance phase loads.
6. Measure steady state load currents at each lighting panel feeder; rearrange circuits in the lighting panel to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.
7. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

K. Networking – EtherNet/IP cabling
1. Install sufficient networking cable, as shown in the contract drawings, to provide a complete networked system.
2. Terminate all wiring with RJ-45 connectors rated for Cat 5e cable transmissions.
3. Test every communication cable, and provide a testing certificate with the results.

L. Fiber Optic cabling
1. Install sufficient fiber optic cable, as shown in the contract drawings, to provide a complete networked system with terminations.
2. Terminate all fiber optic strands with approved connectors rated for fiber optic transmission.
3. Cables shall be pulled with swivel pulling eyes to prevent causing a twist in the cable.
4. Conduit may require lubrication to reduce frictional loads and/ or intermediate pulls.
5. Intermediate pulls require pulling the cable to a point, laying on the ground in a “figure 8” pattern to prevent twisting the cable.
6. A minimum bend radius of 20 times of the cable diameter under tension.

7. A minimum bend radius of 10 times of the cable diameter under no tension.
8. All splices shall be fusion spliced.
9. The contractor shall label all fiber optic cabling in a permanent consistent manner. All tags shall be of a material designed for long term permanent labeling and shall be marked with permanent ink on non-metal types, or embossed lettering on metal tags. Metal tags shall be constructed of stainless steel. Non-metal label materials shall be approved by the engineer. Labels shall be affixed to cable per the manufacturer's recommendations and shall not be affixed in any manner that shall cause damage to the cable. Handwritten labels shall not be allowed.
10. After installation, every fiber and every splice shall be tested with an Optical Time-Domain Reflectometer (OTDR). Written and electric documentation of the test shall be provided to customer.
11. If maximum loss values are not met or exceeded, re-termination of fiber shall be required until maximum loss values are met or exceeded.

a. Single mode fiber maximum loss values

Single mode OS2 @1300nm	
Fiber Attenuation	.4dB/km
Connector Loss	.75dB/Connector
Fusion Splice Loss	.75dB/Splice

b. Multimode fiber maximum loss values

Multimode OM4 @ 850nm	
Fiber Attenuation	3.5dB/km
Connector Loss	.75dB/Connector
Fusion Splice Loss	.75dB/Splice

3.2 FIELD QUALITY CONTROL

A. Low Voltage Cable Testing
   1. Test 600 V power cables for continuity and freedom from short circuits and ground, except where grounding is intentional immediately after installation.
   2. Test all circuits with a 500 V megger or its equivalent.
   3. Replace conductors which read less than 1.5 Megohms between conductors and ground.

3.3 PROTECTION AND STORAGE

A. Protection of equipment during storage:
   1. During construction, all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously. Any means necessary shall be used to protect the equipment at the Contractor's expense.

END OF SECTION

SECTION 16900

INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the furnishing and installation of metering which shall include the following principal items:
   1. Principal components of the metering and control systems shall be as listed on the "Instrument List" at the end of this section.
   2. Miscellaneous. One lot of test equipment, spare parts, and miscellaneous devices as set forth herein. Supplementing this section, the drawings indicate locations and arrangement of instruments, and provide functional diagrams and schematics regarding connection and interaction with other equipment.

B. Related Sections
   1. Section 16050 – Electrical

1.2 REFERENCES

A. Codes & Permits
   1. All work and materials shall comply with the National Electrical Code, the National Electrical Safety Code, and applicable local regulations and ordinances. All panels shall be listed by Underwriters Laboratories or other testing organizations acceptable to the governing authority. The Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections, and approval by the proper authorities in local jurisdiction of such work.

