Central Elmore Water & Sewer Authority

Contract Documents
For The

Central Elmore WTP Upgrade

BID SET

CONSISTING OF:

BIDDING REQUIREMENTS
CONTRACT FORMS
CONDITIONS OF THE CONTRACT
SPECIFICATIONS

Prepared By:

ARDURRA
COLLABORATE. INNOVATE. CREATE.

Huntsville, Alabama
Project No. 2024-0776-00

JULY 2025

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ADVERTISEMENT FOR BIDS

Sealed Bids for the construction of the **Central Elmore WTP Upgrade** will be received by **Central Elmore Water & Sewer Authority** on or before **2:00 p.m. CDT, August 21, 2025,** at the office of **Central Elmore Water & Sewer Authority, 716 U.S. Highway 231, Wetumpka, AL 36093**, at which time said bids will be publicly opened and read.

The Project consists of the following major components:

Water treatment plant improvements including a storage tank, booster pump station, granular activated carbon system installation, chemical injection vault, on-site sodium hypochlorite generation system, yard piping, civil site work, electrical system, and I&C integration and programming.

Contract Documents may be obtained from Ardurra, 200 Clinton Avenue West, Suite 704, Huntsville, AL 35801, upon payment of **$100.00** for each set. All deposits are non-refundable. Contract Documents can also be downloaded from the Ardurra website at: www.ardurra.com/biddocs or from www.questcdn.com, for a fee of $22.00.

A pre-bid meeting will be at the Central Elmore Water & Sewer Authority, 716 U.S. Highway 231, Wetumpka, AL 36093 on August 5, 2025, at 9:30 a.m. CDT.

All questions and clarification requests must be submitted by 4:00 p.m. CDT August 18, 2025.

Each Bid must be submitted on the prescribed form and accompanied by security submitted on the prescribed Bid Bond form in an amount not less than five (5%) percent of the amount bid but not to exceed $10,000.00.

All Contractors are required to provide certification of compliance with the E-Verify program per Alabama Act 2012-491.

For information concerning the proposed Work, contact Shakil Amin, 200 Clinton Avenue, Suite 704, 256-203-9501. To obtain Plans and Specifications contact Michelle Jeffery, 256.203.9501.

INSTRUCTIONS TO BIDDERS

1. BID REQUIREMENTS

A. SUBMISSION OF PROPOSALS

Each Bid must be submitted in a sealed envelope, addressed to **Central Elmore Water & Sewer Authority, 716 U.S. Highway 231, Wetumpka, AL 36093.** Each sealed envelope should bear on the outside the Bidder's name, address, and license number and expiration date, license classification of the Contractor bidding the Project, and the name of the Project "Central Elmore Water & Sewer Authority Water Treatment Plant Improvements" for which the Bid is submitted. Any Bid envelope which contains a listing of more than one (1) Contractor in each license classification will not be accepted. If forwarded by mail, the sealed envelope containing the Bid must be enclosed in another envelope addressed to the Owner at above address. Any Bid received after the time and date specified shall not be considered.

B. PREPARATION OF PROPOSALS

All Bids must be made on the required Bid form. All blank spaces for Bid prices must be filled in, in ink or typewritten, and the Bid form must be fully completed and executed when submitted. Only one (1) copy of the Bid form is required. Any discrepancy in calculation of pay item cost will be resolved by use of the unit cost.

C. ACCEPTANCE OF PROPOSALS

The Owner may waive any informalities or minor defects or reject any and all Bids. Any Bid may be withdrawn prior to the above scheduled time for the opening of Bids or authorized postponement thereof. No Bidder may withdraw a Bid within ninety (90) days after the actual date of the opening thereof. Should there be reasons why the Contract cannot be awarded within the specified period, the time may be extended by mutual agreement between the Owner and the Bidder. A conditional or qualified Bid will not be accepted.

D. BIDDER'S UNDERSTANDING

Bidders must satisfy themselves of the accuracy of the estimated quantities in the Bid Schedule by examination of the site and a review of the Drawings and Specifications including Addenda. After Bids have been submitted, the Bidder shall not assert that there was a misunderstanding concerning the quantities of Work or of the nature of the Work to be done.

The Owner shall provide to Bidders prior to Bidding, all information which is pertinent to, and delineates and describes, the land owned, and rights-of-way acquired or to be acquired.

Each Bidder is responsible for inspecting the site and for reading and being thoroughly familiar with the Contract Documents. The failure or omission of any Bidder to do any of the foregoing shall in no way relieve any Bidder from any obligation in respect to its Bid.

The Contract Documents contain the provisions required for the construction of the Project. Information obtained from an officer, agent, or employee of the Owner or any other person shall not affect the risks or obligations assumed by the Contractor or relieve the Contractor from fulfilling any of the conditions of the Contract.

Information derived from inspection of logs of test borings, or pits, Geotechnical reports, topographic maps, or from Drawings showing location of utilities and structures will not in any way relieve the Contractor from any risk, or from properly examining the site and making such additional investigations as he may elect, or from properly fulfilling all the terms in the Contract Documents.

Prospective Bidders shall contact Chad Shaw, General Manager to schedule inspection trips to the project site.

The Engineer is Ardurra. The Engineer's address is 200 Clinton Avenue West, Suite 704, Huntsville, AL 35801. All questions regarding interpretations of the Contract Documents should be directed to Mr. Shakil Amin, P. E. at 205.282.2163.

E. BID SECURITY

Each Bid must be accompanied by cash, a certified check, a cashier's check drawn on a bank in good standing, or a bid bond payable to the Owner for five (5%) percent of the amount bid. As soon as the Bid prices have been tabulated, the Owner will return the Bid Security of all except the three (3) lowest responsible Bidders. When the Agreement is executed the Bid Security of the two (2) remaining unsuccessful Bidders will be returned. The Bid Security of the successful Bidder will be retained until the Payment Bond and Performance Bond, if applicable, have been executed and approved, after which it will be returned. Bid security shall be valid for 90 days post bid date.

F. TYPE OF BID

The type of Bid for the Work specified in these Contract Documents will be lump sum as set forth in the Proposal. A single price based upon a combination of lump sum and unit price shall be submitted as the base bid in the appropriate spaces set forth in the Proposal. The total amount to be paid to the Contractor shall be the amount of the base bid as adjusted for additions or deletions resulting from Owner authorized changes in the Project and Owner selected deductive and additive alternates.

Where the Proposal requires the Bidder to submit prices for Owner selected deductive and additive alternates, the prices shall be submitted in the appropriate places as set forth in the Proposal. The Owner is not obligated to select any of the alternates so proposed.

G. FUNDING

This project is funded whole or in part by the State Revolving Fund (SRF).

2. AWARD OF CONTRACT

A. BASIS OF AWARD

Work for this Project will be let under one (1) Contract to the lowest responsive, responsible bidder meeting the bidding requirements. The Owner reserves the following rights: (1) to reject all bids where the Owner deems rejection to be in its best interest; (2) to reject any bid that is not in compliance with the Contract Documents; (3) to waive any informalities and irregularities in said bids; and (4) to accept any combination of sub-totals within any schedule which is determined to be in the Owner's best interest; and (5) to postpone award of the Contract for a period of time, which, however, shall not extend beyond ninety (90) days from the bid opening, unless extended by mutual agreement by the Owner and low responsive, responsible Bidder.

B. DETERMINATION OF LOW BIDDER

Award will be made on the basis of the lowest actual bid amount, which is defined as the base bid, plus any additions for additive alternates listed in the Proposal and submitted by a responsive and responsible qualified Bidder. Any discrepancy in calculation of pay item cost will be resolved by use of the unit cost.

C. QUALIFICATIONS OF BIDDER

The Owner may make such investigations as deemed necessary to determine the ability of the Bidder to perform the Work, and the Bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Owner reserves the right to reject any Bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy the Owner that such Bidder is properly qualified to carry out the obligations of the Agreement and to complete the Work contemplated therein.

Bidders are required to register with SAM.gov and provide UEI Number.

Selected contractor and subcontractors will be required to maintain an active SAM.gov registration for the duration of the project

The low Bidder shall supply the names and addresses of major material suppliers and Subcontractors when required to do so by the Owner.

MINORITY BUSINESS ENTERPRISE AND WOMEN'S BUSINESS ENTERPRISE (MBE/WBE) REQUIREMENTS: Documentation of compliance with the MBE/WBE requirements is a matter of contractor responsibility. When subcontracting, the contractor must submit documentation of good faith efforts to meet the project's MBE/WBE requirements before contracted work can commence; MBE/WBE requirements and required documentation are outlined in Supplemental General Conditions for SRF Assisted Public Drinking Water and Wastewater Facilities Construction Contacts. Bidders should use the Subcontractor Listing Form. Failure on the part of the contractor to submit proper documentation may cause the Owner to not execute or to terminate the contract.

DAVIS BACON AND RELATED ACTS: The Davis-Bacon Act and Related Acts are applicable to construction activities under this Contract. The prime contractor, all sub-contractors, and all lower-tier sub-contractors must comply with the Davis-Bacon Act (40 USC. 3141-3144, and 3146-3148) as supplemented by Department of Labor regulations (29 CFR Part 5, "Labor Standards Provisions Applicable to Contracts Covering Federally Financed and Assisted Construction"). The Contract Work Hours and Safety Standards Act (29 CFR §5.5(b)) applies to this contract and the Copeland "Anti-Kickback" Act (40 USC. 3145), as supplemented by Department of Labor regulations (29 CFR Part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States") also applies to all work performed.

Detailed information regarding compliance with the aforementioned labor standards is included in the SRF Supplemental General Conditions.

3. EXECUTION OF THE CONTRACT

A. CONTRACT BONDS

A Performance Bond and Payment Bond in the amount of one-hundred (100%) percent of the Contract Amount with a corporate surety approved by the Owner, will be required for the faithful performance of the Contract.

Attorneys-in-fact who sign Bid Bond, or Performance Bond and/or Payment Bond must file with each Bond a certified and effective dated copy of their power of attorney.

B. INSURANCE

Insurance requirements shall be as specified in Part 3 of the Contract Documents, CONDITIONS OF THE CONTRACT. The successful Bidder shall file with the Owner at the time of delivery of the signed Contract, the insurer's certificate(s) of insurance for each insurance company providing insurance. All evidence of insurance shall be countersigned by a licensed agent residing and engaged in doing business in the State of Alabama. The insurer shall be licensed and authorized to conduct business in the State of Alabama.

C. AGREEMENT

The successful Bidder will be required to execute the Agreement and obtain the Performance Bond and insurance within ten (10) calendar days from the date when Notice of Award is delivered to the Bidder. The Notice of Award shall be accompanied by the necessary Agreement, Bond Forms and evidence of insurance. In case of failure of the Bidder to execute the Agreement, the Owner may consider the Bidder in default, in which case the Bid Security accompanying the proposal shall become the property of the Owner.

Upon receipt of acceptable Bonds, Insurance and Agreement signed by the party to whom the Agreement was awarded, Owner shall sign the Agreement and return to such party an executed duplicate of the Agreement.

D. NOTICE TO PROCEED

A written Notice to proceed shall be issued upon execution of the Agreement by the Owner.

4. CONTRACT DOCUMENTS

A. FORMAT

The Contract Documents governing the Work proposed herein are divided into parts, divisions, and sections for convenient organization and reference. Generally, there has been no attempt to divide the Specification Sections into Work performed by the various building trades, Work by separate Subcontractors, or Work required for separate facilities in the Project.

The separate Sections contained within these Contract Documents are intended to be mutually cooperative and to provide all details reasonably required for the execution of the proposed Work.

B. OTHER

All applicable laws, ordinances, and the rules and regulations of all authorities having jurisdiction over construction of the Project shall apply to the Contract throughout.

PROPOSAL

Proposal of _____ (hereinafter called Bidder"), organized and existing under the laws of the State of _____doing business as * _____, (Individual, Partnership, Corporation) **Central Elmore Water & Sewer Authority**, (hereinafter called "Owner").

In compliance with your Advertisement for Bids, BIDDER hereby proposes to perform all WORK for the construction of the **Central Elmore WTP Upgrade** in strict accordance with the CONTRACT DOCUMENTS, within the time set forth therein, and at the prices stated below.

By submission of this BID, each BIDDER certifies, and in the case of a joint BID each party thereto certifies as to its own organization, that this BID has been arrived at independently, without consultation, communication, or agreement as to any matter relating to this BID with any other BIDDER or with any competitor.

BIDDER hereby agrees to commence the WORK to be performed under this Agreement within seven (7) days from the Agreement start date specified in the Owner's Notice to Proceed, shall substantially complete the Work in all respects within **300** calendar days from the date specified in the Owner's Notice to Proceed and to fully complete the Work, in all respects, within **30** days after substantial completion.

It is mutually agreed between the parties hereto that time is of the essence, and in the event the Work is not substantially completed within the time herein specified it is agreed that the Contractor shall pay liquidated damages in the amount of $1,500.00 per day for each calendar day of delay to the Owner until the Work is substantially completed, as determined by the project engineer. The Contractor agrees that the number of liquidated damages fairly and accurately represents the actual damages which the Owner will have sustained per day by reason of the Contractor's failure to substantially complete the Work within the time specified herein. Liquidated damages are not a penalty but is instead intended to compensate the Owner for costs incurred as a result of the Contractor's delay. The Contractor further agrees that this is a bargained for and essential provision of the agreement and that the Contractor freely and voluntarily submitted a bid for the Work.

Bidder further agrees to compensate the OWNER at the rate of $135.00 per hour for resident observation costs that are a result of:

1. Work performed that requires resident observation services at times other than those considered Normal Work Time as described in the GENERAL CONDITIONS of the contract.

and/or

2. Work performed that requires resident observation services after the specified number of days, previously listed in this PROPOSAL, in order to complete the contract work.

BIDDER hereby acknowledges that he has received Addenda Nos. _____,
_____,_____,_____,_____,_____,_____,_____.

BIDDER agrees to perform all the Work described in the CONTRACT DOCUMENTS for the unit prices or lump sum indicated in the Bid Schedule.

BID SCHEDULE

NOTE: BIDS shall include sales tax, if applicable and all other applicable taxes and fees.

BASE BID

ITEM NO.	QUANTITY AND UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
1.	1 LS	Mobilization/Bonds (<5%)	$_____	$_____
2.	1 LS	Water Treatment Plant improvements including but not limited to storage tank, booster pump station, chemical injection vault, GAC system installation, civil site work, yard piping, electrical systems, temporary systems, landscaping and decommission & demolition of existing structures. I&C Integration and Programming.	$_____	$_____

TOTAL BASE BID $_____

Written: _____ DOLLARS

and _____ CENTS

Additive Alternate Bid Items

ITEM NO.	QUANTITY AND UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
1.	1 LS	Sodium hypochlorite on-site generation system	$_____	$_____
2.	1 LS	Standby Emergency Generator	$_____	$_____
		TOTAL ALTERNATE BIDS	$_____	

Written: _____ DOLLARS

and _____ CENTS

Explanation of Base Bid Items

Item 1 – Mobilization and Bonds
Includes all labor, equipment, and materials required to mobilize to the site and provide project bonding as required in the contract documents. Item 1 shall be less than 5% of the project bid and paid lump sum.

Item 2 – Water Treatment Plant Improvements
Includes all labor, equipment, and materials required to provide a complete operational treatment facility as described in the contract document except for items specifically called for in the bid items below. Payment shall be lump sum based on the contractors approved schedule of values percent complete. This item also provides for plant control systems programming integration by Ardurra for new facility control systems. Allowance includes PLC programming, HMI development, drone photography and control systems start-up assistance and troubleshooting. This allowance does not cover any equipment or labor for items specifically called for in the project specifications or design drawings. All control systems instrumentation, hardware, and software included with the new equipment and improvements shall be furnished by the General Contractor.

Explanation of Alternate Bid Items

Item 1 – Sodium Hypochlorite On-site Generation System
Includes all labor, equipment, and materials required to provide a complete operational sodium hypochlorite generation system as described in the contractor documents and as shown on the drawings. Payment shall be lump sum based on the contractors' approved schedule of values percent complete.

Item 2 – Standby Emergency Generator
Includes all labor, equipment, and materials required to provide a complete operational standby emergency generator as described in the contractor documents and as shown on the

drawings. Payment shall be lump sum based on the contractors' approved schedule of values percent complete.

Non-Pay Items

Items of no specific payment include but are not limited to the following:

1. No specific payment will be made for rock excavation or cushion material.
2. No specific payment will be made for common excavation and back filling.
3. No specific payment will be made for removing spoils and waste.
4. No specific payment will be made for site preparation.
5. No specific payment will be made for plugs, caps, taps, compressors, approved gages and other equipment and labor required for cleaning and testing.
6. No specific payment will be made for the removal and replacing of defective work.
7. No specific payment will be made for unauthorized work and, if directed, it shall be removed without extra compensation.
8. No specific payment will be made for cleanup and maintenance of the Work during construction and the twelve (12) months after final acceptance.
9. No specific payment will be made for returning all unused pipe, fittings or other unused materials to the OWNER's warehouse at the completion of the project.
10. No specific payment will be made for repairing telephone, water, sewer, gas, etc. mains damaged or destroyed by the CONTRACTOR. These utilities shall be repaired by the owner of the damaged utility at the expense of the CONTRACTOR.
11. No specific payment will be made for repairing any property damaged by the CONTRACTOR. This includes property owned by the general public, the Town of Dauphin Island, private individuals, commissions, partnerships, LLCs and any other entity.
12. No specific payment will be made for installation of valves, tees, crosses, caps or other fittings unless specifically called out in the Pricing Format (Bid List). This includes any caps welded on to pipe, fittings or valves for the purposes of testing.

AWARD OF THE CONTRACT

Award of the Contract will be made as stated in the **INSTRUCTIONS TO BIDDERS**. The Owner reserves the right to reject all Proposals where the Owner deems rejection to be in its best interest, or to reject any Proposal not in compliance with the Contract Documents. The Owner reserves the right to waive any informalities and irregularities in said Proposals.

All items required to complete the Work specified but not included in the Proposal shall be considered incidental to the amounts set forth in the Proposal. The total amount paid to the Contractor shall be the amount of the bid as adjusted for Owner selected additives and deductives and as adjusted for Owner authorized changes in the Project.

The Bidder declares that he has carefully examined the Contract Documents for the construction of the Project, that he has personally inspected the site, that he has satisfied himself as to the quantities involved, including materials and equipment, and conditions of Work involved, including the fact that the description of the quantities of Work and materials, as included herein, is brief and is intended only to indicate the general nature of the Work and to identify the said quantities with the detailed requirements of the Contract Documents.

The Bidder further acknowledges that he has satisfied himself as to the nature and location of the Work, the general and local conditions, particularly those bearing upon access to the site; disposal, handling and storage of materials; availability of water, electric power, and roads; and uncertainties of weather, river stages, or similar physical conditions at the site; the conformation and conditions of the ground; the character of equipment and facilities needed preliminary to and during the prosecution of the Work and all other matters which can in any way affect the Work or the cost thereof under this Contract.

Respectfully Submitted:

Bidder	Date
Signature	Address
Title	City, State Zip
License No.	Telephone

SEAL - (if BID is by a corporation)

BID BOND

BOND NO._____
AMOUNT: $_____

STATE OF ALABAMA

KNOW ALL MEN BY THESE PRESENTS, that _____ hereinafter called the PRINCIPAL, and _____ a corporation duly organized under the laws of the State of _____ having its principal place of business at _____ in the State of _____ and authorized to do business in the State of Alabama, as SURETY, are held and firmly bound unto the **Central Elmore Water & Sewer Authority**, Wetumpka, Alabama, as Owner, hereinafter called the OBLIGEE, in the sum of _____ DOLLARS ($_____), for the payment of which we bind ourselves, our heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS BOND IS SUCH THAT:
WHEREAS, the PRINCIPAL is herewith submitting his or its Bid Proposal for the construction of the **Central Elmore WTP Upgrade**, said Bid Proposal, by reference thereto, being hereby made a part hereof.

NOW, THEREFORE, if the Bid Proposal submitted by the PRINCIPAL is accepted, and the Contract awarded to the PRINCIPAL, and if the PRINCIPAL shall execute the proposed Contract, shall provide all insurance required, and shall furnish such Performance Bond, and other bonds as required by the Contract Documents within the time fixed by the Documents, then this obligation shall be void. If the PRINCIPAL shall fail to execute the proposed Contract, provide all insurance required, and furnish these bonds, the SURETY hereby agrees to pay to the OBLIGEE the said sum as noted above.

Signed and sealed this _____ day of _____ 20____.

(SEAL)

_____
PRINCIPAL

By_____
SURETY

By_____
Attorney-In-Fact

(Attach notarized copy of Power-of-Attorney evidencing authority of Attorney-in-Fact to bind the Surety on the date of the execution of the bond.)

AGREEMENT

THIS AGREEMENT, made and entered into on the _____ day of _____ 20 _____, by and between _____ Contractor and **Central Elmore Water & Sewer Authority** Owner:

W I T N E S S E T H:

That the Contractor, for the consideration hereinafter fully set out, hereby agrees with the Owner as follows:

1. That the Contractor shall furnish all the materials and perform all the work for the Project entitled **Central Elmore WTP Upgrade** in manner and form as provided by the following enumerated Drawings, Specifications, and Documents, which are attached hereto and made a part hereof, as if fully contained herein:

   Part 1 - Bidding Requirements
   Part 2 - Contract Forms
   Part 3 - Conditions of the Contract
   Part 4 - Specifications
   Part 5 - Drawings
   Part 6 - Addenda

   (The foregoing are collectively referred to as the "Contract Documents").

2. That the Contractor shall commence the Work to be performed under this Agreement within seven (7) days from the Agreement start date specified in the Owner's Notice to Proceed, shall substantially complete the Work in all respects within _____ Calander days from the date specified in the Owner's Notice to Proceed and to fully complete the Work, in all respects, within **30** days after substantial completion.

3. It is mutually agreed between the parties hereto that time is of the essence, and in the event the Work is not substantially completed within the time herein specified it is agreed that the Contractor shall pay liquidated damages in the amount of $**1,500** per day for each calendar day of delay to the Owner until the Work is substantially completed, as determined by the project engineer. The Contractor agrees that the amount of liquidated damages fairly and accurately represents the actual damages which the Owner will have sustained per day by reason of the Contractor's failure to substantially complete the Work within the time specified herein. Liquidated damages is not a penalty but is instead intended to compensate the Owner for costs incurred as a result of the Contractor's delay. The Contractor further agrees that this is a bargained for and essential provision of the agreement and that the Contractor freely and voluntarily submitted a bid for the Work.

4. That the Owner hereby agrees to pay to the Contractor for the faithful performance of this Agreement, subject to additions and deductions as provided in the Contract Documents in lawful money of the United States, the amount of: _____ Dollars ($_____) based on the lump sum amounts contained herein.

5. That upon submission by the Contractor of evidence satisfactory to the Owner that Notice of Completion requirements have been met, and that all payrolls, material bills, and other costs incurred by the Contractor in connection with the construction of the Work have been paid in full, final payment of account of this Agreement shall be made within thirty (30) days after the completion by the Contractor of all Work covered by this Agreement and the acceptance of such Work by the Owner.

6. That the Work completed herein shall be covered by a warranty as provided by the Performance Bond and as provided in the Contract Documents, effective for a period beginning upon the date of substantial completion and ending one (1) year thereafter.

7. It is further mutually agreed between the parties hereto that if, at any time after the execution of this Agreement and the Surety Bonds hereto attached for its faithful performance and payment, the Owner shall deem the Surety or Sureties upon such bond to be unsatisfactory or if, for any reason such bond ceases to be adequate to cover the performance of the Work, the Contractor shall, at its expense, within five (5) days from the receipt of notice from the Owner so to do, furnish an additional bond or bonds in such form and amount and with such Surety or Sureties as shall be satisfactory to the Owner. In such event, no further payment to the Contractor shall be deemed to be due under this Agreement until such new or additional security for the faithful performance of the Work shall be furnished in manner and form satisfactory to the Owner, and if not furnished the Contractor may be terminated at the option of the Owner by giving ten (10) days written notice.

8. No payment for additional Work or extras will be made unless the same shall be duly authorized by appropriate action by the Owner in writing.

9. By signing this contract, the contracting parties affirm, for the duration of the agreement, that they will not violate federal immigration law or knowingly employ, hire for employment or continue to employ an unauthorized alien within the state of Alabama. Furthermore, a contracting party found to be in violation of this provision shall be deemed in breach of the agreement and shall be responsible for all damages resulting therefrom.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement on the day and date first above written, in four (4) counterparts, each of which shall without proof or accounting for the other counterpart be deemed an original Contract.

If Sole Proprietor or Partnership

_____
Signature of Contractor

_____
Title

If Corporation

(SEAL)

_____
Name of Corporation

ATTEST:

By_____

_____
Secretary

Title _____

ATTEST:

Owner

_____
Secretary

By_____
Chairman

PERFORMANCE BOND

Bond No. _____

Amount: $ _____

STATE OF ALABAMA
KNOW ALL MEN BY THESE PRESENTS, that _____ of _____ hereinafter called the CONTRACTOR (Principal), and _____ a corporation duly organized and existing under and by virtue of the laws of the State of _____, hereinafter called the SURETY, and authorized to transact business within the State of Alabama, as SURETY, are held and firmly bound unto the **Central Elmore Water & Sewer Authority,** as OWNER (Obligee), in the sum of: _____DOLLARS ($ _____) lawful money of the United States of America, for the payment of which, well and truly be made to the OWNER, the CONTRACTOR and the SURETY bind themselves and each of their heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents as follows:

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH THAT:
WHEREAS, the CONTRACTOR has executed and entered into a certain Agreement hereto attached, with the OWNER, dated _____ 20 _____, for the **Central Elmore WTP Upgrade.**

NOW, THEREFORE, if the CONTRACTOR shall in all things perform all the terms and conditions of the within and foregoing Agreement as provided in the Contract Documents to be by such CONTRACTOR performed, and shall honor all claims for defective Work made within the warranty period following completion and acceptance of the Work as established in the Contract Documents and shall pay over, make good and reimburse to the OWNER, all loss or damage which the OWNER may sustain by reason of failure or default on the part of the CONTRACTOR, then this obligation shall be void; otherwise it shall be and remain in full force and effect.

PROVIDED, HOWEVER, that the SURETY, for the value received, hereby stipulates and agrees that no change, extension of time, alteration, or addition to the terms of the Contract Documents or to the Work to be performed, thereunder, shall in any way affect its obligation on this bond, and it does hereby waive notice of any such change, extension of time, alteration, or addition to the terms of the Contract Documents.

IN WITNESS WHEREOF, the above parties bounded together have executed this instrument this _____ day of _____ 20____.

CONTRACTOR

(Seal) By_____

Attest

_____

(Seal) SURETY

By_____

Countersigned:

_____

Resident Agent

_____

Address

_____

(Attach notarized copy of Power-of-Attorney evidencing authority of Attorney-in-Fact to bind the Surety on the date of the execution of the bond.)

PAYMENT BOND

Bond No. _____

Amount: $_____

STATE OF ALABAMA

KNOW ALL MEN BY THESE PRESENTS, that _____ of _____ hereinafter called the CONTRACTOR (Principal), and _____a corporation duly organized and existing under and by virtue of the laws of the State of _____, hereinafter called the SURETY, and authorized to transact business within the State of Alabama, as SURETY, are held and firmly bound unto the **Central Elmore Water & Sewer Authority,** as OWNER (Obligee), in the sum of _____ DOLLARS ($_____) lawful money of the United States of America, for the payment of which, well and truly be made to the OWNER, the CONTRACTOR and the SURETY bind themselves and each of their heirs, executors, administrators, successors, and assigns, jointly and severally, firmly by these presents as follows:

WHEREAS, the CONTRACTOR has executed and entered into a certain Agreement hereto attached, with the OWNER, dated _____20_____, for the which Agreement and the Specifications for said Work shall be deemed a part hereof as fully as if set out herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH that if said Principal and all Subcontractors to whom any portion of Work provided for in said Contract is sublet and all assignees of said Principal and of such Subcontractors shall promptly make payments to all persons supplying him or them with labor, materials, or supplies for or in the prosecution of the Work provided for in such Agreement, or in any amendment or extension of or additions to said Agreement, and for the payment of reasonable attorney's fees, incurred by the claimant or claimants in suits on each bond, then the above obligations shall be void; otherwise to remain in full force and effect. PROVIDED, however, that this bond is subject to the following conditions and limitations.

A. Any person, firm or corporation that has furnished labor, materials, or supplies for or in the prosecution of the Work provided for in said Agreement shall have a direct right of action against the Principal and Surety on this bond, which right of action shall be asserted in a proceeding instituted in the County in which the Work provided for in said Agreement is to be performed or in any County in which said Principal and Surety does business. Such right of action shall be asserted in a proceeding instituted in the name of the claimant or claimants for his or their use and benefit against said Principal and Surety or either of them (but not later than one (1) year after the final settlement of said Agreement) in which action such claim or claims shall be adjudicated and judgment rendered thereon.

B. The Principal and Surety hereby designate and appoint _____.

(To be filled in by Surety Company)

as the agent of each of them to receive and accept service of process or other pleading issued or filed in any proceeding instituted on this bond and hereby consent that such service shall be the same as personal service on the Principal and/or Surety.

C. The Surety shall not be liable hereunder for damage or compensation recoverable under any Worker's Compensation or Employer's Liability Statute.

D. In no event shall the Surety be liable for a greater sum than the penalty of this bond, or subject to any suit, action or preceding thereon that is instituted later than one (1) year after the final settlement of said Agreement.

E. This bond is given pursuant to the terms of Act No. 39, General Laws of Alabama, approved February 8, 1935, entitled "An Act to Further Provide for Bond of Contractors on State and Other Public Works and Suits Thereon."

IN WITNESS WHEREOF, the above parties bounded together have executed this instrument this _____ day of _____ 20_____.

CONTRACTOR

(Seal)

By_____

Attest

_____

(Seal)

SURETY

By_____

Countersigned:

_____

Resident Agent

_____

Address

_____

(Attach notarized copy of Power-of-Attorney evidencing authority of Attorney-in-Fact to bind the Surety on the date of the execution of the bond.)

State of _____)
County of _____)

CERTIFICATE OF COMPLIANCE WITH THE BEASON-HAMMON ALABAMA TAXPAYER AND CITIZEN PROTECTION ACT (ACT 2011-535, as amended by ACT 2012-491)

DATE: _____

RE Contract/Grant/Incentive (describe by number or subject):
_____ by and between
_____ (Contractor/Grantee) and
_____ (State Agency, Department or Public Entity)

The undersigned hereby certifies to the State of Alabama as follows:

1. The undersigned holds the position of _____ with the Contractor/Grantee named above, and is authorized to provide representations set out in this Certificate as the official and binding act of that entity, and has knowledge of the provisions of THE BEASON-HAMMON ALABAMA TAXPAYER AND CITIZEN PROTECTION ACT (ACT 2011-535 of the Alabama Legislature, as amended by ACT 2012-491) which is described herein as "the Act."
2. Using the following definitions from Section 3 of the Act, select and initial either **(a)** or **(b)**, below, to describe the Contractor/Grantee's business structure.

   BUSINESS ENTITY. Any person or group of persons employing one or more persons performing or engaging in any activity, enterprise, profession, or occupation for gain, benefit, advantage, or livelihood, whether for profit or not for profit.

   a. Self-employed individuals, business entities filing articles of incorporation, partnerships, limited partnerships, limited liability companies, foreign corporations, foreign limited partnerships, and foreign limited liability companies authorized to transact business in this state, business trusts, and any business entity that registers with the Secretary of State.

   b. Any business entity that possesses a business license, permit, certificate, approval, registration, charter, or similar form of authorization issued by the state, any business entity that is exempt by law from obtaining such a business license, and any business entity that is operating unlawfully without a business license.

   EMPLOYER. Any person, firm, corporation, partnership, joint stock association, agent, manager, representative, foreman, or other person having control or custody of any employment, place of employment, or of any employee, including any person or entity employing any person for hire within the State of Alabama, including a public employer. This term shall not include the occupant of a household contracting with another person to perform casual domestic labor within the household.

____ (a) The Contractor/Grantee is a business entity or employer as those terms are defined in Section 3 of the Act.
____ (b) The Contractor/Grantee is not a business entity or employer as those terms are defined in Section 3 of the Act.

3. As of the date of this Certificate, the Contractor/Grantee does not knowingly employ an unauthorized alien within the State of Alabama and hereafter it will not knowingly employ, hire for employment, or continue to employ an unauthorized alien within the State of Alabama;
4. The Contractor/Grantee is enrolled in E-Verify unless it is not eligible to enroll because of the rules of that program or other factors beyond its control.

Certified this _____ day of _____ 20_____.

_____
Name of Contractor/Grantee/Recipient

By: _____

Its _____

The above Certification was signed in my presence by the person whose name appears above, on this _____ day of _____ 20_____.

WITNESS: _____

_____
Printed Name of Witness

GENERAL CONDITIONS

1. Definitions
2. Additional Instructions and Detail Drawings
3. Schedules, Reports, and Records
4. Drawings and Specifications
5. Shop Drawings
6. Materials, Services, and Facilities
7. Inspection and Testing
8. Substitutions
9. Patents
10. Surveys, Permits, Regulations
11. Protection of Work, Property, Persons
12. Supervision by Contractor
13. Changes in the Work
14. Changes in Contract Price
15. Time for Completion and Liquidated Damages
16. Correction of Work
17. Subsurface Conditions
18. Suspension of Work, Termination, and Delay
19. Payments to Contractor
20. Acceptance of Final Payment as Release
21. Insurance
22. Contract Security
23. Assignments
24. Indemnification
25. Separate Contracts
26. Subcontracting
27. Engineer's Authority
28. Land and Rights-of-Way
29. Guarantee
30. Taxes
31. Records Retention/Access/Audits

1. DEFINITIONS

Wherever used in the CONTRACT DOCUMENTS, the following terms shall have the meanings indicated and shall be applicable to both the singular and plural thereof:

A. ADDENDA- Written or graphic instruments issued prior to the execution of the Agreement which modify or interpret the CONTRACT DOCUMENTS, DRAWINGS and SPECIFICATIONS, by additions, deletions, clarifications, or corrections.

B. BID- The offer or proposal of the BIDDER submitted on the prescribed form setting forth the price for the WORK to be performed.

C. BIDDER- Any person, firm, or corporation submitting a BID for the WORK.

D. BONDS- Bid, Performance, and Payment Bonds and other instruments of surety, furnished by the CONTRACTOR and the CONTRACTOR'S surety in accordance with the CONTRACT DOCUMENTS.

E. CHANGE ORDER- A written order to the CONTRACTOR authorizing an addition, deletion, or revision in the WORK within the general scope of the CONTRACT DOCUMENTS, or authorizing an adjustment in the CONTRACT PRICE or CONTRACT TIME.

F. CONTRACT DOCUMENTS- The Contract, including Advertisement for BIDS, Instructions to BIDDERS, PROPOSAL, BID BOND, Agreement, Payment BOND, Performance BOND, CHANGE ORDER, DRAWINGS, SPECIFICATIONS, and ADDENDA.

G. CONTRACT PRICE- The total monies payable to the CONTRACTOR under the terms and conditions of the CONTRACT DOCUMENTS.

H. CONTRACT TIME- The number of calendar days stated in the CONTRACT DOCUMENTS for the completion of the WORK.

I. CONTRACTOR- The person, firm, or corporation with whom the OWNER has executed the Agreement.

J. DRAWINGS- The parts of the CONTRACT DOCUMENTS which show the characteristics and scope of the WORK to be performed and which have been prepared or approved by the ENGINEER.

K. ENGINEER- The person, firm, or corporation named as such in the CONTRACT DOCUMENTS.

L. FIELD ORDER- A written order effecting a change in the WORK not involving an adjustment in the CONTRACT PRICE or an extension of the CONTRACT TIME, issued by the ENGINEER to the CONTRACTOR during construction.

M. NOTICE OF AWARD- The written notice of the acceptance of the BID from the OWNER to the successful BIDDER.

N. NOTICE TO PROCEED- Written communication issued by the OWNER to the CONTRACTOR authorizing him/her to proceed with the WORK and establishing the date for commencement of the WORK.

O. OWNER- A public or quasi-public body or authority, corporation, association, partnership, or an individual for whom the WORK is to be performed.

P. PROJECT- The undertaking to be performed as provided in the CONTRACT DOCUMENTS.

Q. RESIDENT PROJECT REPRESENTATIVE- The authorized representative of the OWNER who is assigned to the PROJECT site or any part thereof.

R. SHOP DRAWINGS- All Drawings, diagrams, illustrations, brochures, schedules and other data which are prepared by the CONTRACTOR, a SUBCONTRACTOR, manufacturer, SUPPLIER or distributor, which illustrate how specific portions of the WORK shall be fabricated or installed.

S. SPECIFICATIONS- A part of the CONTRACT DOCUMENTS consisting of written descriptions of a technical nature of materials, equipment, construction systems, standards and workmanship.

T. SUBCONTRACTOR- An individual, firm, or corporation having a direct contract with the CONTRACTOR or with any other SUBCONTRACTOR for the performance of a part of the WORK at the site.

U. SUBSTANTIAL COMPLETION- That date certified by the ENGINEER when the construction of the PROJECT or a specified part thereof is sufficiently completed, in accordance with the CONTRACT DOCUMENTS, so that the PROJECT or specified part can be utilized for the purposes for which it is intended and startup is complete. Startup shall not be complete until the entire treatment facility operates successfully and continuously for seven (7) consecutive days.

V. SUPPLEMENTAL GENERAL CONDITION- Modifications to General Conditions as if included as part of the General Conditions.

W. SUPPLIER- Any person or organization who supplies materials or equipment for the WORK, including that fabricated to a special design, but who does not perform labor at the site.

X. WORK- All labor necessary to produce the construction required by the CONTRACT DOCUMENTS, and all materials and equipment incorporated or to be incorporated in the PROJECT.

Y. WRITTEN NOTICE- Any notice to any party of the Agreement relative to any part of this Agreement in writing and considered delivered and the service thereof completed, when posted by certified or registered mail to the said party at their last given address, or delivered in person to said party or their authorized representative on the WORK.

2. ADDITIONAL INSTRUCTIONS AND DETAIL DRAWINGS

A. The CONTRACTOR may be furnished additional instructions and detail Drawings, by the ENGINEER, as necessary to carry out the WORK required by the CONTRACT DOCUMENTS.

B. The additional Drawings and instructions thus supplied will become a part of the CONTRACT DOCUMENTS. The CONTRACTOR shall carry out the WORK in accordance with the additional detail Drawings and instructions.

3. SCHEDULE, REPORTS AND RECORDS

A. The CONTRACTOR shall submit to the OWNER such schedule of quantities and costs, progress schedules, payrolls, reports, estimates, records and other data where applicable as are required by the CONTRACT DOCUMENTS for the Work to be performed.

B. Prior to the first partial payment estimate the CONTRACTOR shall submit construction progress schedules showing the order in which the CONTRACTOR proposes to carry on the WORK, including dates at which the various parts of the WORK will be started, estimated date of completing each part and, as applicable:

1. The dates at which special detail Drawings will be required; and

2. Respective dates for submission of SHOP DRAWINGS, the beginning of manufacture, the testing and the installation of materials, supplies and equipment.

C. The CONTRACTOR shall also submit a schedule of payments that the CONTRACTOR anticipates will be earned during the course of the WORK.

D. NORMAL WORK TIME, for the purpose of this contract, shall be defined as Monday through Friday for 8 hours per day. Unless previously agreed to before commencement of work under this contract by the OWNER and the ENGINEER, all other work times are not considered NORMAL WORK TIME. Holidays observed by the Federal Government are not considered NORMAL WORK TIME.

The CONTRACTOR may perform work that does not require Engineering and/or inspection services outside of NORMAL WORK TIME. For example, clearing, cleanup, grassing, mulching, etc., may be done on weekends.

4. DRAWINGS AND SPECIFICATIONS

A. The intent of the DRAWINGS and SPECIFICATIONS is that the CONTRACTOR shall furnish all labor, materials, tools, equipment, and transportation necessary for the proper execution of the WORK in accordance with the CONTRACT DOCUMENTS and all incidental Work necessary to complete the Project in an acceptable manner, ready for use, occupancy or operation by the OWNER.

B. Any discrepancies or conflicts found between the DRAWINGS and SPECIFICATIONS and site conditions or any inconsistencies or ambiguities in the DRAWINGS or SPECIFICATIONS shall be immediately reported to the ENGINEER, in writing, who shall promptly correct such inconsistencies or ambiguities in writing. WORK performed by the CONTRACTOR after discovery of such discrepancies, inconsistencies or ambiguities shall be done at the CONTRACTOR'S risk.

5. SHOP DRAWINGS

A. The CONTRACTOR shall provide SHOP DRAWINGS as may be necessary for the prosecution of the WORK as required by the CONTRACT DOCUMENTS. The ENGINEER shall promptly review all SHOP DRAWINGS. The ENGINEER'S approval of any SHOP DRAWING shall not release the CONTRACTOR from responsibility for deviations from the CONTRACT DOCUMENTS. The approval of any SHOP DRAWING which substantially deviates from the requirement of the CONTRACT DOCUMENTS shall be evidenced by a CHANGE ORDER.

B. When submitted for the ENGINEER'S review, SHOP DRAWINGS shall bear the CONTRACTOR'S certification that he has reviewed, checked and approved the SHOP DRAWINGS and that they are in conformance with the requirements of the CONTRACT DOCUMENTS.

C. Portions of the WORK requiring a SHOP DRAWING or sample submission shall not begin until the SHOP DRAWING or submission has been approved by the ENGINEER. A copy of each approved SHOP DRAWING and each approved sample shall be kept in good order by the CONTRACTOR at the site and shall be available to the ENGINEER.

6. MATERIALS, SERVICES AND FACILITIES

A. It is understood that, except as otherwise specifically stated in the CONTRACT DOCUMENTS, the CONTRACTOR shall provide and pay for all materials, labor, tools, equipment, water, light, power, transportation, supervision, temporary construction of any nature, and all other services and facilities of any nature whatsoever necessary to execute, complete, and deliver the WORK within the specified time.

B. Materials and equipment shall be so stored as to insure the preservation of their quality and fitness for the WORK. Stored materials and equipment to be incorporated in the WORK shall be located so as to facilitate prompt inspection.

C. Manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as directed by the manufacturer.

D. Materials, supplies, and equipment shall be in accordance with samples submitted by the CONTRACTOR and approved by the ENGINEER.

E. Materials, supplies, or equipment to be incorporated into the WORK shall not be purchased by the CONTRACTOR or the SUBCONTRACTOR subject to a chattel mortgage or

under a conditional sale contract or other agreement by which an interest is retained by the seller.

7. INSPECTION AND TESTING

A. All materials and equipment used in the construction of the PROJECT shall be subject to adequate inspection and testing in accordance with generally accepted standards, as required and defined in the CONTRACT DOCUMENTS.

B. The CONTRACTOR shall provide all inspection and testing services performed by a third party testing company approved by the OWNER.

C. The CONTRACTOR shall provide at the CONTRACTOR'S expense the testing and inspection services required by the CONTRACT DOCUMENTS.

D. If the CONTRACT DOCUMENTS, laws, ordinances, rules, regulations or orders of any public authority having jurisdiction require any WORK to specifically be inspected, tested, or approved by someone other than the CONTRACTOR, the CONTRACTOR will give the ENGINEER timely notice of readiness. The CONTRACTOR will then furnish the ENGINEER the required certificates of inspection, testing or approval.

E. Inspections, tests, or approvals by the engineer or others shall not relieve the CONTRACTOR from the obligations to perform the WORK in accordance with the requirements of the CONTRACT DOCUMENTS.

F. The ENGINEER, ENGINEER'S representatives , and authorized OWNER representatives will at all times have access to the WORK. In addition, authorized representatives and agents of any participating Federal or State agency must be permitted to inspect all work, materials, payrolls, records or personnel, invoices of materials, and other relevant data and records. The CONTRACTOR will provide proper facilities for such access and observation of the Work and also for any inspection or testing thereof.

G. If any WORK is covered contrary to the written instructions of the ENGINEER it must, if required by the ENGINEER, be uncovered for the ENGINEER'S observation and replaced at the CONTRACTOR'S expense.

H. If the ENGINEER considers it necessary or advisable that covered WORK be inspected or tested by others, the CONTRACTOR, at the ENGINEER'S request, will uncover, expose or otherwise make available for observation, inspection or testing as the ENGINEER may require, that portion of the WORK in question, furnishing all necessary labor, materials, tools, and equipment. If it is found that such WORK is defective, the CONTRACTOR will bear all the expenses of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction. If, however, such WORK is not found to be defective, the CONTRACTOR will be allowed an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, directly attributable to such uncovering, exposure, observation, inspection, testing and reconstruction and an appropriate CHANGE ORDER will be issued.

8. SUBSTITUTIONS

A. Whenever a material, article, or piece of equipment is identified on the DRAWINGS or SPECIFICATIONS by reference to brand name or catalogue numbers, it shall be understood that this is referenced for the purpose of defining the performance or other salient requirements and that other products of equal capacities, quality and function shall be considered. The CONTRACTOR may recommend the substitution of a material, article, or piece of equipment of equal substance and function for those referred to in the CONTRACT DOCUMENTS by reference to brand name or catalogue number, and if, in the opinion of the ENGINEER, such material, article, or piece of equipment is of equal substance and function to the specified, the ENGINEER may approve its substitution and use by the CONTRACTOR. Any cost differential shall be deductible from the CONTRACT PRICE and the CONTRACT DOCUMENTS shall be appropriately modified by CHANGE ORDER. The CONTRACTOR warrants that if substitutes are approved, no major changes in the function or general design of the PROJECT will result. Incidental changes or extra component parts required to accommodate the substitute will be made by the CONTRACTOR without a change in the CONTRACT PRICE or CONTRACT TIME.

9. PATENTS

A. The CONTRACTOR shall pay all applicable royalties and license fees, and shall defend all suits or claims for infringement of any patent rights and save the OWNER harmless from loss on account thereof, except that the OWNER shall be responsible for any such loss when a particular process, design or product of a particular manufacturer or manufacturers is specified, however, if the CONTRACTOR has reason to believe that the design, process or product specified is an infringement of a patent, the CONTRACTOR shall be responsible for such loss unless the CONTRACTOR promptly gives such information to the ENGINEER.

10. SURVEYS, PERMITS, REGULATIONS

A. The OWNER shall furnish all boundary surveys and establish all base lines for locating the principal component parts of the WORK together with a suitable number of bench marks adjacent to the WORK as shown in the CONTRACT DOCUMENTS. From the information provided by the OWNER, unless otherwise specified in the CONTRACT DOCUMENTS, the CONTRACTOR shall develop and make all detail surveys needed for construction such as slope stakes, batter boards, stakes for pipe locations and other working points, lines, elevations and cut sheets.