1.3 SUBMITTALS

A. Complete fabrication, assembly, and installation drawings: wiring and schematic diagrams: and details, specifications, and data covering the materials used and the parts, devices, and accessories forming a part of the equipment furnished shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in two separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Instrument tag numbers indicated on the contract drawings shall be referenced where applicable. Submittal data for multifunctional instruments shall include complete descriptions of the intended functions and configurations of the instruments.
   1. First-stage Submittal. The first-stage submittal shall include the following items.
      a. Product catalog cut sheets clearly marked to show the applicable model number, operational features, and intended service of the device.
      b. A detailed list of any exceptions, functional differences, or discrepancies between the Supplier's proposed system and the contract requirements.
      c. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall include overall dimensions, metal

thickness, door swing, mounting details, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

d. System wiring and installation drawings for all interconnecting wiring between components of the systems furnished and for all interconnecting wiring between the related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections.
e. If panel terminal designations, inter-device connections, device features and options, or other features are modified as a result of the fabrication process or factory testing, revised drawings shall be resubmitted.
f. A total of seven (7) copies for the submittal shall be provided.

2. Second-stage Submittal. Complete system documentation, in the form of operation and maintenance manuals, shall be provided. Manuals shall include complete product instruction books for each item of equipment furnished.
   a. Where instruction booklets cover more than one specific model or range of instrument, product data sheets shall be included which indicate the instrument model number, calibrated range, and all other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings, calibration and startup sheets shall be included with the manuals.
   b. A copy of all final O&M manuals shall be provided in PDF format on a USB Thumb drive. All AutoCAD drawings shall be provided in PDF and DWG formats.
   c. A total of two (2) printed copies, and two (2) softcopies of final O&M manuals shall be provided.

1.4 QUALITY ASSURANCE

A. Supplier's qualifications
   1. The entire system shall be designed, coordinated, and supplied by a qualified system integrator (Integrator) who is regularly engaged in the business of designing and building instrument and control systems for water and wastewater projects. The Contractor's intended Integrator shall meet the following qualifications.
      a. The Integrator shall have and shall maintain a qualified technical staff and design office. The qualifications and experience of key project personnel shall be acceptable to the Engineer.
      b. The Integrator shall have the physical plant and fabricating personnel to complete the work specified. The Integrator's fabrication capabilities and arrangements shall be acceptable to the Engineer.
      c. The Integrator shall employ competent service personnel to service the equipment furnished. The geographic location of service personnel for this project shall be acceptable to the Engineer.
      d. The Integrator shall provide a "Statement of Qualifications" indicating that they have successfully provided similar work for at least 5 years.

B. Coordination.

1. Instrument and control systems shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. All instruments and control devices shall be applied in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the instrument or device manufactured and the manufacturer of related equipment.
2. Installation drawings shall be prepared for interconnecting wiring and piping between the related equipment and the equipment furnished under this section. All interconnecting wiring shall be appropriate for the service and shall result in a properly functioning system.
3. The Integrator shall provide coordination with other contractors and supervision of installation as required during construction.
4. Coordination shall be provided between the Integrator and the process system supplier.
5. Instrument and control systems shall be designed and coordinated for proper operation with other sections of these specifications. These shall include but not be limited to Electrical – Section 16050, Variable Frequency Drives – Section 16150, and Programmable Logic Controllers – Section 16950.

1.5 WARRANTY

A. All suppliers shall warrant their hardware for a period of one year from the date of system acceptance.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment furnished under this section shall be selected by the system supplier for its superior quality and intended performance. Unless indicated otherwise, all equipment and material shall be new, undamaged, and meet the requirements of UL. Where UL requirements are not applicable, equipment and material shall be identified as such by the supplier and approved by the Engineer before purchase and installation. Equipment and materials used shall be subject to review and shall comply with the following requirements.
   1. Power and Instrument Signals. Unless specified otherwise, electrical power supply to the instrumentation equipment will be unregulated 120 VAC at the locations noted on the one-line and functional diagrams. All transmitted electronic analog instrument signals shall be 4-20 mA DC and shall be linear with the measured variable.
   2. Metering Accuracy. System metering accuracy, as compared to the actual process value, shall be determined from the value read at the principal readout device such as the recorder or totalizer. System requirements shall not preclude any requirements specified herein for individual devices.
      a. For systems where the primary measuring device, transmitter, and receiver are furnished under this section, the accuracies shall be within the following limits:
         i) Level: 1.0% of measured span.
         ii) Flow Rate: magnetic or transit time ultrasonic metering: 0.5% of full scale between 1.0 and 100% of scale.