B. The CONTRACTOR shall carefully preserve bench marks, reference points and stakes and, in case of willful or careless destruction, shall be charged with the resulting expense and shall be responsible for any mistake that may be caused by their unnecessary loss or disturbance.

C. Permits and licenses of a temporary nature necessary for the prosecution of the WORK shall be secured and paid for by the CONTRACTOR unless otherwise stated in the Contract Documents. Permits, licenses and easements for permanent structures or permanent changes in existing facilities shall be secured and paid for the OWNER, unless otherwise specified. The CONTRACTOR shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the WORK as drawn and specified. If the CONTRACTOR observes that the CONTRACT DOCUMENTS are at variance therewith, the

CONTRACTOR shall promptly notify the ENGINEER in writing, and any necessary changes shall be adjusted in Section 13, CHANGES IN THE WORK.

11. PROTECTION OF WORK, PROPERTY, AND PERSONS

A. The CONTRACTOR shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the WORK. The CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to all employees on the WORK and other persons who may be affected thereby, all the WORK and all materials or equipment to be incorporated therein, whether in storage on or off the site, and other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course on construction.

B. The CONTRACTOR shall comply with all applicable laws, ordinances, rules, regulations and orders of any public body having jurisdiction. The CONTRACTOR shall erect and maintain, as required by the conditions and progress of the WORK, all necessary safeguards for safety and protection. The CONTRACTOR shall notify owners of adjacent utilities when prosecution of the WORK may affect them. The CONTRACTOR shall remedy all damage, injury or loss to any property caused, directly or indirectly, in whole or part, by the CONTRACTOR, any SUBCONTRACTOR or anyone directly or indirectly employed by any of them or anyone of whose acts any of or loss attributable to the fault of the CONTRACT DOCUMENTS or to the acts or omissions of the OWNER, of the ENGINEER or anyone employed by either of them or anyone for whose acts either of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of the CONTRACTOR.

C. In emergencies affecting the safety of persons or the WORK or property at the site or adjacent thereto, the CONTRACTOR, without special instructions or authorization from the ENGINEER or OWNER, shall act to prevent threatened damage, injury or loss. The CONTRACTOR shall give the ENGINEER prompt WRITTEN NOTICE of any significant changes in the WORK or deviations from the CONTRACT DOCUMENTS caused thereby, and a CHANGE ORDER shall thereupon be issued covering the changes and deviations involved.

12. SUPERVISION BY CONTRACTOR

A. The CONTRACTOR shall supervise and direct the WORK. He shall be solely responsible for the means, methods, techniques, sequences and procedures of construction. The CONTRACTOR shall employ and maintain on the WORK a qualified supervisor or superintendent who shall have been designated in writing by the CONTRACTOR as the CONTRACTOR'S representative at the site. The supervisor shall have full authority to act on behalf of the CONTRACTOR and all communications given to the supervisor shall be as binding as if given to the CONTRACTOR. The supervisor shall be present on the site at all times as required to perform adequate supervision and coordination of the Work.

13. CHANGES IN THE WORK

A. The OWNER may at any time, as the need arises, order changes within the scope of the WORK without invalidating the Agreement. If such changes increase or decrease the amount due under the CONTRACT DOCUMENTS, or in the time required for performance of the WORK, an equitable adjustment shall be authorized by CHANGE ORDER.

B. The ENGINEER, also, may at any time, by issuing a FIELD ORDER, make changes in the details of the WORK. The CONTRACTOR shall proceed with the performance of any changes in the WORK so ordered by the ENGINEER unless the CONTRACTOR believes that such FIELD ORDER entitles the CONTRACTOR to a change in CONTRACT PRICE or TIME, or both, in which event the CONTRACTOR shall give the ENGINEER WRITTEN NOTICE thereof within seven (7) days after the receipt of the ordered change. Thereafter the CONTRACTOR shall document the basis for the change in CONTRACT PRICE or TIME within ten (10) days, unless the ENGINEER agrees in writing to the need for additional time due to no fault of the CONTRACTOR. The CONTRACTOR shall not execute such changes pending the receipt of an executed CHANGE ORDER or further instruction from the OWNER.

14. CHANGES IN CONTRACT PRICE

A. The CONTRACT PRICE may be changed only by a CHANGE ORDER. The value of any WORK covered by a CHANGE ORDER or of any claim for increase or decrease in the CONTRACT PRICE shall be determined by one or more of the following methods in the order of precedence listed below:

1. Unit prices previously approved.
2. An agreed lump sum.
3. Cost of labor and materials plus ten (10%) percent for direct work completed by the CONTRACTOR and a markup of five (5%) percent on Work completed by SUBCONTRACTORS.

15. TIME FOR COMPLETION AND LIQUIDATED DAMAGES

A. The date of beginning and the time for completion of the WORK are essential conditions of the CONTRACT DOCUMENTS and the WORK embraced shall be commenced on a date specified in the NOTICE TO PROCEED.

B. The CONTRACTOR shall proceed with the WORK at such rate of progress to insure full completion within the CONTRACT TIME. It is expressly understood and agreed, by and between the CONTRACTOR and the OWNER, that the CONTRACT TIME for the completion of the WORK described herein is a reasonable time, taking into consideration the average climatic and economic conditions and other factors prevailing in the locality of the WORK.

C. If the CONTRACTOR shall fail to complete the WORK within the CONTRACT TIME, or extension of the time granted by the OWNER, then the CONTRACTOR shall pay to the OWNER the amount for liquidated damages as specified in the BID for each calendar day that the CONTRACTOR shall be in default after the time stipulated in the CONTRACT DOCUMENTS.

D. The CONTRACTOR shall not be charged with liquidated damages or any excess cost when the delay in completion of the WORK is due to the following and the CONTRACTOR has promptly given WRITTEN NOTICE of such delay to the OWNER or ENGINEER.

1. To any preference, priority or allocation order duly issued by the OWNER.

2. To unforeseeable causes beyond the control and without the fault or negligence of the CONTRACTOR, including but not restricted to, acts of God, or of the public enemy, acts of the OWNER, act of another CONTRACTOR in the performance of a contract with the OWNER, fires, floods, epidemics, quarantine restrictions, strikes, freight embargoes, and abnormal and unforeseeable weather.

3. To any delays of SUBCONTRACTORS occasioned by any of the causes specified in paragraphs 1. and 2. of this article.

16. CORRECTION OF WORK

A. The CONTRACTOR shall promptly remove from the premises all WORK rejected by the ENGINEER for failure to comply with the CONTRACT DOCUMENTS, whether incorporated in the construction or not, and the CONTRACTOR shall promptly replace and re-execute the WORK in accordance with the CONTRACT DOCUMENTS and without expense to the OWNER and shall bear the expense of making good all WORK of other CONTRACTORS destroyed or damaged by such removal or replacement.

B. All removal and replacement WORK shall be done at the CONTRACTOR'S expense. If the CONTRACTOR does not take action to remove such rejected WORK within ten (10) days after receipt of WRITTEN NOTICE, the OWNER may remove such WORK and store the materials at the expense of the CONTRACTOR.

17. SUBSURFACE CONDITIONS

A. The CONTRACTOR shall promptly, and before such conditions are disturbed, except in the event of an emergency, notify the OWNER by WRITTEN NOTICE of:

1. Subsurface or latent physical conditions at the site differing materially from those indicated in the CONTRACT DOCUMENTS; or

2. Unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in WORK of the character provided for in the CONTRACT DOCUMENTS.

B. The OWNER will promptly investigate the conditions, and if it is found that such conditions do so materially differ and cause an increase or decrease in the cost of, or in the time required for, performance of the WORK, an equitable adjustment shall be made and the CONTRACT DOCUMENTS shall be modified by a CHANGE ORDER. Any claim of the

CONTRACTOR for adjustment hereunder will not be allowed unless the required WRITTEN NOTICE has been given; provided that the OWNER may, if the OWNER determines the facts so justify, consider and adjust any such claims asserted before the date of final payment.

18. SUSPENSION OF WORK, TERMINATION, AND DELAY

A. The OWNER may suspend the WORK or any portion thereof for a period of not more than ninety days or such further time as agreed upon by the CONTRACTOR, by WRITTEN NOTICE to the CONTRACTOR and the ENGINEER which shall fix the date on which WORK shall be resumed. The CONTRACTOR shall resume that WORK on the date so fixed. The CONTRACTOR shall be allowed an increase in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, directly attributable to any suspension.

B. If the CONTRACTOR is adjudged bankrupt or insolvent, or makes a general assignment for the benefit of its creditors, or if a trustee or receiver is appointed for the CONTRACTOR or for any of its property, or if CONTRACTOR files a petition to take advantage of any debtor's act, or to reorganize under the bankruptcy or applicable laws, or repeatedly fails to supply sufficient skilled workmen or suitable materials or equipment, or repeatedly fails to make prompt payments to SUBCONTRACTORS or for labor, materials or equipment, or disregards laws, ordinances, rules, regulations or orders of any public body having jurisdiction of the WORK or disregards the authority of the ENGINEER, or otherwise violates any provision of the CONTRACT DOCUMENTS, then the OWNER may without prejudice to any other right or remedy and after giving the CONTRACTOR and its surety a minimum of ten (10) days from delivery of a WRITTEN NOTICE, terminate the services of the CONTRACTOR and take possession of the PROJECT and of all materials, equipment, tools, construction equipment and machinery thereon owned by the CONTRACTOR, and finish the WORK by whatever method the OWNER may deem expedient.

In such case the CONTRACTOR shall not be entitled to receive any further payment until the WORK is finished. If the unpaid balance of the CONTRACT PRICE exceeds the direct and indirect costs of completing the PROJECT, including compensation for additional professional services, such excess SHALL BE PAID TO THE CONTRACTOR. If such costs exceed such unpaid balance, the CONTRACTOR shall pay the difference to the OWNER. Such costs incurred by the OWNER will be determined by the ENGINEER and incorporated in a CHANGE ORDER.

C. Where the CONTRACTOR'S services have been so terminated by the OWNER, said termination shall not affect any right of the OWNER against the CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of monies by the OWNER due the CONTRACTOR will not release the CONTRACTOR from compliance with the CONTRACT DOCUMENTS.

D. After ten (10) days from delivery of a WRITTEN NOTICE to the CONTRACTOR and the ENGINEER, the OWNER may, without cause and without prejudice to any other right or remedy, elect to abandon the PROJECT and terminate the CONTRACT. In such case the CONTRACTOR will be paid for all WORK executed and any expense sustained plus reasonable profit.

E. If, through no act or fault of the CONTRACTOR, the WORK is suspended for a period of more than ninety (90) days by the OWNER or under an order of court or other public authority, or the ENGINEER fails to act on any request for payment within thirty (30) days after it is submitted, or the OWNER fails to pay the CONTRACTOR substantially the sum approved by the ENGINEER within thirty (30) days of its approval and presentation, then the CONTRACTOR may, after ten (10) days from delivery of a WRITTEN NOTICE to the OWNER and the ENGINEER terminate the CONTRACT and recover from the OWNER payment for all WORK until paid all amounts then due, in which event and upon resumption of the WORK CHANGE ORDERS shall be issued for adjusting the CONTRACT PRICE or extending the CONTRACT TIME or both to compensate for the costs and delays attributable to the stoppage of the WORK.

F. If the performance of all or any portion of the WORK is suspended, delayed, or interrupted as a result of a failure of the OWNER or ENGINEER to act within the time specified in the CONTRACT DOCUMENTS, or if no time is specified, within a reasonable time, an adjustment in the CONTRACT PRICE or an extension of the CONTRACT TIME, or both, will be made by CHANGE ORDER to compensate the CONTRACTOR for the costs and delays necessarily caused by the failure of the OWNER or ENGINEER.

19. PAYMENT TO CONTRACTOR

A. At least ten (10) days before each progress payment falls due (but not more often than once a month), the CONTRACTOR shall submit to the ENGINEER a partial payment estimate filled out and signed by the CONTRACTOR covering the WORK performed during the period covered by partial payment estimate and supported by such data as the ENGINEER may reasonably require. If payment is requested on the basis of materials and equipment not incorporated in the WORK but delivered and suitably stored at or near the site, the partial payment estimate shall also be accompanied by such supporting data, satisfactory to the OWNER, as will establish the OWNER'S title to the material and equipment and protect the OWNER'S interest therein, including applicable insurance.

The ENGINEER will, within ten (10) days after receipt of each partial payment estimate, either indicate in writing approval of payment, and present the partial payment estimate to the OWNER, or return the partial payment estimate to the CONTRACTOR indicating in writing the reasons for refusing to approve payment. In the latter case, the CONTRACTOR may make the necessary corrections and resubmit the partial payment estimate. The OWNER will, within ten (10) days of presentation of an approved partial payment estimate, pay the CONTRACTOR a progress payment on the basis of the approved partial payment estimate less the retainage. The retainage shall be an amount equal to five (5%) percent of said estimate until one hudred (100%) percent of the Work has been completed. Retainage is per ADCNR requirements.

At fifty (50%) percent completion or any time thereafter when the progress of the Work is not proceeding satisfactory, additional amounts may be retained but in no event will the total retainage be more than ten (10%) percent of the value of the Work completed. Upon substantial completion of the Work, any amount retained may be paid to the CONTRACTOR. When the Work has been substantially completed except for WORK which cannot be completed because of weather conditions, lack of materials or other reasons which in the judgment of the OWNER

are valid reasons for noncompletion, the OWNER may make additional payments, retaining at all times an amount sufficient to cover the estimated cost of the WORK still to be completed.

B. The request for payment may also include an allowance for the cost of such major materials and equipment which are suitably stored either at or near the site.

C. Prior to SUBSTANTIAL COMPLETION, the OWNER, with the approval of the ENGINEER and with the concurrence of the CONTRACTOR, may use any completed or substantially completed portions of the WORK. Such use will not constitute an acceptance of such portions of the WORK.

D. The OWNER will have the right to enter the premises for the purpose of doing Work not covered by the CONTRACT DOCUMENTS. This provision shall not be construed as relieving the CONTRACTOR of the sole responsibility for the care and protection of the WORK, or the restoration of any damaged WORK except such as may be caused by agents or employees of the OWNER.

E. Upon completion and acceptance of the WORK, the ENGINEER will issue a certificate attached to the final payment request that the WORK has been accepted under the conditions of the CONTRACT DOCUMENTS. The entire balance found to be due the CONTRACTOR, including the retained percentages, but except such sums as may be lawfully retained by the OWNER, will be paid to the CONTRACTOR within thirty (30) days of completion and acceptance of the WORK and receipt of an Affidavit for advertising final completion.

F. The CONTRACTOR shall indemnify and save the OWNER or the OWNER'S agents harmless from all claims growing out of the lawful demand of SUBCONTRACTORS, laborers, workmen, mechanics, materialmen, and furnishers of machinery and parts thereof, equipment, tools, and all supplies, incurred in the furtherance of the performance of the WORK. After completion of all Work, the CONTRACTOR shall publish a Notice of Completion in a newspaper of general circulation in the area where the Work was done. Such notice shall be published once per week for period of four (4) successive weeks. Proof of publication of such notice shall consist of an Affidavit of publisher and a printed copy of the notice. The CONTRACTOR shall, at the OWNER'S request, furnish additional satisfactory evidence that all obligations of the nature designated above have been paid, discarded, or waived. If the CONTRACTOR fails to do so the OWNER may, after having notified the CONTRACTOR, either pay unpaid bills or withhold from the CONTRACTOR'S unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to the CONTRACTOR will be resumed in accordance with the terms of the CONTRACT DOCUMENTS, but in no event shall the provisions of this sentence be construed to impose any obligations upon the OWNER to either the CONTRACTOR, the CONTRACTOR'S Surety, or any third party. In paying any unpaid bills of the CONTRACTOR, and any payment so made by the OWNER shall be considered as a payment made under the CONTRACT DOCUMENTS by the OWNER to the CONTRACTOR and the OWNER shall not be liable to the CONTRACTOR for any such payments made in good faith.

G. If the OWNER fails to make payment thirty (30) days after the CONTRACTOR has completed fulfillment of advertisement and waived all claims after approval by the ENGINEER, in addition to other remedies available to the CONTRACTOR, there will be added to each such payment interest at the maximum legal rate commencing on the first day after said payment is due and continuing until the payment is received by the CONTRACTOR.

H. The CONTRACTOR shall include with each monthly Payment Estimate, a letter stating any delays incurred during that pay period as provided for under Article "Time for Completion and Liquidated Damages" as stated hereinbefore.

I. An updated construction Work Progress Schedule, outlining ALL PHASES OF THE CONTRACTOR'S PORTION of Work to be performed shall be submitted with each Payment Estimate.

20. ACCEPTANCE OF FINAL PAYMENT AS RELEASE

A. The acceptance by the CONTRACTOR of final payment shall be and shall operate as a release to the OWNER of all claims and all liability to the CONTRACTOR other than claims in stated amounts as may be specifically excepted by the CONTRACTOR for all things done or furnished in connection with this WORK and for every act and neglect of the OWNER and others relating to or arising out of this WORK. Any payment, however, final or otherwise, shall not release the CONTRACTOR or its sureties from any obligations under the CONTRACT DOCUMENTS or the Performance and Payment BONDS.

21. INSURANCE

A. The CONTRACTOR shall purchase and maintain such insurance as will protect it from claims set forth below which may arise out of, or result from, the CONTRACTOR'S execution of the WORK, whether such execution be by the CONTRACTOR, any SUBCONTRACTOR, or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

1. Claims under workmen's compensation, disability benefit and other similar employee benefit acts;

2. Claims for damages because of bodily injury, occupational sickness or disease, or death of employees;

3. Claims for damages because of bodily injury, occupational sickness or disease, or death of any person other than employees;

4. Claims for damages insured by usual personal injury liability coverage which are sustained (1) by any person as a result of an offense directly or indirectly related to the employment of such person by the CONTRACTOR, or (2) any other person; and

5. Claims for damages because of injury to or destruction of tangible property, including loss of use resulting therefrom.

B. Certificates of Insurance acceptable to the OWNER shall be filed with the OWNER prior to commencement of the WORK. These Certificates shall contain a provision that coverage's afforded under the policies will not be canceled unless at least thirty (30) days prior WRITTEN NOTICE has been given to the OWNER. Each insurance certificate shall name the OWNER and the ENGINEER as additional insured.

C. The CONTRACTOR shall procure and maintain, at the CONTRACTOR'S own expense, during the CONTRACT TIME, Liability insurance as hereinafter specified:

1. CONTRACTOR'S General Public Liability and Property Damage Insurance including vehicle coverage issued to the CONTRACTOR and protecting the CONTRACTOR from all claims for personal injury, including death, and all claims for destruction of or damage to property, arising out of or in connection with any operations under the CONTRACT DOCUMENTS, whether such operations be by the CONTRACTOR or by any SUB- CONTRACTOR employed by the CONTRACTOR or anyone directly or indirectly employed by the CONTRACTOR or by a SUBCONTRACTOR employed by the CONTRACTOR. Insurance shall be written with a limit of liability of not less than $500,000 for all damages arising out of bodily injury, including death, at any time resulting therefrom, sustained by any one (1) person in any one (1) accident; and a limit of liability of not less than $500,000 aggregate for any such damages sustained by two (2) or more persons in any one (1) accident. Insurance shall be written with a limit of liability of not less than $200,000 for all property damage sustained by any one (1) person in any one (1) accident; and a limit of liability of not less than $200,000 aggregate for any such damage sustained by two (2) or more persons in any one (1) accident.

2. Additional umbrella excess liability coverage for the General Liability and Automobile Liability insurance shall be not less than $2,000,000 per occurrence in excess of the above stated primary limits.

3. The CONTRACTOR shall acquire and maintain, if applicable, Fire and Extended Coverage insurance upon the PROJECT to the full insurable value thereof for the benefit of the OWNER, the CONTRACTOR, and SUBCONTRACTORS as their interest may appear.

   This provision shall in no way release the CONTRACTOR or CONTRACTOR'S surety from obligations under the CONTRACT DOCUMENTS to fully complete the PROJECT.

D. The CONTRACTOR shall procure and maintain, at the CONTRACTOR'S own expense, during the CONTRACT TIME, in accordance with the provisions of the laws of the state in which the WORK is performed, Workmen's Compensation Insurance, including occupational disease provisions, for all of the CONTRACTOR'S employees at the site of the PROJECT and in case any WORK is sublet, the CONTRACTOR shall require such SUBCONTRACTOR similarly to provide Workmen's Compensation Insurance, including

occupational disease provisions for all of latter's employees unless such employees are covered by the protection afforded by the CONTRACTOR. In case any class of employees engaged in hazardous Work under this contract at the site of the PROJECT is not protected under Workmen's Compensation statue, the CONTRACTOR shall provide, and shall cause each SUBCONTRACTOR to provide, adequate and suitable insurance for the protection of its employees not otherwise protected.

E. The CONTRACTOR shall secure, if applicable, "All Risk" type Builder's Risk Insurance for WORK to be performed. Unless specifically authorized by the OWNER, the amount of such insurance shall not be less than the CONTRACT PRICE totaled in the BID. The policy shall cover not less than the losses due to fire, explosion, hail, lightning, vandalism, malicious mischief, wind, collapse, riot, aircraft, and smoke during the CONTRACT TIME, and until the WORK is accepted by the OWNER. The policy shall name as the insured the CONTRACTOR and the OWNER.

22. CONTRACT SECURITY

A. If required by the Instructions to Bidders, the CONTRACTOR shall within ten (10) days after the receipt of the NOTICE OF AWARD furnish the OWNER with a Performance BOND and a Payment BOND in penal sums equal to the amount of the CONTRACT PRICE, conditioned upon the performance by the CONTRACTOR of all undertakings, covenants, terms, conditions and agreements of the CONTRACT DOCUMENTS, and upon the prompt payment by the CONTRACTOR to all persons supplying labor and materials in the prosecution of the WORK provided by the CONTRACT DOCUMENTS. Such BONDS shall be executed by the CONTRACTOR and a corporate bonding company licensed to transact such business in the state in which the WORK is to be performed and named on the current list of "Surety Companies Acceptable on Federal Bonds" as published in the Treasury Department Circular Number 570. The expense of these BONDS shall be borne by the CONTRACTOR. If at any time a surety on any such BOND is declared bankrupt or loses its right to do business in the state in which the WORK is to be performed or is removed from the list of Surety Companies accepted on Federal Bonds, CONTRACTOR shall within ten (10) days after notice from the OWNER to do so, substitute an acceptable BOND (or BONDS) in such form and sum and signed by such other surety or sureties as may be satisfactory to the OWNER. The premiums on such BOND shall be paid by the CONTRACTOR. No further payment shall be deemed due nor shall be made until the new surety or sureties have furnished an acceptable BOND to the OWNER.

23. ASSIGNMENTS

A. Neither the CONTRACTOR nor the OWNER shall sell, transfer, assign, or otherwise dispose of the Contract or any portion thereof, or of any right, title or interest therein, or any obligation thereunder, without written consent of the other party.

24. INDEMNIFICATION

A. The CONTRACTOR shall indemnify and hold harmless the OWNER and the ENGINEER and their agents and employees from and against all claims, damages, losses and expenses including attorney's fees arising out of or resulting from the performance of the WORK, provided that any such claims, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property including the loss of use resulting therefrom; and is caused in whole or in part by any negligent or willful act or omission of the CONTRACTOR, and SUBCONTRACTOR, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable.

B. In any and all claims against the OWNER or the ENGINEER, or any of their agents or employees, by any employee of the CONTRACTOR, any SUBCONTRACTOR, anyone directly or indirectly employed by any of them, or anyone for whose act any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the CONTRACTOR or any SUBCONTRACTOR under workmen's compensation acts, disability benefit acts or other employee benefits acts.

C. The obligation of the CONTRACTOR under this paragraph shall not extend to the liability of the ENGINEER, its agents or employees arising out of the preparation or approval of maps, DRAWINGS, opinions, reports, surveys, CHANGE ORDERS, designs or SPECIFICATIONS.

25. SEPARATE CONTRACTS

A. The OWNER reserves the right to let other contracts in connection with this PROJECT. The CONTRACTOR shall afford other CONTRACTORS reasonable opportunity for the introduction and storage of their materials and the execution of their WORK, and shall properly connect and coordinate the WORK with theirs. If the proper execution or results of any part of the CONTRACTOR'S WORK depends upon the WORK of any other CONTRACTOR, the CONTRACTOR shall inspect and promptly report to the ENGINEER any defects in such WORK that render it unsuitable for such proper execution and results.

B. The OWNER may perform additional WORK related to the PROJECT or the OWNER may let other contracts containing provisions similar to these. The CONTRACTOR will afford the other CONTRACTORS who are parties to such Contracts (or the OWNER, if the OWNER is performing the additional WORK) reasonable opportunity for the introduction and storage of materials and equipment and the execution of WORK, and shall properly connect and coordinate the WORK with theirs.

C. If the performance of additional WORK by other CONTRACTORS or the OWNER is not noted in the CONTRACT DOCUMENTS prior to the execution of the CONTRACT, written notice thereof shall be given to the CONTRACTOR prior to starting any such additional WORK. If the CONTRACTOR believes that the performance of such additional WORK by the OWNER or others involves it in additional expense or entitles it to an extension of the CONTRACT TIME, the CONTRACTOR may make a claim thereof as provided in Sections 14 and 15.

26. SUBCONTRACTING

A. The CONTRACTOR may utilize the services of specialty SUBCONTRACTS on those parts of the WORK which, under normal contracting practices, are performed by specialty SUBCONTRACTORS.

B. The CONTRACTOR shall not award WORK to SUBCONTRACTOR(s), in excess of fifty (50%) percent of the CONTRACT PRICE, without prior written approval of the OWNER.

C. The CONTRACTOR shall be fully responsible to the OWNER for the acts and omissions of its SUBCONTRACTORS, and of persons either directly or indirectly employed by them, as the CONTRACTOR is for the acts and omissions of persons directly employed by the CONTRACTOR.

D. The CONTRACTOR shall cause appropriate provisions to be inserted in all subcontracts relative to the WORK to bind SUBCONTRACTORS to the CONTRACTOR by the terms of the CONTRACT DOCUMENTS insofar as applicable to the WORK of SUBCONTRACTORS and to give the CONTRACTOR the same power as regards terminating any subcontract that the OWNER may exercise over the CONTRACTOR under any provision of the CONTRACT DOCUMENTS.

E. Nothing contained in this CONTRACT shall create any contractual relationship between any SUBCONTRACTOR and the OWNER.

F. Any Subcontractor identified in the bid and added after award must be procured in accordance with 2 CFR 200.321.

G. The CONTRACTOR shall verify and provide documentation that all subcontractors are registered with SAM.gov and have an active UEI number throughout their work period for the project

27. ENGINEER'S AUTHORITY

A. The ENGINEER will act as the OWNER'S representative during the construction period, shall decide questions which may arise as to quality and acceptability of materials furnished and WORK performed, and shall interpret the intent of the CONTRACT DOCUMENTS in a fair and unbiased manner. The ENGINEER will make visits to the site and determine if the WORK is proceeding in accordance with the CONTRACT DOCUMENTS.

B. The CONTRACTOR will be held strictly to the intent of the CONTRACT DOCUMENTS in regard to the quality of materials, workmanship, and execution of the WORK. Inspections may be made at the factory or fabrication plant of the source of material supply.

C. The ENGINEER will not be responsible for the construction means, controls, techniques, sequences, procedures, or construction safety.

D. The ENGINEER will promptly make decisions relative to interpretation of the CONTRACT DOCUMENTS.

28. LAND AND RIGHTS-OF-WAY

A. PRIOR to issuance of NOTICE TO PROCEED, the OWNER will obtain all land and rights-of-way necessary for carrying out and for the completion of the WORK to be performed pursuant to the CONTRACT DOCUMENTS, unless otherwise mutually agreed.

B. The OWNER will provide to the CONTRACTOR information which delineates and describes the lands owned and rights-of-way acquired.

C. The CONTRACTOR will provide at its own expense and without liability to the OWNER any additional land and access thereto that the CONTRACTOR may desire for temporary construction facilities, or for storage of materials.

29. GUARANTEE

A. The CONTRACTOR shall guarantee all materials and equipment furnished and WORK performed for a period of one (1) year from the date of SUBSTANTIAL COMPLETION. The CONTRACTOR warrants and guarantees for a period of one (1) year from the date of SUBSTANTIAL COMPLETION of the system that the completed system is free from all defects due to faulty materials or workmanship and the CONTRACTOR shall promptly make such corrections as may be necessary by reason of such defects including the repairs of any damage to other parts of the system resulting from such defects. The OWNER will give notice of observed defects with reasonable promptness. In the event that the CONTRACTOR should fail to make such repairs, adjustments, or other WORK that may be made necessary by such defects, the OWNER may do so and charge the CONTRACTOR the cost thereby incurred. The Performance BOND shall remain in full force and effect through the guarantee period.

30. TAXES

A. The CONTRACTOR shall pay all sales, consumer, use, and other similar taxes required by the laws of the place where the WORK is performed.

31. **RECORDS RETENTION/ACCESS/AUDITS**

CONTRACTOR shall maintain detailed records sufficient to account for the receipt, obligation, and expenditure of grant funds (including, if applicable and allowed, records related to tracking program income). Accordingly, CONTRACTOR agrees as follows:

a. Record Retention: CONTRACTOR shall maintain (and require all subcontractors) to maintain records and accounts associated with this Agreement, including, but not limited to, property, personnel and financial records, in accordance with ADCNR's records retention policy and 2 C.F.R. §200.333, as well as all other applicable federal, state and local requirements, the Federal Award and Special Award Conditions and Supplemental Construction Terms incorporated within the Federal Award. Such records will be made available to all entities listed below in Paragraph 31(b) and

shall be retained for a minimum of three (3) years after expiration of this Agreement, unless ADCNR grants permission in writing to destroy. However, CONTRACTOR agrees that it is responsible for being familiar with all such retention requirements and maintaining records for periods longer than this 3-year minimum, as applicable.

b. Access: The RESTORE Council, ADCNR, the Alabama Examiners of Public Accounts, or any of their duly authorized representatives shall have timely and unrestricted access during normal business hours to any pertinent books, documents, papers, and records (including electronic records) of the CONTRACTOR and its agents, and subcontractors in order to make audits, inspections, financial reviews, excerpts, transcripts and other examinations as directed by law (and to make copies of such). In addition, such rights to access shall include timely and reasonable access to the CONTRACTORS personnel for the purpose of interview and discussion related to such records.

c. Audit Requirements: CONTRACTOR shall follow all audit requirements under the Federal Award and this Agreement and applicable federal, state, and local laws. CONTRACTOR shall also ensure applicable lower tier compliance.

d. Survival: The provisions of this Section 31 of the General Conditions survive the Agreement Term and remain a continuing obligation of the CONTRACTOR.

END OF SECTION

State of Alabama
Alabama Department of Environmental Management
State Revolving Fund (SRF) Loan Program

SRF Section
Permits and Services Division
Alabama Department of Environmental Management
Post Office Box 301463
Montgomery, Alabama 36130-1463

(334) 271-7796
(334) 271-7950 FAX

Supplemental General Conditions

for SRF Assisted

Public Drinking Water and Wastewater
Facilities Construction Contracts

Clean Water
State Revolving Fund

Protect Our Health from Source to Tap
Drinking Water State Revolving Fund

SRF Project Number: _____

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I – ADEM Special Conditions

1. Construction within State right-of-way shall be in accordance with Alabama Department of Transportation policies and procedures.

2. Construction is to be carried out in compliance with applicable NPDES permits and in a manner that prevents bypassing of raw wastewater flows during construction. If bypassing is anticipated, the ADEM NPDES Enforcement Branch (334-271-7975) shall be advised in advance and the contractor shall take all necessary steps to minimize the impacts of bypassing.

3. Siltation and soil erosion shall be minimized during construction. The contractor shall obtain an NPDES storm water permit for construction if required.

4. The owner shall provide and maintain competent and adequate supervision and inspection.

5. ADEM and EPA shall have access to the site and the project work at all times.

6. These Special Conditions shall supersede any conflicting provisions of this contract.

7. A project sign is required. See **Parts XVII and XVIII, pages SGC-34 – SGC-35**, for more information.

II – Bonds and Insurance

Bonding requirements shall comply with Alabama Act No. 97-225. Provisions of the Act are summarized below:

1. Bid Bond – Not less than 5% of either the owner's estimated cost or of the contractor's bid up to a maximum $10,000. The bid guarantee shall consist of a cashier's check drawn on an Alabama bank or a bid bond executed by a surety company duly authorized and qualified to make bonds in the State of Alabama.

2. Performance Bond – 100% of the contract price.

3. Payment Bond – Payable to the awarding authority, shall be executed in an amount not less than 50% of the contract price.

In addition to the insurance requirements elsewhere in the specifications, the owner or the contractor, as appropriate, must acquire any flood insurance made available by the Federal Emergency Management Agency as required by 40 CFR 30.600 (b), if construction will take place in a flood hazard area identified by the Federal Emergency Management Agency.

III – Utilization of Disadvantaged Businesses Enterprises (DBEs)

It is the policy of the State Revolving Loan Fund (SRF) to promote a "fair share" of sub-agreement awards to small, minority, and women-owned businesses for equipment, supplies, construction, and services. Compliance with these contract provisions is required in order for project costs to be eligible for SRF funding. The "fair share" objective is a goal, not a quota.

Failure on the part of the apparent successful bidder to submit required information to the loan recipient (Owner) may be considered by the Owner in evaluating whether the bidder is responsive to bid requirements.

The project objectives for utilization of Minority Business Enterprises (MBE's) and Women's Business Enterprises (WBE's) are as follows:

Commodities (Supplies)	MBE 4%	WBE 11%
Contractual (Services)	MBE 8%	WBE 30%
Equipment	MBE 5%	WBE 20%
Construction	MBE 2.5%	WBE 3%

For purposes of clarification:

- This objective applies to any Federally assisted procurement agreement in excess of $10,000.
- This objective necessitates three responsibilities; separate solicitations must be made of small and minority and women's business enterprises.
- A minority business is a business, at least 51 percent of which is owned and controlled by minority group members (Black; Hispanics; Asian American; American Indian; and, any other designations approved by the Office of Management and Budget).
- A women's business is a business, at least 51 percent of which is owned and controlled by one or more women.
- The control determination will revolve around the minority or woman owner's involvement in the day-to-day management of the business enterprise.
- Solicitation should allow adequate time for price analysis; ADEM recommends that contact be made no later than 15 days before bid opening.
- Efforts taken to comply with this objective must be documented in detail; maintain records of firms contacted, including any negotiation efforts to reach competitive price levels, and awards to the designated firms.
- ADEM recommends that the prime contractor utilize the services of the Minority Business Development Service Centers. These Centers are funded by the U.S. Department of Commerce to provide technical, financial and contracting assistance to minority and women's business enterprises. These Centers are located in a number of Regional cities.
- Use of the services provided by Centers does not absolve the prime contractors from pursuing additional efforts to meet this objective.

IV – Six Affirmative Steps for Good Faith DBE Solicitation

The loan recipient shall follow the six affirmative steps found in the SRF application when using loan funds to procure sources of supplies, construction and services.

If the successful bidder plans to subcontract a portion of the project, the bidder must submit to the owner within 10 days after bid opening, evidence of the affirmative steps taken to utilize small, minority and women's businesses. These six affirmative steps or ‘good faith efforts’ are required methods to ensure that DBEs have the opportunity to compete for procurements funded by EPA financial assistance dollars. Such affirmative steps are described as follows:

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities. This will include placing DBEs on solicitation lists and soliciting them whenever there are potential sources.

2. Make information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. This includes, whenever possible, posting solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

3. Consider in the contracting process whether firms competing for large contracts could subcontract with DBEs. This will include dividing total requirements when economically feasible into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.

4. Encourage contracting with a consortium of DBEs when a contract is too large for one of these firms to handle individually.

5. Use the resources, services, and assistance of the Department of Transportation (DOT), Small Business Administration (SBA), and the Minority Business Development Agency of the Department of Commerce (MBDA).

6. If the Contractor awards subcontracts, it must take the steps described in items (1) through (5) listed above.

V – Documentation Required from Owner and Contractor

The low, responsive, responsible bidder must forward the following items, in duplicate, to the Owner no later than 10 days after bid opening. The Owner shall transmit one (1) copy of its DBE documentation of the prime contractor solicitation and the bidder's DBE documentation of all subcontractor solicitation to ADEM within 14 days after bid opening.

1. SRF project number and project name.

2. List of subcontractors (name, address and telephone) with dollar amount and duration for subcontracts). If there are to be no subcontractors, please indicate as such.

3. List of any subcontract work yet to be committed with estimate of dollar amount and duration of contract.

4. DBE Documents - See **Part IV, page SGC-3**.

5. Debarred Firms Certification – See **Part XIV, page SGC-23**.

6. Certification Regarding Equal Employment Opportunity – See **Part XIII, page SGC-22.**

The Owner shall submit annual MBE/WBE Utilization Reports (EPA Form 5700-52A, **pages SGC-16 - SGC-17**) within 30 days of the end of the annual reporting period **(October 30th)**. Submit reports directly to:

Diane Lockwood
Administrative Section
Fiscal Branch
Alabama Department of Environmental Management
Post Office Box 301463
Montgomery, Alabama 36130-1463

The Prime Contractor must submit the following items to the Owner:

1) DBE Compliance Form. The Owner must submit this information to ADEM to demonstrate compliance with the DBE requirements. ADEM's approval is required prior to award of the construction contract and commencement of any SRF-funded construction. (**Page SGC-8**)

2) Certification Regarding Equal Employment Opportunity. This form is required for the prime contractor and for all subcontractors. The prime contractor's form should be submitted with the DBE Compliance Form and the subcontractors' forms should be submitted as the subcontracts are executed. (**Page SGC-22**)

3) Debarred Firms Certification. This form is required for the prime contractor and for all subcontractors. The prime contractor's form should be submitted with the DBE Compliance Form and the subcontractors' forms should be submitted as the subcontracts are executed. (**Page SGC-23**)

4) EPA Form 6100-2 DBE Subcontractor Participation Form. This form gives a DBE subcontractor the opportunity to describe the work the DBE subcontractor received from the prime contractor, how much the DBE subcontractor was paid, and any other concerns the DBE subcontractor might have. The prime contractor must provide this form to each DBE subcontractor for the DBE subcontractor's submittal to ADEM's DBE Coordinator (to be forwarded to EPA's DBE Coordinator). (**Page SGC-10**)

5) EPA Form 6100-3 DBE Subcontractor Performance Form. This form captures an intended DBE subcontractor's description of work to be performed for the prime contractor and the price of the work. This form is to be provided by the prime contractor to each DBE subcontractor and submitted with the DBE Compliance Form. (**Page SGC-12**)

6) EPA Form 6100-4 DBE Subcontractor Utilization Form. This form captures the prime contractor's intended use of an identified DBE subcontractor and the estimated dollar amount of the work. This form is to be completed by the prime contractor and submitted with the DBE Compliance Form. (**Page SGC-14**)

7) EPA Form 5700-52 A MBE/WBE Utilization Reports (DBE Annual Report). The Owner must submit this information to ADEM within 30 days of the end of the annual reporting period **(October 30th)**. (**Pages SGC-16 - SGC-17**)

8) Changes to Approved DBE Compliance Form. If any changes, substitutions, or additions are proposed to the subcontractors included in previous Department approvals, the Owner must submit this information to the Department for prior approval in order for the affected subcontract work to be eligible for SRF funding. (**Page SGC-21**)

9) Certified Payrolls. These should be submitted to the Owner at least monthly for the prime contractor and all subcontractors. The Owner must maintain payroll records and make these available for inspection.

Please note that DBEs, MBEs, and WBEs must be certified by EPA, SBA, or DOT (or by state, local, Tribal, or private entities whose certification criteria match EPA's). DBEs must be certified in order to be counted toward the recipient's MBE/WBE accomplishments. Depending upon the certifying agency, a DBE may be classified as a DBE, a Minority Business Enterprise (MBE), or a Women's Business Enterprise (WBE).

The documentation of these good faith solicitation efforts must be detailed in order to allow for satisfactory review. Such documentation might include fax confirmation sheets, copies of solicitation letters/emails, printouts of the online solicitations, printouts of online search results, affidavits of publication in newspapers, etc. The prime contractor is strongly encouraged to follow up each written, fax, or email solicitation with at least 1 logged phone call.

The prime contractor must employ the six affirmative steps to subcontract with DBEs, even if the prime contractor has achieved its fair share objectives.

If a DBE subcontractor fails to complete work under the subcontract for any reason, the prime contractor must notify the Owner in writing prior to any termination and must employ the six good faith efforts described above if using a replacement subcontractor. Any proposed changes from an approved DBE subcontractor must be reported to the Owner and to ADEM on the Changes to Approved Subcontractors Form prior to initiation of the action. EPA Forms Nos. 6100-3 and 6100-4 must also be submitted to ADEM for new DBE subcontracts.

VI – Resources for Identifying DBE Contractors/Subcontractors

The following organizations may provide assistance in soliciting DBE participation:

City of Birmingham
Office of Economic Development
ATTN: Andrew Mayo, Economic Specialist
710 20th Street North
Birmingham, Alabama 35203
205/254-2799
205/254-7741 FAX
ajmayo@ci.birmingham.al.us

U.S. Small Business Administration
http://www.pro-net.sba.gov

National Association of Minority Contractors (NAMC)
http://www.namc-atl.org

Alabama Department of Transportation
ATTN: John Huffman
1409 Coliseum Boulevard
Montgomery, Alabama 36130
334-244-6261
http://www.dot.state.al.us

U.S. Department of Commerce
Minority Business Development Agency
401 West Peachtree Street NW – Suite 1715
Atlanta, Georgia 30308
404/730-3300
404/730-3313 FAX
http://www.mbda.gov/

Governor's Office of Minority and Women's Business Enterprises
401 Adams Avenue
Suite 360
Montgomery, Alabama 36130
1-800-447-4191
334/242-2220
334/242-4203 FAX

Birmingham Construction Industrial Authority
ATTN: Rhonsha Walker or Kimberly Bivins
3600 4th Avenue South
Birmingham, Alabama 35222
205/324-6202
205/324-6210 FAX
http://www.BCIA1.org

NOTES:

(1) The Owner and the prime contractor shall use the necessary resources to identify and directly solicit no less than 3 certified DBE/MBE firms and 3 WBE firms to bid in each expected contract/subcontract area. If a diligent and documented search of ALDOT, SBA, and MBDA directories does not identify 3 potential certified DBE/MBE firms and 3 potential certified WBE firms, then the prime contractor shall post an advertisement in at least 1 of the other online or print resources. Whenever possible, post solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

(2) Expenditures to a DBE that acts merely as a broker or passive conduit of funds, without performing, managing, or supervising the work of its subcontract in a manner consistent with normal business practices may not be counted.

(3) The prime contractor should attempt to identify and first solicit DBEs in the geographic proximity of the project before soliciting those located farther away.

(4) In addition, you may contact ADEM's DBE Coordinator, Diane Lockwood, at (334) 271-7815 for assistance.

VII – DBE Compliance Form

PLEASE NOTE: ALL INFORMATION OUTLINED ON THIS FORM IS REQUIRED FOR DBE COMPLIANCE. THE PROPOSED PRIME CONTRACTOR AND OWNER SHOULD ENSURE THAT THIS INFORMATION IS COMPLETE PRIOR TO SUBMITTAL.

Loan Recipient: _____ SRF Loan Number: _____

CERTIFICATIONS:

I certify that the information submitted on and with this form is true and accurate and that this firm has met and will continue to meet the conditions of this construction contract regarding DBE solicitation and utilization. I further certify that criteria used in selecting subcontractors and suppliers were applied equally to all potential participants and that EPA Forms 6100-2 and 6100-3 were distributed to all DBE subcontractors.

_____ Date_____
(Prime Contractor signature)

_____
(Printed name and title)

I certify that I have reviewed the information submitted on and with this form and that it meets the requirements of the Owner's State Revolving Fund loan contract.

_____ Date_____
(Signature of Owner or Owner's representative)

_____
(Printed name and title)

GENERAL INFORMATION:

Owner contact: _____

Owner phone number/email:
_____

Consulting engineer contact:
_____

Consulting engineer phone number/email:
_____

Proposed prime contractor:
_____

Prime contractor contact:
_____

Prime contractor phone number/email:
_____

Proposed prime contract amount: $ _____

Proposed total DBE/MBE participation: $ _____ Percentage: ____% Goal: 2.5%

Proposed total WBE participation: $ _____ Percentage: ____% Goal: 3.0%

Please submit the following with the DBE COMPLIANCE FORM:

(1) List of all committed and uncommitted subcontractors by trade, including company name, address, telephone number, contact person, dollar amount of subcontract, and DBE/MBE/WBE status. Indicate in writing if no solicitations were made because the contractor intends to use only its own forces to accomplish the work.

(2) Proof of certification by EPA, SBA, DOT (or by state, local, Tribal, or private entities whose certification criteria match EPA's) for each subcontractor listed as a DBE, MBE, or WBE.

(3) Documentation of solicitation effort for prospective DBE firms, such as fax confirmation sheets, copies of solicitation letters/emails, printout of the online solicitations, printouts of online search results, affidavits of publication in newspapers, etc. The prime contractor is strongly encouraged to follow up each written, fax, or email solicitation with at least 1 logged phone call. Whenever possible, post solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

(4) Justification for not selecting a certified DBE subcontractor that submitted a low bid for any subcontract area.

(5) Certification By Proposed Prime Contractor or Subcontractor Regarding Equal Employment Opportunity. (**Page SGC-22**)

(6) Debarred Firms Certification. (**Page SGC-23**)

(7) EPA Form 6100-3 DBE Subcontractor Performance Form for all DBE subcontracts. (**Page SGC-12**)

(8) EPA Form 6100-4 DBE Subcontractor Utilization Form for all DBE subcontracts. (**Page SGC-14**)

United States Environmental Protection Agency

OMB Control No: 2090-0030
Approved: 8/13/2013
Approval Expires: 8/31/2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

An EPA Financial Assistance Agreement Recipient must require its prime contractors to provide this form to its DBE subcontractors. This form gives a DBE[1] subcontractor[2] the opportunity to describe work received and/or report any concerns regarding the EPA-funded project (e.g., in areas such as termination by prime contractor, late payments, etc.). The DBE subcontractor can, as an option, complete and submit this form to the EPA DBE Coordinator at any time during the project period of performance.