3. Appurtenances. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation requirements shall be furnished and installed as required for proper performance of the equipment.
4. Interchangeability and Appearance. Instruments used for the same types of functions and services shall be of the same brand and model line insofar as possible. Similar components of different instruments shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished. Recorders, process indicators, control stations, and similar panel-mounted instruments shall be of the same style and shall be products of the same major instrument manufacturer.
5. Programming Devices. A programming or system configuring device shall be provided for systems that contain any equipment which required such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete and in like-new condition and shall be turned over to the Owner at completion of the startup.
6. Device Tag Numbering System. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the instrument device schedules and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanels, and rack-mounted devices shall have laminated plastic identification tags securely fastened to the device. Hand lettered labels or tape labels will not be acceptable.
7. Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.
8. Provide sunshade for outdoor installations.
9. Provide stainless steel tags for each instrument.

2.2 PANEL FABRICATION

A. General Fabrication Requirements. All panels furnished hereunder shall conform to the requirements of NEMA ICS-6-1988. The following paragraphs describe general fabrication requirements for the instrument panels, consoles, enclosures, and subpanels:
   1. Wiring.
      a. All internal instrument and component device wiring shall be as normally furnished by the manufacturer. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded tinned copper, insulated for not less than 600 volts, with a moisture-resistant and flame-retardant covering rated for not less than 90°C.
      b. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 VAC. Surge protectors shall be of a non-faulting and non-interrupting design, with a response time of not more than 5 nanoseconds. Surge protectors shall be Cutler Hammer AEGISPowerline Filters, or equal.
      c. Panels that are over 15 cubic feet in total volume shall have panel lighting above each door of the panel.
      d. Power distribution wiring on the line side of the panel's protective devices shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 16

AWG. Wiring for control circuits shall be minimum 16 AWG. Electronic analog circuits shall be 18 AWG twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Wiring for ac power distribution, DC power distribution, and control circuits shall have different colors and shall agree with the color-coding legend on the system supplier's panel wiring diagrams.

e. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with a marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 20% spare terminals shall be provided. Each control loop or system shall be individually fused, and all fused or circuit breakers shall be clearly labeled and located for easy maintenance. Terminal block shall be Phoenix Contact UT 4-MTD series.
f. All wiring shall be grouped and firmly supported inside the panel. Wiring shall be routed in nonmetallic slotted wire duct or similar. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40% of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables. Wire duct shall be Thomas & Betts Ty Duct or approved equal.
g. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams.
h. All analog input signals coming from external from the building where the panel is located shall have surge protection.
i. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic drawings.
j. All wires in the panel shall be identified at both ends of the wire. These labels shall agree with the labels shown on the wiring diagrams. The wire labels shall be of the heat-shrink tube type of wire marker as manufactured by Brady thermal labels.
k. All instruments that require 120 VAC power that have the signal from the instrument going to a panel, shall be provided 120 VAC from that panel. The 120 VAC circuit to these instruments shall be individually fused.

2. Nameplates. Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall have approximate dimensions and legends, as indicated on the drawings, letters approximately 3/16-inch-high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified herein under the Device Tag Numbering System paragraph.
3. Painting. Interior and exterior surfaces of all panels shall be thoroughly cleaned and painted with rust-inhibitive primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the

manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils.

4. Factory test. Panels shall be factory tested electrically by the panel fabricator before shipment.

2.3 METERING & CONTROL SYSTEMS

A. Principal components for the metering and control systems are indicted on the "Instrument List" at the end of this specification.

2.4 INSTRUMENTATION

A. Pressure and Level Instrumentation
   1. Hydrostatic Level Transducers
      a. Each transducer shall be a hydrostatic pressure sensor for submerged level measurement of fresh water and wastewater applications. The sensor shall be a permanently sealed submersible probe and cable combination with waterproof 316 Stainless Steel Housing. The transducer shall be a of the two-wire type which requires no direct power connection to the transducer. Transducer output shall be 4-20mA DC. The transducer shall be capable of the ranges and pressures for which the application will require. The transducer shall have an operating temperature range of 0 to 140ºF. Accuracy shall be +/- 0.35%. Transducer should be protected from moisture intrusion with a vent filter. The transducer shall be mounted as shown on drawings or as required for application. The transducer shall be an Endress-Hauser "Waterpilot FMX21", GE Sensing (Druck) "PDCR/PTX- 1730", Mercoid SBLT2, or approved equal.