Subcontractor Name		Project Name Central Elmore WTP Upgrade
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Prime Contractor Name		Issuing/Funding Entity:

Contract Item Number	Description of Work Received from the Prime Contractor Involving Construction, Services, Equipment or Supplies	Amount Received by Prime Contractor

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

EPA FORM 6100-2 (DBE Subcontractor Participation Form)

United States Environmental Protection Agency

OMB Control No: 2090-0030
Approved: 8/ 13/ 2013
Approval Expires: 8/ 31/ 2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

Please use the space below to report any concerns regarding the above EPA-funded project:

Subcontractor Signature	Print Name
Title	**Date**

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

EPA FORM 6100-2 (DBE Subcontractor Participation Form)

United States Environmental Protection Agency

OMB Control No: 2090-0030
Approved: 8/13/2013
Approval Expires: 8/31/2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

This form is intended to capture the DBE[1] subcontractor's[2] description of work to be performed and the price of the work submitted to the prime contractor. An EPA Financial Assistance Agreement Recipient must require its prime contractor to have its DBE subcontractors complete this form and include all completed forms in the prime contractors bid or proposal package.

Subcontractor Name		Project Name Central Elmore WTP Upgrade
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Prime Contractor Name		Issuing/Funding Entity:

Contract Item Number	Description of Work Submitted to the Prime Contractor Involving Construction, Services, Equipment or Supplies	Price of Work Submitted to the Prime Contractor
DBE Certified By: O DOT O SBA O Other: _____		Meets/ exceeds EPA certification standards? O YES O NO O Unknown

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

EPA FORM 6100-3 (DBE Subcontractor Performance Form)

EPA United States Environmental Protection Agency

OMB Control No: 2090-0030
Approved: 8/13/2013
Approval Expires: 8/31/2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor Signature	Print Name
Title	**Date**

Subcontractor Signature	Print Name
Title	**Date**

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

EPA FORM 6100-3 (DBE Subcontractor Performance Form)

EPA United States Environmental Protection Agency

OMB Control No: 2090-0030
Approved: 8/13/2013
Approval Expires: 8/31/2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form

This form is intended to capture the prime contractor's actual and/or anticipated use of identified certified DBE[1] subcontractors[2] and the estimated dollar amount of each subcontract. An EPA Financial Assistance Agreement Recipient must require its prime contractors to complete this form and include it in the bid or proposal package. Prime contractors should also maintain a copy of this form on file.

Prime Contractor Name		Project Name Central Elmore WTP Upgrade
Bid/ Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Issuing/Funding Entity:		

I have identified potential DBE certified subcontractors	○ YES	⊙ NO
If yes, please complete the table below. If no, please explain:		

Subcontractor Name/ Company Name	Company Address/ Phone/ Email	Est. Dollar Amt	Currently DBE Certified?

Continue on back if needed

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.205 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an EPA award of financial assistance.

EPA FORM 6100-4 (DBE Subcontractor Utilization Form)

United States Environmental Protection Agency

OMB Control No: 2090-0030
Approved: 8/13/2013
Approval Expires: 8/31/2015

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Utilization Form

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does not signify a commitment to utilize the subcontractors above. I am aware of that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor Signature	Print Name
Title	**Date**

The public reporting and recordkeeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Include the OMB control number in any correspondence. Do not send the completed form to this address.

EPA FORM 6100-4 (DBE Subcontractor Utilization Form)

OMB CONTROL NO. 2090-0030
APPROVED: 05/01/2008
APPROVAL EXPIRES: 12/22/2013

U.S. ENVIRONMENTAL PROTECTION AGENCY
MBE/WBE UTILIZATION UNDER FEDERAL GRANTS AND COOPERATIVE AGREEMENTS

PART I. (Reports are required even if no procurements are made during the reporting period.)

1A. FEDERAL FISCAL YEAR (Oct. 1-Sep 30) 20_____	1B. REPORTING PERIOD (Check ALL appropriate boxes) ☐ 1st (Oct-Dec) ☐ 2nd (Jan-Mar) ☐ 3rd (Apr-Jun) ☐ 4th (Jul-Sep) ☐ Semi-Annual (Oct-Mar) ☐ Semi-Annual (Apr-Sep) ☐ Annual ☐ Check if this is the last report for the project (Project completed).
1C. REVISION OF A PRIOR REPORT? Y or N Year: _____ Quarter: _____	BRIEFLY DESCRIBE THE REVISIONS YOU ARE MAKING:

2A. EPA FINANCIAL ASSISTANCE OFFICE ADDRESS (ATTN: DBE Coordinator)		3A. RECIPIENT NAME AND ADDRESS	
2B. EPA DBE COORDINATOR Name: E-mail:	2C. PHONE: Fax:	3B. RECIPIENT REPORTING CONTACT: Name: E-mail:	3C. PHONE: Fax:
4A. FINANCIAL ASSISTANCE AGREEMENT ID NUMBER (SRF State Recipients, refer to Instructions for Completion of blocks 4A, 5A and 5C.)		4B. FEDERAL FINANCIAL ASSISTANCE PROGRAM TITLE or CFDA NUMBER:	

5A. TOTAL ASSISTANCE AGREEMENT AMOUNT (SRF State Recipients, refer to Instructions for Completion of blocks 4A, 5A and 5C.) EPA Share: $_____ Recipient Share: $_____	5B. If NO procurement and NO accomplishments were made this reporting period (by the recipients, sub-recipients, loan recipients, and prime contractors), **CHECK** and **SKIP** to Block No. 7. (Procurements are all expenditures through contract, order, purchase, lease or barter of supplies, equipment, construction, or services needed to complete Federal assistance programs. Accomplishments, in this context, are procurements made with MBEs and/or WBEs. ☐

5C. Total Procurements This Reporting Period
(Only include amount not reported in any prior reporting period)

Total Procurement Amount $_____ (Include total dollar values awarded by recipient, sub-recipients and SRF loan recipients, **including MBE/WBE expenditures.)**

5D.
Were sub-awards issued under this assistance agreement? Yes☐ No☐ Were contracts issued under this assistance agreement ? Yes☐ No☐

5E. MBE/WBE Accomplishments This Reporting Period

Actual MBE/WBE Procurement Accomplished:
(Include total dollar values awarded by recipient, sub-recipients, SRF loan recipients and Prime Contractors.)

	Construction	Equipment	Services	Supplies	Total
$MBE:					0.00
$WBE:					0.00

6. COMMENTS: (If no MBE/WBE procurements were accomplished during the reporting period, please explain what steps you are taking to achieve the MBE/WBE Program requirements specified in the terms and conditions of the Assistance Agreement.)

7. NAME OF RECIPIENT'S AUTHORIZED REPRESENTATIVE	TITLE
8. SIGNATURE OF RECIPIENT'S AUTHORIZED REPRESENTATIVE	DATE

EPA FORM 5700-52A available electronically at http://www.epa.gov/osbp/pdfs/5700_52a.pdf

PART II. **MBE/WBE PROCUREMENTS MADE DURING REPORTING PERIOD**
EPA Financial Assistance Agreement Number: _____

1. Procurement Made By			2. Business Enterprise		3. $ Value of Procurement	4. Date of Procurement MM/DD/YY	5. Type of Product or Services[A] (Enter Code)	6. Name/Address/Phone Number of MBE/WBE Contractor or Vendor
Recipient	Sub-Recipient and/or SRF Loan Recipient	Prime	Minority	Women				

Type of product or service codes:

1 = Construction 2 = Supplies 3 = Services 4 = Equipment

Note: Refer to Terms and conditions of your Assistance Agreement to determine the frequency of reporting. Recipients are required to submit MBE/WBE reports to EPA beginning with the Federal fiscal year quarter the recipients receive the award, continuing until the project is completed.

EPA FORM 5700-52A - (Approval Expires 12/22/13)

Instructions:

A. General Instructions:

MBE/WBE utilization is based on 40 CFR Part 33. EPA Form 5700-52A must be completed by recipients of Federal grants, cooperative agreements, or other Federal financial assistance which involve procurement of supplies, equipment, construction or services to accomplish Federal assistance programs.

Recipients are required to report 30 days after the end of each federal fiscal quarter, semiannually, or annually, per the terms and conditions of the financial assistance agreement.

	Quarterly Reporting Due Date	Semiannual Reporting Due Date	Annual Reporting Due Date
Agreements awarded prior to May 27, 2008	January 30, April 30, July 30, October 30	N/A	October 30
Agreements awarded on or after May 27, 2008	N/A	April 30, October 30	October 30

MBE/WBE program requirements, including reporting, are material terms and conditions of the financial assistance agreement.

B. Definitions:

Procurement is the acquisition through contract, order, purchase, lease or barter of supplies, equipment, construction or services needed to accomplish Federal assistance programs.

*A **contract*** is a written agreement between an EPA recipient and another party (also considered "prime contracts") and any lower tier agreement (also considered "subcontracts") for equipment, services, supplies, or construction necessary to complete the project. This definition excludes written agreements with another public agency. This definition includes personal and professional services, agreements with consultants, and purchase orders.

*A **minority business enterprise*** (MBE) is a business concern that is (1) at least 51 percent owned by one or more minority individuals, or, in the case of a publicly owned business, at least 51 percent of the stock is owned by one or more minority individuals; and (2) whose daily business operations are managed and directed by one or more of the minority owners. In order to qualify and participate as an MBE prime or subcontractor for EPA recipients under EPA's DBE Program, an entity must be properly certified as required by 40 CFR Part 33, Subpart B.

U.S. citizenship is required. Recipients shall presume that minority individuals include Black Americans, Hispanic Americans, Native Americans, Asian Pacific Americans, or other groups whose members are found to be disadvantaged by the Small Business Act or by the Secretary of Commerce under section 5 of Executive order 11625. The reporting contact at EPA can provide additional information.

*A **woman business enterprise*** (WBE) is a business concern that is, (1) at least 51 percent owned by one or more women, or, in the case of a publicly owned business, at least 51 percent of the stock is owned by one or more women and (2) whose daily business operations are managed and directed by one or more of the women owners. In order to qualify and participate as a WBE prime or subcontractor for EPA recipients under EPA's DBE Program, an entity must be properly certified as required by 40 CFR Part 33, Subpart B.

Business firms which are 51 percent owned by minorities or women, but are in fact managed and operated by non-minority individuals do not qualify for meeting MBE/WBE procurement goals. U.S. Citizenship is required.

Good Faith Efforts

A recipient is required to make the following good faith efforts whenever procuring construction, equipment, services, and supplies under an EPA financial assistance agreement. These good faith efforts for utilizing MBEs and WBEs must be documented. Such documentation is subject to EPA review upon request:

1. Include of MBEs/WBEs on solicitation lists.
2. Assure that MBEs/WBEs are solicited once they are identified.
3. Divide total requirements into smaller tasks to permit maximum MBE/WBE participation, where feasible.
4. Establish delivery schedules which will encourage MBE/WBE participation, where feasible.
5. Encourage use of the services of the U.S. Department of Commerce's Minority Business Development Agency (MBDA) and the U.S. Small Business Administration to identify MBEs/WBEs.

6. Require that each party to a subgrant, subagreement, or contract award take the good faith efforts outlined here.

C. Instructions for Part I:

1a. Specify Federal fiscal year this report covers. The Federal fiscal year runs from October 1st through September 30th **(e.g. November 29, 2010 falls within Federal fiscal year 2011)**

1b. Check applicable reporting box, quarterly, semiannually, or annually. Also indicate if this is the last report for the project.

1c. Indicate if this is a revision to a previous year, half-year, or quarter, and provide a brief description of the revision you are making.

2a-c. Please refer to your financial assistance agreement for the mailing address of the EPA financial assistance office for your agreement.

The "EPA DBE Reporting Contact" is the DBE Coordinator for the EPA Region from which your financial assistance agreement was originated. For a list of DBE Coordinators please refer to the EPA OSBP website at www.epa.gov/osbp. Click on "Regional Contacts" for the name of your coordinator.

3a-c. Identify the agency, state authority, university or other organization which is the recipient of the Federal financial assistance and the person to contact concerning this report.

4a. Provide the Assistance Agreement number assigned by EPA. A separate report must be submitted for each Assistance Agreement.

***For SRF recipients**: In box 4a list numbers for ALL OPEN Assistance Agreements being reported on this form. Please note that although the New DBE Rule (which took effect May 27, 2008) revised the reporting frequency requirements from quarterly to semiannually, that change only applies to agreements awarded AFTER the New DBE Rule took effect. Therefore, SRF recipients may either continue to report activity for all Agreements on one form on a quarterly basis until the last award that was made prior to the New DBE Rule has been closed out; OR, the recipient may split the submission of SRF reports into quarterly reports for Agreements awarded prior the New DBE Rule, and semiannually for the awards made after the New DBE Rule.

4b. Refer back to Assistance Agreement document for this information.

5a. Provide the total amount of the Assistance Agreement which includes Federal funds plus recipient matching funds and funds from other sources.

***For SRF recipients only**: SRF recipients will not enter an amount in 5a. Please leave 5a blank.

5b. Self-explanatory.

5c. Provide the total dollar amount of **ALL** procurements awarded this reporting period by the recipient, sub-recipients, and SRF loan recipients, **including** MBE/WBE expenditures. For example: Actual dollars for procurement from the procuring office; actual contracts let from the contracts office; actual goods, services, supplies, etc., from other sources including the central purchasing/ procurement centers).

***NOTE**: To prevent double counting on line 5C, if any amount on 5E is for a subcontract and the prime contract has already been included on Line 5C in a prior reporting period, then report the amount going to MBE or WBE subcontractor on line 5E, but exclude the amount from Line 5C. To include the amount on 5C again would result in double counting because the prime contract, which includes the subcontract, would have already been reported.

5d. State whether or not sub-awards and/or subcontracts have been issued under the assistance agreement by indicating "yes" or "no".

5e. Where requested, also provide the total dollar amount of all MBE/WBE procurement awarded during this reporting period by the recipient, sub-recipients, SRF loan recipients, and prime contractors in the categories of construction, equipment, services and supplies. These amounts include Federal funds plus recipient matching funds and funds from other sources.

***For SRF recipients only**: In 5c please enter the total procurement amount for the quarter, or semiannual period, under all of your SRF Assistance Agreements. The figure reported in this section is **not** directly tied to an individual Assistance Agreement identification number. **(SRF state recipients report state procurements in this section)**

6. If there were no MBE/WBE accomplishments this reporting period, please briefly explain what

specific steps you are taking to achieve the MBE/WBE requirements specified in the terms and conditions of the Assistance Agreement.

7. Name and title of official administrator or designated reporting official.

8. Signature, month, day, and year report submitted.

D. Instructions for Part II:

For each MBE/WBE procurement made under this assistance agreement during the reporting period, provide the following information:

1. Check whether this procurement was made by the recipient, sub-recipient/SRF loan recipient, or the prime contractor.

2. Check either the MBE or WBE column. If a firm is both an MBE and WBE, the recipient may choose to count the entire procurement towards EITHER its MBE or WBE accomplishments. The recipient may also divide the total amount of the procurement (using any ratio it so chooses) and count those divided amounts toward its MBE and WBE accomplishments. If the recipient chooses to divide the procurement amount and count portions toward its MBE and WBE accomplishments, please state the appropriate amounts under the MBE and WBE columns on the form. **The combined MBE and WBE amounts for that MBE/WBE contractor must not exceed the "Value of the Procurement" reported in column #3**

3. Dollar value of procurement.

4. Date of procurement, shown as month, day, year. Date of procurement is defined as the date the contract or procurement was awarded, **not** the date the contractor received payment under the awarded contract or procurement, unless payment occurred on the date of award. **(Where direct purchasing is the procurement method, the date of procurement is the date the purchase was made)**

5. Using codes at the bottom of the form, identify type of product or service acquired through this procurement (e.g., enter 1 if construction, 2 if supplies, etc).

6. Name, address, and telephone number of MBE/WBE firm.

**This data is requested to comply with provisions mandated by: statute or regulations (40 CFR Part 30, 31, and 33); OMB Circulars; or added by EPA to ensure sound and effective assistance management. Accurate, complete data are required to obtain funding, while no pledge of confidentiality is provided.

The public reporting and recording burden for this collection of information is estimated to average I hour per response annually. Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, or disclosure or provide information to or for a Federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjust the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able to respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, OPPE Regulatory Information Division, U.S. Environmental Protection Agency (2136), 1200 Pennsylvania Avenue, NW, Washington, D.C. 20460. Include the OMB Control number in any correspondence. Do not send the completed form to this address.

XII - Changes to Approved DBE Compliance Form

Loan Recipient: _____ SRF Loan Number: _____

CERTIFICATIONS:

I certify that the information submitted on and with this form is true and accurate and that this firm has met and will continue to meet the conditions of this construction contract regarding DBE solicitation and utilization. I further certify that criteria used in selecting subcontractors and suppliers were applied equally to all potential participants.

_____ Date_____
(Prime Contractor signature)

_____
(Printed name and title)

I certify that I have reviewed the information submitted on and with this form and that it meets the requirements of the Owner's State Revolving Fund loan contract.

_____ Date_____
(Signature of Owner or Owner's representative)

_____
(Printed name and title)

GENERAL INFORMATION:

(1) If an approved subcontractor is terminated or replaced, please identify this company and briefly state reason.

(2) For new or additional subcontractors, list name, trade, address, telephone number, contact person, dollar amount of subcontract, and DBE status.

(3) Attach proof of certification by EPA, SBA, DOT (or by state, local, Tribal, or private entities whose certification criteria match EPA's) for each subcontractor listed as a DBE, MBE, or WBE.

(4) Attach documentation of solicitation effort for prospective DBE firms, such as fax confirmation sheets, copies of solicitation letters/emails, printouts of the online solicitations, printouts of online search results, affidavits of publication in newspapers, etc. The prime contractor is strongly encouraged to follow up each solicitation with at least 1 logged phone call. Whenever possible, post solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.

(5) Provide justification for not selecting a certified DBE subcontractor that submitted a low bid for any subcontract area.

XIII – Certification Regarding Equal Employment Opportunity

The contractor is required to comply with Executive Order 112-46 of September 24, 1965 entitled “Equal Employment Opportunity” as amended by Executive Order 11375 of October 13, 1967.

The contract for the work under this proposal will obligate the prime contractor and its subcontractors not to discriminate in employment practices.

The contractor shall not maintain or provide for his/her employees the facilities, which are segregated on a basis of race, creed, color or national origin, whether such facilities are segregated by directive or on a de facto basis.

The contractor must, if requested, submit a compliance report concerning their employment practices and policies in order to maintain his/her eligibility to receive the award of the contract.

The contractor must be prepared to comply in all respects with any contract provisions regarding non-discrimination stipulated in conjunction with labor standards.

CONTRACTOR'S CERTIFICATION:

Contractor's Name: _____

Address: _____

_____

_____

1. Bidder has participated in a previous contract or subcontract subject to the Equal Opportunity Clause. Yes____ No____
2. Compliance Reports were required to be filed in connection with such contract or subcontract. Yes____ No____
3. Bidder has filed all compliance reports due under applicable contract requirements. Yes____ No____

If answer to item 3 is “No”, please explain in detail on reverse side of this certification.

Certification - The information above is true and complete to the best of my knowledge and belief.

Signature of Authorized Official: _____

Title: _____

Date: _____

XIV – Debarred Firms Certification

All prime construction contractors shall certify that Subcontracts have not and will not be awarded to any firm that is currently on the General Service Administration's Master List of Debarred, Suspended and Voluntarily Excluded Persons, in accordance with the provisions of ADEM Administrative Code 335-6-14-.35. Debarment action is taken against a firm for noncompliance with Federal Law.

All bidders shall complete this certification in duplicate and submit both copies to the owner with the bid proposal. The owner shall transmit one copy to ADEM within 14 days after the bid opening.

Project Name: Central Elmore WTP Upgrade

SRF Project No.: _____

The undersigned hereby certifies that the firm of _____ _____ has not and will not award a subcontract, in connection with any contract awarded to it as the result of this bid, to any firm that is currently on the General Service Administration's Master List of Debarred, Suspended, and Voluntarily Excluded Persons.

Signature of Authorized Official: _____

Title: _____

Date: _____

XV – Davis-Bacon and Related Acts

Labor Standards Provisions for Federally Assisted Contracts

Wage Rate Requirements Under FY 2013 Continuing Appropriation

I. Requirements under the Consolidated and Further Continuing Appropriations Act. 2013 (P.L. 113-6) For Subrecipients That Are Governmental Entities:

The following terms and conditions specify how recipients will assist EPA in meeting its Davis-Bacon (DB) responsibilities when DB applies to EPA awards of financial assistance under the FY 2013 Continuing Resolution with respect to State recipients and subrecipients that are governmental entities. If a subrecipient has questions regarding when DB applies, obtaining the correct DB wage determinations, DB provisions, or compliance monitoring, it may contact the State recipient. If a State recipient needs guidance, the recipient may contact Cynthia Y. Edwards at Edwards.Cynthiay@epa.gov or at 404-562-9340 of EPA, Region 4 Grants and SRF Management Section, for guidance. The recipient or subrecipient may also obtain additional guidance from DOL's web site at http://www.dol.gov/whd/

1. Applicability of the Davis- Bacon (DB) prevailing wage requirements.

Under the FY 2013 Continuing Resolution, DB prevailing wage requirements apply to the construction, alteration, and repair of treatment works carried out in whole or in part with assistance made available by a State water pollution control revolving fund and to any construction project carried out in whole or in part by assistance made available by a drinking water treatment revolving loan fund. If a subrecipient encounters a unique situation at a site that presents uncertainties regarding DB applicability, the subrecipient must discuss the situation with the recipient State before authorizing work on that site.

2. Obtaining Wage Determinations.

(a) Subrecipients shall obtain the wage determination for the locality in which a covered activity subject to DB will take place prior to issuing requests for bids, proposals, quotes or other methods for soliciting contracts (solicitation) for activities subject to DB. These wage determinations shall be incorporated into solicitations and any subsequent contracts. Prime contracts must contain a provision requiring that subcontractors follow the wage determination incorporated into the prime contract.

(i) While the solicitation remains open, the subrecipient shall monitor www.wdol.gov weekly to ensure that the wage determination contained in the solicitation remains current. The subrecipients shall amend the solicitation if DOL issues a modification more than 10 days prior to the closing date (i.e. bid opening) for the solicitation. If DOL modifies or supersedes the applicable wage determination less than 10 days prior to the closing date, the subrecipients may request a finding from the State recipient that there is not a reasonable time to notify interested contractors of the modification of the wage determination. The State recipient will provide a report of its findings to the subrecipient.

(ii) If the subrecipient does not award the contract within 90 days of the closure of the solicitation, any modifications or supersedes DOL makes to the wage determination contained in the solicitation shall be effective unless the State recipient, at the request of the subrecipient, obtains an extension of the 90 day period from DOL pursuant to 29 CFR 1.6(c)(3)(iv). The subrecipient shall monitor www.wdol.gov on a weekly basis if it does not award the contract within 90 days of closure of the solicitation to ensure that wage determinations contained in the solicitation remain current.

(b) If the subrecipient carries out activity subject to DB by issuing a task order, work assignment or similar instrument to an existing contractor (ordering instrument) rather than by publishing a solicitation, the subrecipient shall insert the appropriate DOL wage determination from www.wdol.gov into the ordering instrument.

(c) Subrecipients shall review all subcontracts subject to DB entered into by prime contractors to verify that the prime contractor has required its subcontractors to include the applicable wage determinations.

(d) As provided in 29 CFR 1.6(f), DOL may issue a revised wage determination applicable to a subrecipient's contract after the award of a contract or the issuance of an ordering instrument if DOL determines that the subrecipient has failed to incorporate a wage determination or has used a wage determination that clearly does not apply to the contract or ordering instrument. If this occurs, the subrecipient shall either terminate the contract or ordering instrument and issue a revised solicitation or ordering instrument or incorporate DOL's wage determination retroactive to the beginning of the contract or ordering instrument by change order. The subrecipient's contractor must be compensated for any increases in wages resulting from the use of DOL's revised wage determination.

3. Contract Subcontract Provisions.

(a) The Recipient shall insure that the subrecipient(s) shall insert in full in any contract in excess of $2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a treatment work under the CWSRF or a construction project under the DWSRF financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1 or the FY 2010 appropriation , the following clauses:

(1) Minimum wages.

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in § 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

Subrecipients may obtain wage determinations from the U.S. Department of Labor's web site, www.dol.gov.

(ii)(A) The subrecipient(s), on behalf of EPA, shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The State award official shall approve a request for an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the subrecipient(s) agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), documentation of the action taken and the request, including the local wage determination shall be sent by the subrecipient (s) to the State award official. The State award official will transmit the request, to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210 and to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification request within 30 days of receipt and so advise the State award official or will notify the State award official within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the subrecipient(s) do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the award official shall refer the request and the local wage determination, including the views of all interested parties and the recommendation of the State award official, to the Administrator for determination. The request shall be sent to the EPA DB Regional Coordinator concurrently. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt of the request and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii)(B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) Withholding.

The subrecipient(s), shall upon written request of the EPA Award Official or an authorized representative of the Department of Labor, withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) Payrolls and basic records.

(i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly, for each week in which any contract work is performed, a copy of all payrolls to the subrecipient, that is, the entity that receives the sub-grant or loan from the State capitalization grant recipient. Such documentation shall be available on request of the State recipient or EPA. As to each payroll copy received, the subrecipient shall provide written confirmation in a form satisfactory to the State indicating whether or not the project is in compliance with the requirements of 29 CFR 5.5(a)(1) based on the most recent payroll copies for the specified week. The payrolls shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on the weekly payrolls. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the subrecipient(s) for transmission to the State or EPA if requested by EPA , the State, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the subrecipient(s).

(B) Each payroll submitted shall be accompanied by a “Statement of Compliance,” signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the “Statement of Compliance” required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the State, EPA or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency or State may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) Apprentices and trainees.

(i) Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program.

If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) Compliance with Copeland Act requirements.

The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) Subcontracts.

The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the EPA determines may by appropriate, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) Contract termination: debarment.

A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) Compliance with Davis-Bacon and Related Act requirements.

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) Disputes concerning labor standards.

Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and Subrecipient(s), State, EPA, the U.S. Department of Labor, or the employees or their representatives.

(10) Certification of eligibility.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

4. Contract Provision for Contracts in Excess of $100,000.

(a) Contract Work Hours and Safety Standards Act. The subrecipient shall insert the following clauses set forth in paragraphs (a)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Item 3, above or 29 CFR 4.6. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) Overtime requirements.

No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) Violation; liability for unpaid wages; liquidated damages.

In the event of any violation of the clause set forth in paragraph (a)(1) of this section the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (a)(1) of this section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (a)(1) of this section.

(3) Withholding for unpaid wages and liquidated damages.

The subrecipient, upon written request of the EPA Award Official or an authorized representative of the Department of Labor, shall withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) Subcontracts.

The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (a)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (a)(1) through (4) of this section.

(b) In addition to the clauses contained in Item 3, above, in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in 29 CFR 5.1, the Subrecipient shall insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Subrecipient shall insert in any such contract a clause providing hat the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

5. Compliance Verification

(a) The subrecipient shall periodically interview a sufficient number of employees entitled to DB prevailing wages (covered employees) to verify that contractors or subcontractors are paying the appropriate wage rates. As provided in 29 CFR 5.6(a)(6), all interviews must be conducted in confidence. The subrecipient must use Standard Form 1445 (SF 1445) or equivalent documentation to memorialize the interviews. Copies of the SF 1445 are available from EPA on request.

(b) The subrecipient shall establish and follow an interview schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, the subrecipient should conduct interviews with a representative group of covered employees within two weeks of each contractor or subcontractor's submission of its initial weekly payroll data and two weeks prior to the estimated completion date for the contract or subcontract. Subrecipients must conduct more frequent interviews if the initial interviews or other information
indicates that there is a risk that the contractor or subcontractor is not complying with DB. Subrecipients shall immediately conduct necessary interviews in response to an alleged violation of the prevailing wage requirements. All interviews shall be conducted in confidence.

(c) The subrecipient shall periodically conduct spot checks of a representative sample of weekly payroll data to verify that contractors or subcontractors are paying the appropriate wage rates. The subrecipient shall establish and follow a spot check schedule based on its assessment of the risks of noncompliance with DB posed by contractors or subcontractors and the duration of the contract or subcontract. At a minimum, if practicable, the subrecipient should spot check payroll data within two weeks of each contractor or subcontractor's submission of its initial payroll data and two weeks prior to the completion date the contract or subcontract . Subrecipients must conduct more frequent spot checks if the initial spot check or other information indicates that there is a risk that the contractor or subcontractor is not complying with DB. In addition, during the examinations the subrecipient shall verify evidence of fringe benefit plans and payments there under by contractors and subcontractors who claim credit for fringe benefit contributions.

(d) The subrecipient shall periodically review contractors and subcontractors use of apprentices and trainees to verify registration and certification with respect to apprenticeship and training programs approved by either the U.S Department of Labor or a state, as appropriate, and that contractors and subcontractors are not using disproportionate numbers of, laborers, trainees and apprentices. These reviews shall be conducted in accordance with the schedules for spot checks and interviews described in Item 5(b) and (c) above.

(e) Subrecipients must immediately report potential violations of the DB prevailing wage requirements to the EPA DB contact listed above and to the appropriate DOL Wage and Hour District Office listed at http://www.dol.gov/esa/contacts/whd/america2.htm.

(Insert applicable wage rate determination here.)

Wage Rates are county specific for *Heavy Construction* and can be found at:
http://www.gpo.gov/davisbacon/al.html .

"General Decision Number: AL20250115 01/03/2025

Superseded General Decision Number: AL20240115

State: Alabama

Construction Type: Heavy

Counties: Autauga, Elmore, Lowndes and Montgomery Counties in Alabama.

HEAVY CONSTRUCTION PROJECTS

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(1).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least $17.75 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2025.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least $13.30 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2025.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/03/2025

SUAL2015-043 08/02/2017

	Rates	Fringes
CARPENTER, Includes Form Work	$ 18.72	7.91
CEMENT MASON/CONCRETE FINISHER, Includes Water Sewer Lines	$ 13.78 **	0.00
ELECTRICIAN	$ 19.56	0.00
LABORER: Common or General, Includes Water Sewer Lines	$ 12.33 **	0.00
LABORER: Pipelayer, Includes Water Sewer Lines	$ 11.95 **	0.00
OPERATOR: Backhoe/Excavator/Trackhoe, Includes Water Sewer Lines	$ 14.84 **	0.00
OPERATOR: Loader, Includes Water Sewer Lines	$ 17.64 **	2.14
TRUCK DRIVER: Dump Truck, Includes Water Sewer Lines	$ 12.56 **	2.12

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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** Workers in this classification may be entitled to a higher minimum wage under Executive Order 14026 ($17.75) or 13658 ($13.30). Please see the Note at the top of the wage determination for more information. Please also note that the minimum wage requirements of Executive Order 14026 are not currently being enforced as to any contract or subcontract to which the states of Texas, Louisiana, or Mississippi, including their agencies, are a party.

Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after

award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (iii)).

The body of each wage determination lists the classifications and wage rates that have been found to be prevailing for the type(s) of construction and geographic area covered by the wage determination. The classifications are listed in alphabetical order under rate identifiers indicating whether the particular rate is a union rate (current union negotiated rate), a survey rate, a weighted union average rate, a state adopted rate, or a supplemental classification rate.

Union Rate Identifiers

A four-letter identifier beginning with characters other than ""SU"", ""UAVG"", ?SA?, or ?SC? denotes that a union rate was prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2024. PLUM is an identifier of the union whose collectively bargained rate prevailed in the survey for this classification, which in this example would be Plumbers. 0198 indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2024 in the example, is the effective date of the most current negotiated rate.

Union prevailing wage rates are updated to reflect all changes over time that are reported to WHD in the rates in the collective bargaining agreement (CBA) governing the classification.

Union Average Rate Identifiers

The UAVG identifier indicates that no single rate prevailed for those classifications, but that 100% of the data reported for the classifications reflected union rates. EXAMPLE: UAVG-OH-0010 01/01/2024. UAVG indicates that the rate is a weighted union average rate. OH indicates the State of Ohio. The next number, 0010 in the example, is an internal number used in producing the wage determination. The date, 01/01/2024 in the example, indicates the date the wage determination was updated to reflect the most current union average rate.

A UAVG rate will be updated once a year, usually in January, to reflect a weighted average of the current rates in the collective bargaining agreements on which the rate is based.

Survey Rate Identifiers

The ""SU"" identifier indicates that either a single non-union rate prevailed (as defined in 29 CFR 1.2) for this classification in the survey or that the rate was derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As a weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SUFL2022-007 6/27/2024. SU indicates the rate is a single non-union prevailing rate or a weighted average of survey data for that classification. FL indicates the State of Florida. 2022 is the year of the survey on which these classifications and rates are based. The next number, 007 in the example, is an internal

number used in producing the wage determination. The date, 6/27/2024 in the example, indicates the survey completion date for the classifications and rates under that identifier.

?SU? wage rates typically remain in effect until a new survey is conducted. However, the Wage and Hour Division (WHD) has the discretion to update such rates under 29 CFR 1.6(c)(1).

State Adopted Rate Identifiers

The ""SA"" identifier indicates that the classifications and prevailing wage rates set by a state (or local) government were adopted under 29 C.F.R 1.3(g)-(h). Example: SAME2023-007 01/03/2024. SA reflects that the rates are state adopted. ME refers to the State of Maine. 2023 is the year during which the state completed the survey on which the listed classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. The date, 01/03/2024 in the example, reflects the date on which the classifications and rates under the ?SA? identifier took effect under state law in the state from which the rates were adopted.

WAGE DETERMINATION APPEALS PROCESS

1) Has there been an initial decision in the matter? This can be:

a) a survey underlying a wage determination
b) an existing published wage determination
c) an initial WHD letter setting forth a position on a wage determination matter
d) an initial conformance (additional classification and rate) determination

On survey related matters, initial contact, including requests for summaries of surveys, should be directed to the WHD Branch of Wage Surveys. Requests can be submitted via email to davisbaconinfo@dol.gov or by mail to:

Branch of Wage Surveys
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

Regarding any other wage determination matter such as conformance decisions, requests for initial decisions should be directed to the WHD Branch of Construction Wage Determinations. Requests can be submitted via email to BCWD-Office@dol.gov or by mail to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2) If an initial decision has been issued, then any interested party (those affected by the action) that disagrees with the decision can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Requests for review and reconsideration can be submitted via

email to dba.reconsideration@dol.gov or by mail to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210.

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END OF GENERAL DECISION"

XVI – American Iron and Steel Requirement

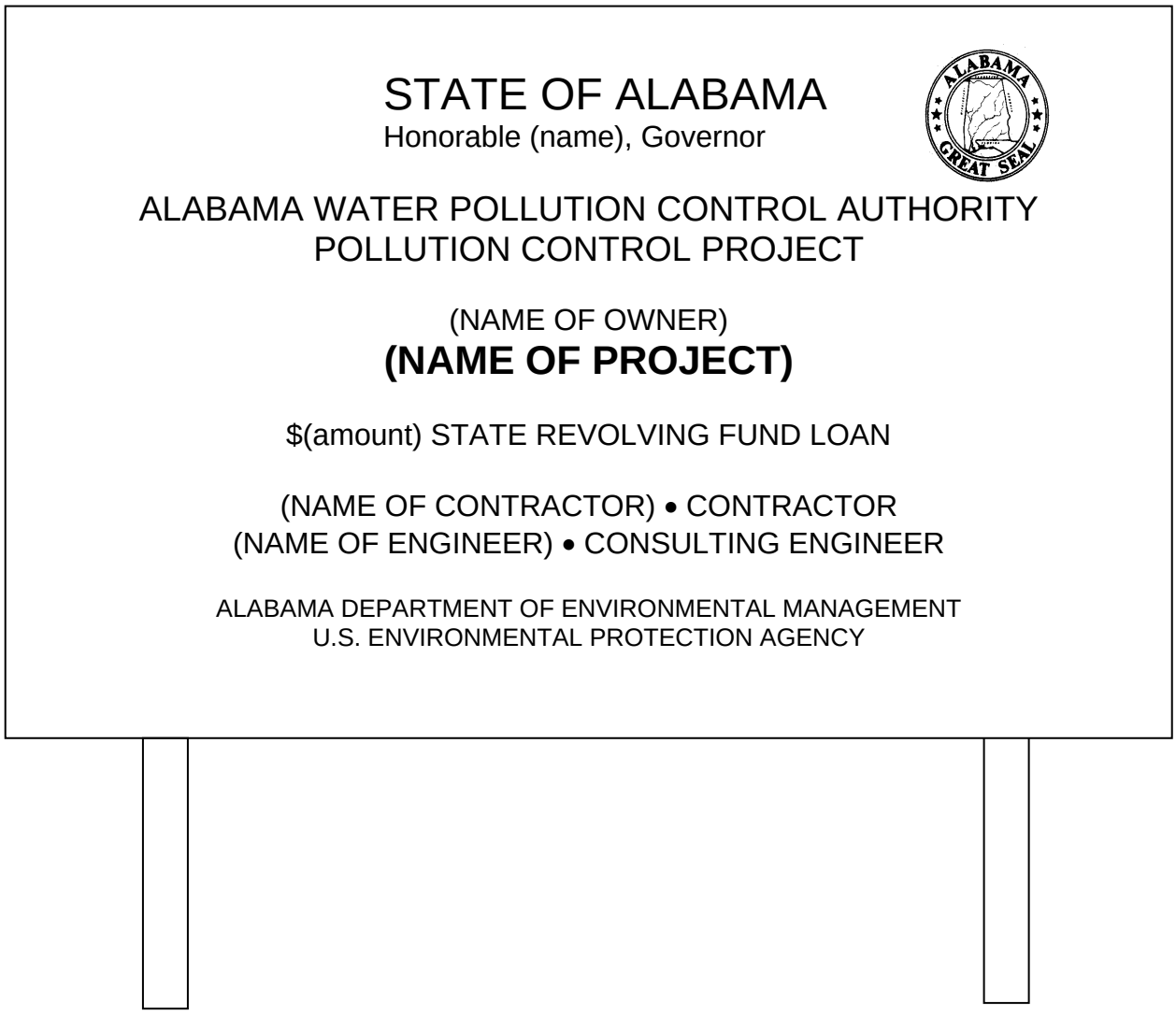
Section 4.13 Compliance with 2014 Appropriations Act. (a) The Loan Recipient agrees to comply with all federal requirements applicable to the Authority Loan (including those imposed by P.L. 113-76, Consolidated Appropriations Act (the "2014 Appropriations Act") and related SRF Policy Guidelines) which the Loan Recipient understands includes, among other things, requirements that all of the iron and steel products used in the Project are to be produced in the United States ("American Iron and Steel") unless (i) the Loan Recipient has requested and obtained a waiver from the U.S. Environmental Protection Agency pertaining to the Project or (ii) the Authority has otherwise advised the Loan Recipient in writing that the Buy American Requirement is not applicable to the Project. .

(b) The Loan Recipient also agrees to comply with all recordkeeping and reporting requirements under the Clean Water Act (codified generally under 33 U.S.C. §1251 et seq.) (the "Clean Water Act"), including any reports required by a federal agency or the Authority such as performance indicators of program deliverables, information on costs and Project progress. The Loan Recipient understands that (i) each contract and subcontract related to the Project is subject to audit by appropriate federal and state entities, and (ii) failure to comply with the Clean Water Act and this Agreement may be an Event of Default hereunder that results in a repayment of the Authority Loan in advance of the maturity of the Evidence of Indebtedness and/or other remedial actions.

The Loan Recipient agrees to cause all contractors and subcontractors to comply with (through the inclusion of appropriate terms and conditions in all contracts, subcontracts and lower tiered transactions, such terms and conditions to be in substantially the form set forth in connection with the development and construction of the project

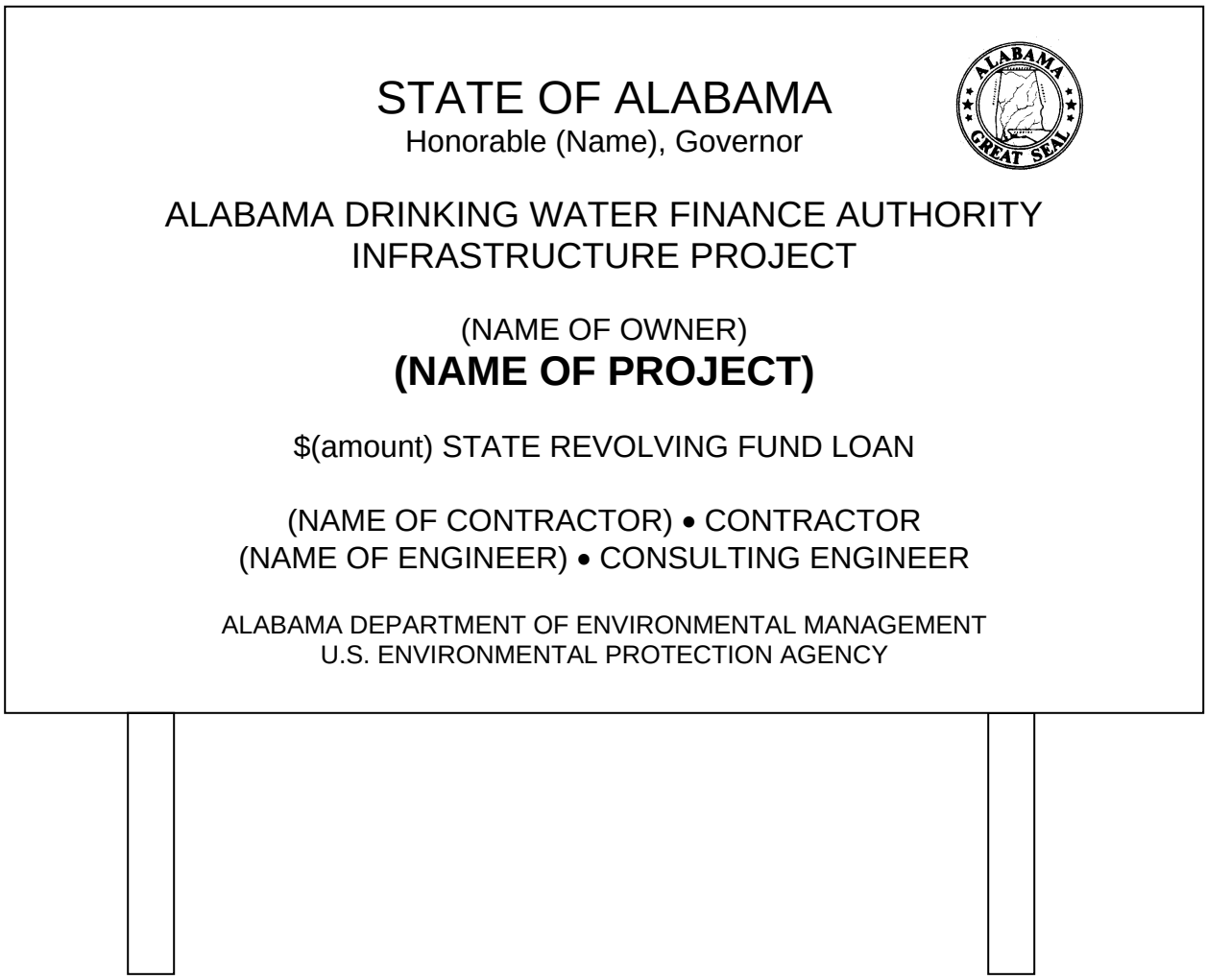
The Contractor acknowledges to and for the benefit of the _____, Alabama ("Purchaser"), and the Alabama Water Pollution Control Authority or the Drinking Water Finance Authority (the "State Authority") that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund that have statutory requirements commonly known as "American Iron and Steel;" that requires all of the iron and steel products used in the project to be produced in the United States ("American Iron and Steel") including iron and steel products provided by the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State Authority that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State Authority. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State Authority to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney's fees) incurred by the Purchaser or State Authority resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State Authority or any damages owed to the State Authority by the Purchaser). While the Contractor has no direct contractual privity with the State Authority, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State Authority is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State Authority.

XVII – Project Sign Detail - CWSRF



1. Sign is to be constructed of ½" MDO plywood, 4' x 8'.
2. Paint with two (2) coats oil-base enamel before lettering.
3. Background color white; lettering black.
4. Lettering may be painted or vinyl. All lettering sizes to be proportionate to sign layout.
5. Sign shall be attached to 4" x 4" x 8' treated posts.
6. Sign shall be placed in prominent location, easily readable from existing street or roadway.
7. Sign shall be maintained in good condition until completion of project.

XVIII – Project Sign Detail - DWSRF



1. Sign is to be constructed of ½" MDO plywood, 4' x 8'.
2. Paint with two (2) coats oil-base enamel before lettering.
3. Background color white; lettering black.
4. Lettering may be painted or vinyl. All lettering sizes to be proportionate to sign layout.
5. Sign shall be attached to 4" x 4" x 8' treated posts.
6. Sign shall be placed in prominent location, easily readable from existing street or roadway.
7. Sign shall be maintained in good condition until completion of project.

XIX – Construction Contract Requirements

This checklist is to be completed by the Owner/Engineer when submitting plans and specifications to the SRF and Operator Certification Section for review. It affirms to the SRF reviewer that the Owner/Engineer has addressed these items (in boilerplate form) within the specifications manual.

Contract Page No.	Satisfied Yes/No	
_____	_____	Bid Advertisement (including date, time, and location of bid opening).
_____	_____	Bid Bond.
_____	_____	Performance Bond (100%).
_____	_____	Payment Bond (Not less than 50%).
_____	_____	Contract Length.
_____	_____	Liquidated Damages.
_____	_____	Liability Insurance (including workman's comp, public liability, and builder's risk, if applicable).
_____	_____	Method of Award (i.e. lowest, responsive, responsible bidder).
_____	_____	Air testing of gravity sewers (if applicable).

Within 14 days after bid opening, the Owner/Engineer is to prepare the Project Review and Cost Summary (**page SGC-37**) and submit it to the SRF and Operator Certification Section of ADEM. Upon completion of review, an Approval to Award will be issued.

Note: The Owner assumes all financial risk if the construction contract is awarded prior to the issuance of an Approval to Award by the SRF and Operator Certification Section.

XX – Project Review and Cost Summary

ADEM Alabama Department of Environmental Management	SRF Project Review and Cost Summary	Form Revised 03 -10-10

This form is to be completed and sent with supporting documentation to ADEM within 14 days after bid opening. Following review, an Approval to Award letter will be issued. Upon award of the contract, a complete, bound set of the contract documents should be forwarded to ADEM for review.