B. Miscellaneous Instrumentation
   1. Magnetic Door Switch
      a. The magnetic door switch shall be a two-piece switch rated 100V AC/DC. Switch shall be Edwards 60 Series or approved equal.

PART 3 EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General Requirements
   1. The instrumentation equipment shall be installed by the Contractor or his subcontractors in accordance with the manufacturers' instructions. The services of the system Supplier's technical representative shall be provided as necessary to calibrate, test, and advise others of procedures for adjustment and operation.

B. Inspection.
   1. Inspect materials and equipment for signs of damage, deterioration or other deleterious effects of storage, transportation, handling, or defects in manufacture or assembly.

a. Replace with identical new materials or equipment or repair to like new condition any materials or equipment showing such effects to the satisfaction of the Engineer and Owner.

C. Equipment Installation.
   1. Handle, install, connect, clean, condition, align and adjust products and equipment in strict accordance with manufacturer's instructions and in conformity with specification requirements.
      a. Maintain one complete set of manufacturer's installation instructions at the jobsite during installation and until installation is accepted by the Engineer and Owner.
      b. Perform all work in accordance with manufacturer's instructions.
         i) Do not omit any preparatory step or installation procedure unless specifically modified or exempted by contract documents.
         ii) Should job conditions or specification requirements conflict with manufacturer's instructions, consult with Engineer prior to proceeding.
      c. Field Wiring. Field wiring materials and installation shall conform to the requirements of the electrical section.
      d. Field Piping. Field piping materials and installation shall conform to the requirements of the miscellaneous piping section.
      e. Field-Mounted Instruments. Instruments shall be mounted so they may be easily read and serviced and all appurtenant devices are easily operated. Installation details for some instruments are indicated on the drawings. Unless otherwise indicated on the drawings, instruments which include local indicators shall be mounted approximately 5 feet above the floor and shall be oriented for ease of viewing. Transmitters shall be mounted on corrosion-resistant pipe supports suitable for floor, wall, or bracket mounting.

D. Field Calibration. A technical representative of the system supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final tuning adjustment settings. The adjustment of each calibrated instrument shall be sealed or marked, insofar as possible, to discourage tampering. Instruments shall be calibrated before checkout of the operation of the system.

E. Systems Check. A technical representative of the system supplier shall participate in the checkout of metering and control systems. If interrelated devices furnished by other suppliers, such as valve actuators, motor controls, chemical feeders, or primary measuring devices, do not perform properly when placed in service, the technical representative shall use suitable test equipment to introduce simulated signals to verify or measure signals from such devices as required to locate the source of trouble or malfunction. A written report stating the results of such tests shall be furnished, if requested by the Engineer, to assign responsibility for corrective measures.
   1. Installation Test Equipment. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by the Contractor for the duration of the testing work. Unless specified otherwise, test equipment will remain the property of the Contractor or the system Supplier.

F. Adjustment and Cleaning

1. Perform all required adjustments, tests, operational checks, cleaning and other start-up activities required.
2. Take precautions, as necessary, to properly protect all equipment from damage. Installed equipment to be protected from further construction operations.

3.2 CUSTOMER TRAINING

A. The coordinating supplier shall provide a qualified representative at the job site to train the Owner's personnel in operating and maintenance of the equipment. The training session shall include a technical explanation of the equipment and an actual hands-on demonstration. The training session shall consist of one 4-hour session, and the schedule shall be arranged and coordinated with the Engineer.

3.3 INSTRUMENT LIST

City of Grand Junction Purdy Mesa Flow Control Tank
Instrument List
(This list does not include instruments provided by the packaged systems)

Tag #	Description	Service	Scale	Provided Under Specification
LIT-100	Flow Control Tank Level	Hydrostatic Level Transducer		16900
YA-102	Hatch Intrusion Switch	Magenetic Door Switch		16900

END OF SECTION