Loan Applicant:_____ Project Number:_____

Contract Number/Name:_____

1. Date of plans and specifications concurrence letter from ADEM:_____

   Date of construction permit issuance from ADEM:_____

2. Attach copies of the following documents:

   a. Bid advertisement with certification by publisher and date(s) of publication.

   b. Certified bid tabulation.

   c. Proposal of the selected bidder.

   d. Bid bond.

   e. Engineer's letter to loan applicant recommending award of the contract. If the award is made to other than the low bidder, provide justification.

   f. Site certificates for the project if not previously submitted with SRF loan application.

   g. Documentation from the owner and contractor. The list of required documents can be found in Part III, page SGC-3 of the ADEM Supplemental General Conditions for SRF Assisted Public Drinking Water and Wastewater Facilities Construction Contracts (ADEM FORM 341).

   h. Copy of the wage determination used in bidding.

   i. Any addenda that have been issued after ADEM review of the plans and specifications.

Comments:

SECTION 01001
GENERAL REQUIREMENTS

PART 1 GENERAL

1.01 GENERAL

A. A brief description of the Work is stated in the Advertisement for Bids. To determine the full scope of the project or any particular part of the project, coordinate the applicable information in the several parts of these Contract Documents.

PART 2 SEQUENCE OF OPERATIONS

2.01 SCHEDULING

A. Prior to starting the Work, confer with the Engineer and Owner's representative to develop an approved Work schedule. Do not make connections between existing Work and new Work until necessary inspection and tests have been completed on the new Work and it is found to conform in all respects to the requirements of the Contract Documents.

B. Work on existing facilities shall be performed on a schedule and in a manner that will permit the existing wastewater treatment system to operate continuously, unless agreed to by the Owner as described herein.

2.02 SHUTDOWN OR ALTERATION OF EXISTING OPERATIONS OR UTILITIES

A. Continuous operation of the existing wastewater treatment system is of critical importance.

B. Connections to existing services or utilities, or other Work that requires the temporary shutdown of any existing operations or utilities shall be planned in detail with appropriate scheduling of the Work and coordinated with the Owner or Engineer. The approved schedule for shutdown or restart shall be indicated on the Contractor's Progress Schedule, and advance notice shall be given in order that the Owner or Engineer may witness the shutdown, tie-in, and startup.

C. All materials and equipment (including emergency equipment) necessary to expedite tie-ins shall be on hand prior to the shutdown of existing services or utilities.

2.03 OPERATION OF EXISTING SYSTEM PROHIBITED

A. At no time undertake to close off any lines or open valves or take any other action which would affect the operation of the existing system, except as specifically required by the Drawings and Specifications and after approval is

granted by the Owner. Request approval to change the system operation three (3) working days in advance of the time that interruption of the existing system is required.

2.04 EQUIPMENT AND SYSTEM TESTING

A. Functional (or run) testing, in the presence of the manufacturer's representative and/or Engineer, will be required for each item of equipment following installation. Functional testing is defined, as that testing necessary to determine if installed equipment and systems will operate as intended.

B. In addition to the functional test, specific performance testing of installed equipment and systems shall be conducted by the Contractor as required in the section specifying the equipment or system.

C. The Contractor shall furnish all labor, materials, tools, equipment, instruments, and services necessary to perform the functional and performance testing.

2.05 SEQUENCE OF DEMOLITION AND CONSTRUCTION

A. Project Construction Sequence: The overall intent of the project construction sequence is to keep the existing plant in operation during construction of the new facility. At no time shall the facility lose the ability to convey and treat wastewater.

1. This sequence of operation is intended to provide one logical option for proceeding through the construction phases, however, it is not expected to be the only sequence to accomplish the required work.

2. The Contractor may determine other sequences that ultimately result in the same outcome with a varied timeline and with similar or improved outage periods.

3. Alternate sequences should be submitted for review and approval by the Owner and Engineer.

4. For clarity, this sequence description has separate sections for Electrical, Process and Controls, however it is expected the General Contractor (GC) and the individual disciplines (subcontractors) will work together to minimize plant and individual processes downtime by scheduling outages with coinciding work between disciplines.

B. Plant Outage & Notifications:

1. All partial plant outages will require 14 days' notice to the OWNER; additionally, confirmation of outages should be given at 72 hours and 24 hours prior to the shutdown.

2. Local short term (<24hrs) outages not affecting overall plant production (i.e. SCADA systems, chemical systems, sampling systems, individual pumps and mechanical systems) require a 7-day notice to the OWNER.

3. The contractor shall submit a detailed shutdown work plan and schedule for approval by the OWNER and ENGINEER

4. A pre-shutdown coordination meeting will be required between plant personnel, Engineer and Contractor prior to approval of the shutdown plan.

C. Demolition and Construction Schedule

1. The following outline serves as the demolition and construction schedule:

1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

PART 3 SITE CONDITIONS

3.01 SITE INVESTIGATION AND REPRESENTATION

A. The Contractor acknowledges satisfaction as to the nature and location of the Work, the general and local conditions, particularly those bearing upon availability of transportation, access to the site, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river stages, or similar physical conditions at the site, the conformation and conditions of the ground, the character of equipment and facilities needed preliminary to and during the prosecution of the Work, and all other matters which can in any way affect the Work or the cost thereof under this Contract.

B. The Contractor further acknowledges satisfaction as to character, quality, and quantity of surface and subsurface materials to be encountered from his inspection of the site and from reviewing any available records of exploratory Work furnished by the Owner or included in these Documents. Failure by the Contractor to become acquainted with the physical conditions of the site and all the available information will not relieve the Contractor from responsibility for properly estimating the difficulty or cost of successfully performing the Work.

C. The Contractor warrants that as a result of examination and investigation of all the aforesaid data, the Contractor can perform the Work in a good and workmanlike manner and to the satisfaction of the Owner. The Owner assumes no responsibility for any representations made by any of its officers or agents during or prior to the execution of this Contract, unless (1) such representations are expressly stated in the Contract, and (2) the Contract expressly provides that the responsibility therefor is assumed by the Owner.

3.02 INFORMATION ON SITE CONDITIONS

A. General: Any information obtained by the Engineer regarding site conditions, groundwater elevations, existing construction of site facilities as applicable, and similar data will be available for inspection at the office of the Engineer upon request. Such information is offered as supplementary information only. Neither the Engineer nor the Owner assumes any responsibility for the completeness or interpretation of such supplementary information.

3.03 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

A. Utilities and structures adjacent to or expected to be encountered in the Work are the Contractor's sole responsibility to locate. A utility notification service is available, and it is encouraged that it be used to notify those utilities that participate in the service.

B. Where the Contractor's operations could cause damage or inconvenience to railway, telegraph, telephone, television, power, oil, gas, water, sewer, or irrigation systems, the operations shall be suspended until all arrangements necessary for the protection of these utilities and services have been made by the Contractor.

C. Notify all utility offices which are affected by the construction operation at least forty-eight (48) hours in advance. Under no circumstances expose any utility without first obtaining permission from the appropriate agency. Once permission has been granted, locate, expose, and provide temporary support for all existing underground utilities.

D. The Contractor shall be solely and directly responsible to the Owner and operators of such properties for any damage, injury, expense, loss, inconvenience, delay, suits, actions, or claims of any character brought because of any injuries or damage which may result from the construction operations under this Contract.

E. Neither the Owner nor its officers or agents shall be responsible to the Contractor for damages as a result of the Contractor's failure to protect utilities encountered in the Work.

F. If the Contractor while performing the Contract discovers utility facilities not identified by the public agency in the Contract Drawings or Specifications, he shall immediately notify the public agency and utility in writing.

G. The public utility, where they are the Owner, shall have the sole discretion to perform repairs or relocation Work or permit the Contractor to do such repairs or relocation Work at a reasonable price.

H. The Contractor shall replace, at his own expense, all existing utilities or structures removed or damage during construction, unless otherwise provided for in these Contract Documents or ordered by the Engineer.

3.04 INTERFERING STRUCTURES

A. Take necessary precautions to prevent damage to existing structures whether on the surface, aboveground, or underground. An attempt has been made to show major structures on the Drawings. The completeness and accuracy of information shown cannot be guaranteed, and it is presented simply as a guide to avoid known possible difficulties.

B. Protect underground and aboveground existing structures from damage, whether or not they lie within the limits of the easements obtained by the Owner. Where such existing fences, gates, barns, sheds, buildings, or any other structure must be removed in order to properly carry out the construction, or are damaged during construction, restore to their original condition to the satisfaction of the property owner involved at the Contractor's own expense. Notify the Engineer of any damaged underground structure, and make repairs or replacements before backfilling.

C. Without additional compensation, the Contractor may remove and replace in a condition as good as or better than original, such small miscellaneous structures as fences, mailboxes, and signposts that interfere with the Contractor's operation.

D. Contractor is responsible for holding all traffic signals and light poles that interfere with construction or are susceptible to damage from construction activities.

3.05 FIELD RELOCATION

A. During the progress of construction, it is expected that minor relocations of the Work will be necessary. Such relocations shall be made only by direction of the Engineer. If existing structures are encountered which prevent the construction, and which are not properly shown on the Drawings, notify the Engineer before continuing with the construction in order that the Engineer may make such field revisions as necessary to avoid conflict with the existing structures. If the Contractor fails to so notify the Engineer when an existing structure is encountered, and proceeds with the construction despite this interference, he shall do so at his own risk.

PART 4 SALVAGE OF MATERIALS

4.01 SALVAGE OF EQUIPMENT AND MATERIALS REMOVED

A. If existing equipment or materials are removed and replaced, they shall be salvaged by the Owner. Upon removal and replacement, the Contractor shall place the equipment or materials at an on-site location directed by the Owner.

PART 5 TEMPORARY CONSTRUCTION UTILITIES AND FACILITIES

5.02 PROJECT SIGN

A. The Contractor shall install a Project sign at the entrance to the construction site.

5.03 TEMPORARY WATER

A. The Contractor shall provide all water required to accomplish the actual construction, including water required for testing, flushing and sterilization. Temporary piping for transporting the water to the Work shall be paid for by the Contractor.

5.04 TEMPORARY ELECTRIC POWER

A. The Contractor shall be responsible for obtaining a source of electric power for construction. The Contractor shall pay the cost of electric service for construction and testing until substantial completion is achieved.

5.05 SAFETY REQUIREMENT FOR TEMPORARY ELECTRIC POWER

A. Temporary electric power installation shall meet the construction safety requirements of OSHA, State, and other governing agencies.

5.06 SANITARY FACILITIES

A. The Contractor shall provide and maintain sanitary facilities for his employees and his subcontractors' employees that will comply with the regulations of the local and state departments of health and as directed by the Engineer.

5.07 RECEIVING, INSPECTION, AND UNLOADING PRODUCTS

A. Contractor shall record the receipt of products at the job site.

B. Upon receipt of products at the job site, Contractor shall inspect for completeness and evidence of damage during shipment.

1. Owner’s representative may be present for inspection.

2. Should there appear to be damage, notify the Owner’s representative immediately and inform the Manufacturers and the Transportation Company.

3. Expedite replacement of damaged, incomplete, or lost items.

C. After completion of inspection, unload products in accordance with manufacturer's instructions for unloading, or as specified. Do not unload damaged or incomplete products to be returned to manufacturer for replacement, except as necessary to expedite return shipment.

5.08 HANDLING, STORAGE, AND MAINTENANCE OF PRODUCTS

A. Handle products in accordance with the manufacturer's written recommendations, and in a manner to prevent damage.

B. Store products prior to installation as recommended by the manufacturer.

1. Store products such as pipe and reinforcing steel off the ground in approved storage yards.

2. Store items subject to damage by the elements, vandalism, or theft in secure buildings.

3. Provide environmentally controlled storage facilities for items requiring environmental control for protection.

C. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.

D. Store products to provide access for inspection and inventory control. Contractor shall document products in storage to facilitate inspection and to estimate progress payments for products delivered but not installed in the Work.

5.09 STORAGE OF MATERIALS

A. Materials shall be so stored as to ensure the preservation of their quality and fitness for the Work. When considered necessary, they shall be placed on wooden platforms or other hard, clean surfaces, and not on the ground. Stored materials shall be located so as to facilitate prompt inspection. Private property shall not be used for storage purposes without the written permission of the Owner or lessee.

B. Delicate instruments and materials subject to vandalism shall be placed under locked cover and, if necessary, provide with temperature control as recommended by the manufacturer.

PART 6 SAFETY AND CONVENIENCE

6.01 CONSTRUCTION SAFETY PROGRAM

A. The Contractor shall develop and maintain for the duration of this Contract, a safety program that will effectively incorporate and implement all required

safety provisions. The Contractor shall appoint an employee who is qualified and authorized to supervise and enforce compliance with the safety program.

B. The duty of the Engineer to conduct construction review of the Contractor's performance is not intended to include a review or approval of the adequacy of the Contractor's safety supervisor, the safety program, or any safety measures taken in, on, or near the construction site.

6.02 SAFETY EQUIPMENT

A. The Contractor, as part of his safety program, shall maintain at his office or other well-known place at the job site, safety equipment applicable to the Work as prescribed by the governing safety authorities, all articles necessary for giving first-aid to the injured, and shall establish the procedure for the immediate removal to a hospital or a doctor's care of any person who may be injured on the job site.

B. The Contractor shall do all Work necessary to protect the general public from hazards, including, but not limited to, pedestrian sidewalk or walkway, and trenches or excavations in roadway. Barricades, lanterns, and proper signs shall be furnished in sufficient amount to safeguard the public and the Work.

C. The performance of all Work and all completed construction, particularly with respect to ladders, platforms, structure openings, scaffolding, shoring, lagging, machinery guards and the like, shall be in accordance with the applicable governing safety authorities.

D. During construction, the Contractor shall construct and at all times maintain satisfactory and substantial temporary chain link fencing, solid fencing, railing, barricades or steel plates, as applicable, at all openings, obstruction, or other hazards in streets, sidewalks, floors, roofs, and walkways. All such barriers shall have adequate warning light as necessary, or required, for safety.

6.03 ACCIDENT REPORTS

A. If death or serious injuries or serious damage are caused, the accident shall be reported immediately by telephone or messenger to the Engineer. In addition, the Contractor must promptly report in writing to the Engineer all accidents whatsoever arising out of or in connection with, the performance of the Work whether on, or adjacent to, the site, giving full details and statements of witnesses.

B. If claim is made by anyone against the Contractor or any subcontractor on account of any accidents, the Contractor shall promptly report the facts in writing to the Engineer, giving full details of the claim.

6.04 SAFE ACCESS BY FEDERAL, STATE, AND LOCAL GOVERNMENT OFFICIALS

A. Authorized representatives of the Alabama Department of Environmental Management, and other government officials shall at all time have safe access to the Work, and the Contractor shall provide proper facilities for such access and inspection.

6.05 PROTECTION OF PROPERTY

A. Protect stored materials, cultivated trees and crops, and other items located adjacent to the proposed Work. Notify property owners affected by the construction at least forty-eight (48) hours in advance of the time construction begins. During construction operations, construct and maintain such facilities as may be required to provide access by all property owners to their property. No person shall be cut off from access to his residence or place of business for a period exceeding eight (8) hours, unless the Contractor has made special arrangements with the affected persons.

6.06 FIRE PREVENTION AND PROTECTION

A. The Contractor shall perform all Work in a fire-safe manner. He shall supply and maintain on the site adequate fire-fighting equipment capable of extinguishing incipient fires. The Contractor shall comply with applicable Federal, State, and local fire-prevention regulations. Where these regulations do not apply, applicable parts of the National Fire Prevention Standard for Safeguarding Building Construction Operation (NFPA No. 241) shall be followed.

6.07 TRAFFIC MAINTENANCE AND SAFETY

A. Comply with all rules and regulations of the State, County, and City authorities regarding closing or restricting the use of public streets or highways. No public or private road shall be closed, except by express permission of the Owner. Conduct the Work so as to assure the least possible obstruction to traffic and normal commercial pursuits. Protect all obstructions within traveled roadways by installing approved signs, barricades, and lights where necessary for the safety of the public. The convenience of the general public and residents adjacent to the project and the protection of persons and property are of prime importance and shall be provided for in an adequate and satisfactory manner.

B. When flagmen and guards are required by regulation or when deemed necessary for safety, they shall be furnished with approved orange wearing apparel and other regulation traffic-control devices.

6.08 ACCESS AND NOTIFICATION FOR POLICE, FIRE, AND POSTAL SERVICE

A. Notify the fire department and police department before closing any street or portion thereof. No closing shall be made without the Owner's approval. Notify said departments when the streets are again passable for emergency vehicles. Conduct operations with the least interference to fire equipment access and at no time prevent such access.

B. The Contractor shall leave a night emergency telephone number or numbers with the police departments, so that contact may be made easily at all times in case of barricade or flare trouble or other emergencies.

C. Maintain postal service facilities in accordance with the requirements of the U.S. Postal Service, and at the completion of the Work in each area, replace them in their original location and in a condition satisfactory to the U.S. Postal Service.

PART 7 USE OF EXPLOSIVES

A. The Contractor shall use all precaution, control, and safety features necessary to insure the safety of life or property in the area of operation.

B. Blasting operations shall be performed under the most skilled supervision. Where necessary, Contractor shall use suitable mats or other approved methods to smother blast.

C. No loaded holes shall be left unattended.

D. Extreme care shall be taken to minimize the amount and degree of ground vibration, noise, overpressure, and flying debris.

E. All explosives shall be stored in a safe manner, in compliance with local, state and federal laws and ordinances.

PART 8 PRESERVATION, RESTORATION, AND CLEANUP

8.01 EROSION CONTROL

A. The Contractor shall protect floodplains and wetlands by complying with the requirements in Title 33 of the Code of Federal Regulations Part 330, Appendix A. The Contractor shall provide silt fences and straw bales or wattles, as required or by the recommendations of the Owner or Engineer.

B. The CONTRACTOR shall be responsible for obtaining a construction stormwater permit, in accordance with ADEM Administrative Code Chapter 335-6-6, for all land disturbance activities, and associated areas, that exceed one acre or disturbance activities less than one acre that are a part of, adjacent to, or in close proximity to, or associated with a larger plan of development that might

eventually exceed one acre. The contractor shall also be responsible for installing and maintaining all BMPs required by the stormwater permit.

8.02 SITE RESTORATION AND CLEANUP

A. At all times during the Work, keep the premises clean and orderly, and upon completion of the Work, repair all damage caused by equipment and leave the project free of rubbish or excess materials of any kind.

B. All existing drainage ditches and culverts shall be reopened and graded and natural drainage restored. Restore culverts broken or damaged to their original condition and location.

8.03 FINISHING OF SITE, BORROW, AND STORAGE AREAS

A. Upon completion of the project, all areas used by the Contractor shall be properly cleared of all temporary structures, rubbish, and waste materials and properly graded to drain and blend in with the abutting property. Areas used for the deposit of waste materials shall be finished to properly drain and blend with the surrounding terrain.

8.04 RESEEDING AND FERTILIZING

A. If damaged originally seeded areas inside and outside of the construction area shall be fertilized and reseeded with first-quality seed or planted with new sod as approved by the property owner. All ground preparation, reseeding, and sodding shall be done in accordance with the best accepted practices for lawn planting. The Contractor shall be responsible for obtaining a satisfactory grass turf acceptable to the property owner.

8.05 STREET CLEANUP DURING CONSTRUCTION

A. Thoroughly clean all foreign material caused by the construction operations from all streets and roads at the conclusion of each day's operation.

PART 9 SUBMITTALS DURING CONSTRUCTION

9.01 GENERAL

A. Requirements in this Section are in addition to any specific requirements for submittals specified in other Sections of these Contract Documents.

B. Submittals to the Engineer shall be addressed to:

Ardurra Group
200 Clinton Avenue West, Suite 704
Huntsville, AL 35801
Attn: Shakil Amin

C. Submitted data shall be fully sufficient in detail for determination of compliance with the Contract Documents.

D. Review, acceptance, or approval of substitutions, schedules, shop Drawings, lists of materials, and procedures submitted or requested by the Contractor shall not add to the Contract amount, and all additional costs which may result therefrom shall be solely the obligation of the Contractor.

E. The Owner is not precluded, by virtue of review, acceptance, or approval, from obtaining a credit for construction savings resulting from allowed concessions in the Work or materials therefore.

F. It shall not be the responsibility of the Owner to provide engineering or other services to protect the Contractor from additional costs accruing from such approvals.

G. No equipment or material for which listings, Drawings, or descriptive material is required shall be installed until the Engineer has on hand copies of such approved lists and the appropriately stamped final shop Drawings.

H. The review of Drawings by the Engineer will be limited to general design requirements only, and shall in no way relieve the Contractor from responsibility for errors or omissions contained therein.

I. Submittals will be acted upon by the Engineer as promptly as possible, and returned to the Contractor no later than the time allowed for review in SHOP DRAWING SUBMITTAL PROCEDURE. Delays caused by the need for resubmittals shall not constitute reason for an extension of Contract time.

9.02 SHOP DRAWING SUBMITTAL PROCEDURE

A. The Contractor shall submit five (5) copies, to the Engineer for his review, of shop Drawings, electrical diagrams, and catalog cuts for fabricated items and manufactured items (including mechanical and electrical equipment) furnished under this Contract. Shop Drawings shall be submitted in sufficient time to allow the Engineer not less than twenty (20) regular working days for examining the shop Drawings.

B. These shop Drawings shall be accurate, distinct, and complete, and shall contain all required information, including satisfactory identification of items, units, and assemblies in relation to the Contract Drawings and Specifications.

C. Shop Drawings shall be submitted only by the Contractor, who shall indicate by a signed stamp on the shop Drawings, or other approved means, that he (the Contractor) has checked and approved the shop Drawings, and that the Work shown is in accordance with Contract requirements and has been checked for dimensions and relationship with Work of all other trades involved. The practice of submitting incomplete or unchecked shop Drawings for the Engineer

to correct or finish will not be acceptable, and shop Drawings which, in the opinion of the Engineer, clearly indicate that they have not been checked by the Contractor will be considered as not complying with the intent of the Contract Documents and will be returned to the Contractor for resubmission in the proper form.

D. When the shop Drawings have been reviewed by the Engineer, two (2) sets of submittals will be returned to the Contractor appropriately stamped. If major changes or corrections are necessary, the shop Drawing may be rejected and one set will be returned to the Contractor with such changes or corrections indicated, and the Contractor shall correct and resubmit the shop Drawings in the same manner and quantity as specified for the original submittal, unless otherwise directed by the Engineer. If changes are made by the Contractor (in addition to those requested by the Engineer) on the resubmitted shop Drawings, such changes shall be clearly explained in a transmittal letter accompanying the resubmitted shop Drawings.

E. The review of such shop Drawings and catalog cuts by the Engineer shall not relieve the Contractor from responsibility for correctness of dimension, fabrication details, and space requirements, or for deviations from the Contract Drawings or Specifications, unless the Contractor has called attention to such deviations in writing by the letter accompanying the shop Drawings and the Engineer approves the change or deviation in writing at the time of submission; nor shall review by the Engineer relieve the Contractor from the responsibility for errors in the shop Drawings.

F. The Contractor agrees that shop Drawing submittals processed by the Engineer do not become Contract Documents and are not Change Orders; that the purpose of the shop Drawing review is to establish a reporting procedure and is intended for the Contractor's convenience in organizing his Work and to permit the Engineer to monitor the Contractor's progress and understanding of the design.

9.03 SHOP DRAWING REQUIREMENTS

A. Shop Drawings referred to herein shall include shop Drawings and other submittals for both shop and field-fabricated items. The Contractor shall submit, as applicable, the following for all prefabricated or manufactured structural, mechanical, electrical, plumbing, process systems, and equipment:

1. Shop Drawings or equipment Drawings, including dimensions, size and location of connections to other Work, and weight of equipment.
2. Catalog information and cuts.
3. Installation or placing Drawings for equipment, drives, and bases.
4. Supporting calculations for equipment and associated supports specified to be designed by equipment manufacturers or suppliers.
5. Wiring and control diagrams of systems and equipment.

6. Complete manufacturer's specifications, including materials description and paint system.
7. List of special motor features being provided (i.e., space heaters, altitude corrections, thermal protectors, etc.).
8. Complete motor rating for all motors fifteen (15) hp and larger, including motor no-load, starting, and full-load current at rated voltage; full-load speed and full-load current at one hundred-ten (110%) percent voltage; motor efficiency and power factor at ½, ¾, and full load at rated voltage.
9. Performance data and pump curves.
10. Suggested spare parts list with current price information.
11. List of special tools required for checking, testing, parts replacement, and maintenance (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics).
12. List of special tools furnished with the equipment.
13. List of materials and supplies required for the equipment prior to and during startup.
14. List of materials and supplies furnished with the equipment.
15. Samples of finish colors for selection.
16. Special handling instructions.
17. Requirements for storage and protection prior to installation.
18. Requirements for routine maintenance required prior to plant startup.
19. List of all requested exceptions to the Contract Documents.

B. The submittals shall include satisfactory identification of items, units, and assemblies in relation to the Specification Section number, and the system or equipment identification or tag number shown on the Drawings or as provided in the applicable Specification Section.

C. Should the Contractor propose any item on his shop Drawings, or incorporate an item into the Work, and that item should subsequently prove to be defective or otherwise unsatisfactory, (regardless of the Engineer's preliminary review), the Contractor shall, at his own expense, replace the item with another item that will perform satisfactorily.

9.04 OPERATIONS AND MAINTENANCE (O&M) MANUALS

A. The CONTRACTOR shall furnish four (4) copies of a complete instruction manual for installation, operation, maintenance, and lubrication requirements for each component of mechanical and electrical equipment or system under this Contract. All equipment manufacturers and/or suppliers shall be made aware of these requirements and all associated costs shall be included in the costs for

furnishing the equipment or system. Each instruction manual furnished shall be fixed in a hard-back binder which is clearly labeled to designate the system or equipment for which it is intended with reference to the building and equipment number and the Specification section where the item is specified.

B. The manuals shall be furnished at least thirty (30) calendar days prior to the scheduled completion of the Work but in no case shall submission of the manuals be delayed beyond seventy-five (75%) percent completion point of the Work. Submission of the manuals shall precede any payment to the CONTRACTOR for Work completed in excess of the seventy-five (75%) percent completion level. Any deficiencies found by the ENGINEER to exist in the manuals submitted shall be corrected by the CONTRACTOR within thirty (30) calendar days following notification by the ENGINEER of the deficiencies.

C. Each instruction manual shall include, but not be limited, to the following:

1. Diagrams and illustrations.
2. Detailed description of the function of each principal component of the system.
3. Performance and nameplate data.
4. Installation instructions.
5. Procedure for starting.
6. Proper adjustment.
7. Test procedures.
8. Procedure for operating.
9. Shutdown instructions.
10. Emergency operating instructions and troubleshooting guide.
11. Safety precautions.
12. Maintenance and overhaul instructions which shall include detailed assembly Drawings with part numbers, parts list, instructions for ordering spare parts, and complete preventive maintenance instruction required to ensure satisfactory performance and longevity of the equipment.
13. Lubrication instructions, which shall list points to be greased or oiled, shall recommend type, grade, and temperature range of lubricants, and shall recommend frequency of lubrication.
14. List of electrical relay settings and control and alarm contact settings.
15. Electrical interconnection wiring diagram for equipment furnished, including all control and lighting systems.

D. Manuals shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances.

E. Manuals shall be assembled in one (1) or more binders, each with title page, typed table of contents, and heavy section dividers with numbered plastic index tabs. Each manual shall be divided into sections paralleling the equipment Specifications. Binders shall be three (3) ring, hard-back type. All data shall be punched for binding and composition and printing shall be arranged so that punching does not obliterate any data. The Project title, division designation, and manual title printed thereon shall be furnished by the ENGINEER.

F. Where more than one (1) binder is required, they shall be labeled "Vol. 1", "Vol. 2", and so on. The table of contents for the entire set, identified by volume number, shall appear in each binder. Submit manual organization and format to the Engineer for approval prior to manual preparation.

G. Each O & M Manual shall be transmitted to the ENGINEER prior to the installation of the equipment and all equipment shall be serviced in accordance with the manufacturer's recommendations prior to operation. A service record shall be maintained on each item of equipment and shall be delivered to the ENGINEER prior to final acceptance of the Project.

9.05 MAINTENANCE SUMMARY FORMS

A. In addition to the O & M Manuals, provide Maintenance Summaries in the format of the form bound at the end of this Section and described below. The timing of submission of these forms shall be the same as prescribed above for the Operation and Maintenance Manuals.

B. An individual Maintenance Summary for each equipment item shall be completed following the outlined provided; and six (6) copies submitted for review by the ENGINEER. The manufacturer's standard form will not be acceptable as a substitute for the Maintenance Summary.

C. The term "Maintenance Operation" as used in the Maintenance Summary bound at the end of this Section is understood to mean any routine operation required to ensure the satisfactory performance and longevity of the equipment. Examples of some typical Maintenance Operations are lubrications, belt tensioning, adjustment of pump packing glands, routine adjustments, etc.

D. The Maintenance Summary may take as many pages as required. However, the order and format shown must be adhered to. Only 8½ inch by eleven (11) inch paper will be accepted.

9.06 RECORD DRAWINGS

A. The Contractor will prepare a set of Record Drawings for the Project, which will include the changes made in materials, equipment, locations, and dimensions of

the Work. Each month, or as otherwise agreed, the Contractor shall submit to the Engineer a current listing and description of each change incorporated into the Work since the preceding submittal.

9.07 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

A. Where required in the Specifications, the Contractor shall submit manufacturer's certification of proper installation of equipment prior to startup or performance testing. Such certificate shall state that the equipment or system has been installed in accordance with the manufacturer's recommendation and has been inspected by a manufacturer's authorized representative, that it has been serviced with the proper initial lubricants, that applicable safety equipment has been properly installed, and the proper electrical and mechanical connections have been made.

9.08 MATERIAL AND EQUIPMENT COLORS

A. The Engineer will provide a schedule of colors within thirty (30) days after approval of materials and equipment and after receiving samples of all standard colors those items requiring selections.

B. No individual color selections will be made until after approval of all pertinent materials and equipment and after receipt of appropriate samples.

9.09 CERTIFICATES OF COMPLIANCE WITH SPECIFIED STANDARDS AND CODES

A. A Certificate of Compliance shall be furnished for materials specified to a recognized standard or code prior to the use of any such materials in the Work. The Engineer may permit the use of certain materials or assemblies prior to sampling and testing if accompanied by a Certificate of Compliance. The certificate shall be signed by the manufacturer of the material or the manufacturer of assembled materials and shall state that the materials involved comply in all respects with the requirements of the Specifications. A Certificate of Compliance shall be furnished with each lot of material delivered to the Work and the lot so certified shall be clearly identified in the certificate.

B. All materials used on the basis of a Certificate of Compliance may be sampled and tested at any time. The fact that material is used on the basis of a Certificate of Compliance shall not relieve the Contractor of responsibility for incorporating material in the Work which conforms to the requirements of the Contract Documents and any such material not conforming to such requirements will be subject to rejection whether in place or not.

C. The Engineer reserves the right to refuse permission for use of material on the basis of a Certificate of Compliance.

D. The form of the Certificate of Compliance and its disposition shall be as directed by the Engineer.

9.10 STARTING OF SYSTEMS

A. Definitions:

1. System: A system means the overall process or a portion thereof, that performs a specific function. A system may consist of two (2) or more subsystems as well as two (2) or more types of equipment.

2. Subsystem: A subsystem is a portion of a larger systems consisting of two (2) or more types of equipment.

3. Functional Testing: Tests necessary to demonstrate that installed equipment and systems function as specified and operate in the manner intended. Functional testing is a prerequisite to performance testing for equipment and systems specified to have a performance test.

4. Performance Testing: Tests necessary to demonstrate, after successful functional testing, that equipment and systems meet specified performance requirements.

5. Startup:

a. Startup of any portion of the entire facility is considered complete when, in the opinion of the Engineer, the facility or designated portion has properly operated for seven (7) continuous days without significant interruption. The startup period is in addition to the specified functional and performance testing and training.

b. Significant interruption during startup shall include any of the following events:

1). Failure of a system (process, control, building service, etc.) that is not permanently corrected within four (4) hours after such failure occurs.

2). Failure of a process equipment unit (mechanical, electrical, instrument, etc.) that is not permanently corrected within six (6) hours after such failure occurs.

3). Failure of an analytical, HVAC, building service, or hoisting equipment unit that is not permanently corrected within eight (8) hours after such failure occurs.

c. "Permanently corrected" shall consist of all the following:

1). Work repaired and replaced to conform with specified requirements.

2). Parts and components replaced as recommended by original manufacturer and conforming with reviewed submittals.

3). Piping and valves properly installed and connected.

4). Wiring properly terminated and enclosed in raceways.

5). Accessories, including spare parts and lubricants, furnished as specified.

d. Occurrence of a significant interruption shall require startup then in progress to be stopped and restarted after permanent corrections are made.

6. Operation: The operation period begins when the facility has been substantially completed as defined in the GENERAL CONDITIONS.

B. Testing and Startup Responsibilities

1. Contractor's Responsibilities: The Contractor shall:

a. Furnish labor and materials, tools, instruments, and service for checking, testing, and startup specified for each equipment item. This includes such services as required by the manufacturer's representatives, subcontractors, electricians, instrumentation technicians, and pipe fitters.

b. Prepare testing schedule and incorporate testing and startup activities in the progress schedule for the Work.

c. Designate one (1) person (other than field superintendent) to be responsible for coordinating and expediting testing and start-up responsibilities, and to be present during all pre-startup meetings and available to Owner's personnel during the testing and startup.

d. Obtain and furnish qualified manufacturer's representative to assist testing of each equipment type and system.

e. Develop a standard testing log to be used as a record of testing each item and subsystem. This log shall:

1). Be subject to approval of Engineer.

2). Include subsystem and equipment name.

3). Have provisions for recording dates of completion for checking, inspection by manufacturer, verification of instrumentation and controls, and completion of subsystem tests, and;

4). Provide space for problems remaining with equipment and for signature of Engineer and manufacturer's representative indicating acceptance.

f. Notify Engineer and Owner at least fourteen (14) days prior to the date when each equipment system is scheduled to be initially started; also submit testing plan starting schedule, quantity and source of utilities, chemicals, and other materials needed.

g. Furnish spare parts and special tools as specified for the respective equipment.

h. Furnish O & M information needed for O & M Manuals, as specified herein.

2. Owner's Responsibilities: The Owner will:

a. Furnish for Contractor's use during startup:

1). Electrical power.

2). Potable and/or raw water for testing, as appropriate.

3). Chemicals including chlorine, polyaluminum chloride, lime, sodium bisulfite and sodium hexametaphosphate, provided adequate prior notice is given by Contractor.

4). Sample containers for Contractor's use in sample collection.

b. Provide sampling labor and materials and laboratory analysis.

c. Furnish Owner's representative to witness all tests.

C. Testing Preparation

1. Cleaning and Checking: Prior to initial startup of equipment:

a. Inspect and clean equipment, devices, and connected piping so they are free of foreign material.

b. Lubricate equipment in accordance with manufacturer's instructions.

c. Turn rotating equipment by hand and check motor-driven equipment for correct rotation.

d. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.

e. Check power supply to electric-powered equipment for correct voltage.

f. Obtain manufacturer's certification of proper installation, where specified.

2. Ready-To-Test Determination: Equipment shall be determined ready to test by Engineer based on the following:

a. Notification by Contractor of equipment and system readiness for testing.

b. Submittal of testing plan stating detailed procedures including quantity and source of utilities, chemicals, and other materials needed for each test.

c. Receipt of O & M Manuals incorporating review comments.

d. Receipt of manufacturer's certification of proper installation, where specified.

e. Cleanliness of equipment, devices, and connected work.

f. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.

3. Pre-testing Meeting: Contractor shall arrange a meeting to review the Contractor's detailed testing plan for each equipment item and system, at least two (2) days prior to the first test run.

D. Functional Testing

1. Subsystem Tests: Startup and operate the individual components and subsystems that make up each equipment system, as specified in the respective sections of the Specifications. Functional testing of a complete system shall not begin until subsystem testing is completed to the Engineer's satisfaction.

2. Equipment and System Tests: Contractor shall functionally test each separate piece of equipment, and each system requiring simultaneous operation of interdependent equipment, in accordance with the following procedures:

a. Separate items of equipment demonstrated to function properly during subsystem testing shall require no further functional test, if documentation of subsystem testing is accepted by Engineer.

b. Functional testing of each system shall begin after subsystems and equipment units have been satisfactorily tested.

c. Functional testing will begin at a time mutually agreed upon by the Engineer, Owner, Manufacturer's Representative(s) and Contractor.

1). The Owner or Engineer will be present during tests.

2). Notify Engineer, Owner, and Manufacturer's Representative at least seven (7) days prior to schedule date of functional tests.

d. Performance tests, where specified for individual equipment, shall not begin until functional testing of the complete systems in which they operate is completed to the satisfaction of the Engineer.

e. If, in the opinion of the Engineer, each system meets the requirements specified, they will be accepted as conforming for the purposes of advancing to the performance testing phase. If, in the opinion of the Engineer, the functional test results do not meet the requirements specified, the systems will be considered as nonconforming.

1). In the case of a nonconforming system, advancement to the performance testing phase shall not commence until the Contractor has made such adjustments, changes, and additions necessary to correct the system and retest it as specified and, in the opinion of the Engineer, the system functions as specified.

3. Documentation: Contractor shall document subsystem and system tests in writing, in a format acceptable to the Engineer. Obtain respective manufacturer's signature and approval for subsequent performance testing or startup on the appropriate test logs.

E. Performance Testing

1. Testing Fluid: Performance testing shall use plant fluid or material that the equipment or system is designed to handle during normal service conditions, unless otherwise specified.

2. Equipment and Subsystem Tests: Contractor shall:

a. Clean and check equipment and devices, as specified herein prior to starting equipment and subsystem performance tests.

b. Performance testing will begin at a time mutually agreed upon by the Engineer, Owner, Manufacturer's Representative(s), and Contractor.

1). The Owner or Engineer will be present during tests.

2). Notify Engineer, Owner, and manufacturer's representative at least seven (7) days prior to schedule date of performance testing.

c. Operate the necessary equipment units as specified in the respective O & M Manuals for a continuous period of four (4) hours.

d. Follow Engineer-approved testing plan and detailed procedures specified for each equipment unit and subsystem.

e. Complete acceptable performance testing of all equipment and subsystems included in a system, and submit test documentation before starting the system performance test.

F. Startup

1. Performance testing of all individual equipment and subsystems shall be completed before the startup period begins, unless otherwise allowed by the Engineer.

2. Prepare startup activity schedule.

   a. Schedule shall identify and sequence distinct activities to be conducted or tasks to be accomplished.

   b. Examples of startup activities to be conducted are:

      1). Demonstrate manual and automatic operation of equipment.

      2). Simulate power failure and observe operation of components, tripping of breakers, etc.

   c. Conduct additional non process activities such as:

      1). Operate all plumbing systems.

      2). Operate all HVAC systems.

      3). Open, close, lock, and unlock all doors and windows to check master keying.

      4). Check all electrical and lighting systems.

   d. Indicate timing and interdependence of activities in the program, indicating each system, subsystem, and unit to be operated. Allow for rotation of standby units with operating units so that each unit is started and stopped at least twice and receives approximately the same elapsed time of operation.

3. After review and revisions requested by Engineer and Owner, begin the startup activities. Attend a pre-startup meeting not more than five (5) days to startup to review the program and resolve questions.

4. During startup operations, keep complete records of each activity and performance of each system, subsystem, and equipment unit. Use similar forms approved for functional testing, or as otherwise submitted and approved by Engineer.

5. If performance testing of certain systems cannot be completed before successful startup, continue such performance tests after entire facility is in continuous operation.

6. After successful startup as defined in this Section, perform remaining Work to not interfere with facility operations.

G. Continuous Operation

1. Owner will accept equipment and systems as ready for continuous operation only after successful testing and startup is completed and documented, test and startup reports submitted and manufacturers' services completed for training of Owner's personnel.

2. After successful performance testing of a particular equipment type or system, Owner may elect to start up a portion of the equipment or system for continuous operation in accordance with the GENERAL CONDITIONS. Such operation will not interfere with testing of other equipment and systems that may still be underway, and shall not preclude the need to start up the portion operated in combination with the rest of the facility when all testing is completed.

3. Where completed systems require disinfection, they shall only be accepted for continuous operation after disinfection work specified is satisfactorily completed.

9.11 SUPPLIERS'/ MANUFACTURERS' SPECIAL SERVICES

A. Installation Assistance: Competent and experienced technical personnel shall represent the manufacturers of all equipment and systems as may be necessary to resolve assembly or installation problems at the Work site which are attributable to, or associated with, the equipment furnished.

B. Functional Testing: Where functional testing services are called for in the Technical Specifications, or when technical assistance is necessary to resolve performance problems that may become apparent during the performance test, the manufacturer's representative shall provide such assistance as necessary to demonstrate the specified performance.

C. Startup: Where startup services are called for in the Technical Specifications, or when technical assistance is necessary due to any malfunction of the equipment or system furnished, the manufacturer's representative shall provide such services as necessary to provide the Owner with an acceptable operating facility.

D. Costs for Services:

1. Costs for providing services during installation, testing, and for the training of Owner's personnel shall be included in the costs for providing the applicable specified equipment.

2. Where the number of days for services is not stated in the Technical Specifications, services shall be furnished for installation, testing, and plant startup as required to provide the Owner with a satisfactory operating facility.

END SECTION

TYPICAL MAINTENANCE SUMMARY FORM

1. EQUIPMENT ITEM

2. MANUFACTURER

3. NAMEPLATE DATE (hp, voltage, speed, etc.)

4. MANUFACTURER'S LOCAL REPRESENTATIVE

Name _____ Telephone Number _____

Address _____

5. SPARE PARTS. Include your recommendations regarding what spare parts, if any should be kept on the job.

6. MAINTENANCE REQUIREMENTS

Maintenance Operation[1]	**Frequency[2]**	**Lubricant (If Applicable) [3]**	**Comments**

1. List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable.

2. List required frequency of each maintenance operation.

3. List lubricant manufacturers, types, and identification numbers.

SECTION 01100
SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Work covered by the Contract Documents.

2. Organization and interpretation of Contract Documents.

1.02 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Identification: **Central Elmore WTP Upgrade**

1. Project Location: Eclectic, AL

B. Project No. 2024-0776-00

C. OWNER: Central Elmore Water and Sewer Authority

1. OWNER's Representative: Mr. Ross Caton, PE

2. OWNER's Address: 716 U.S. Highway 231, Wetumpka, AL 36093

D. Engineer: Mr. Shakil Amin, PE

E. The Work consists of the following:

- Construction of concrete pads for new water storage tank, pump station, emergency generator, and GAC vessels
- Installation of pre-cast vault for chemical injection and mixing
- Installation of static mixer and bypass piping
- Installation of pre-cast flow meter vault
- Installation of storage tank, pumps, piping, and appurtenances
- Installation of GAC vessels, piping, and accessories
- Installation of sodium hypochlorite generation system
- Installation of standby emergency generator
- Other civil/site improvements

F. Project will be constructed under a single prime contract.

1.03 ORGANIZATION AND INTERPRETATION OF CONTRACT DOCUMENTS

A. Specifications and Drawings included in these Contract Documents establish the performance, quality requirements, location and general arrangement of

materials and equipment, and establish the minimum standards for quality of workmanship and appearance.

B. A part of the work that is necessary or required to make each installation satisfactory and operable for its intended purpose, even though it is not specifically included in the Specifications or on the Drawings, shall be performed as incidental work as if it were described in the Specifications and shown on the Drawings.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01250
CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

B. See Division 1 Section "Allowances" for procedural requirements for handling and processing allowances.

C. See Division 1 Section "Unit Prices" for administrative requirements for using unit prices.

1.02 MINOR CHANGES IN THE WORK

A. ENGINEER will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on form provided by ENGINEER.

1.03 PROPOSAL REQUESTS

A. OWNER-Initiated Proposal Requests: ENGINEER will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Proposal Requests issued by ENGINEER are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.

2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

c. Include costs of labor and supervision directly attributable to the change.

d. Include an updated CONTRACTOR's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

B. CONTRACTOR-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, CONTRACTOR may propose changes by submitting a request for a change to ENGINEER.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.

3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.

4. Include costs of labor and supervision directly attributable to the change.

5. Include an updated CONTRACTOR's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

6. Comply with requirements in Division 1 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

C. Proposal Request Form: Use forms provided by ENGINEER

1.04 ALLOWANCES

A. Allowance Adjustment: To adjust allowance amounts, base each Change Order proposal on the difference between purchase amount and the allowance, multiplied by final measurement of work-in-place. If applicable, include reasonable allowances for cutting losses, tolerances, mixing wastes, normal product imperfections, and similar margins.

1. Include installation costs in purchase amount only where indicated as part of the allowance.

2. If requested, prepare explanation and documentation to substantiate distribution of overhead costs and other margins claimed.

3. Submit substantiation of a change in scope of work, if any, claimed in Change Orders related to unit-cost allowances.

4. OWNER reserves the right to establish the quantity of work-in-place by independent quantity survey, measure, or count.

B. Submit claims for increased costs because of a change in scope or nature of the allowance described in the Contract Documents, whether for the Purchase Order amount or CONTRACTOR's handling, labor, installation, overhead, and profit. Submit claims within 14 days of receipt of the Change Order or Construction Change Directive authorizing work to proceed. OWNER will reject claims submitted later than 14 days after such authorization.

1. Do not include CONTRACTOR's or subcontractor's indirect expense in the Change Order cost amount unless it is clearly shown that the nature or extent of work has changed from what could have been foreseen from information in the Contract Documents.

2. No change to CONTRACTOR's indirect expense is permitted for selection of higher- or lower-priced materials or systems of the same scope and nature as originally indicated.

1.05 CHANGE ORDER PROCEDURES

A. On OWNER's approval of a Proposal Request, ENGINEER will issue a Change Order for signatures of OWNER and CONTRACTOR on forms provided by ENGINEER.

1.06 CONSTRUCTION CHANGE DIRECTIVE

A. Work Change Directive: ENGINEER may issue a Construction Change Directive on forms provided by ENGINEER. Work Change Directive instructs CONTRACTOR to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Work Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Work Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 01300
SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. This Section specifies the general methods and requirements of submissions applicable to Shop Drawings, Product Data, and Samples. Detailed submittal requirements are specified in the technical Sections.

B. All submittals shall be clearly identified by reference to Section Number, Paragraph, Drawing Number or Detail as applicable. Submittals shall be clear, legible, and of sufficient size for presentation of data.

1.02 SHOP DRAWINGS, PRODUCT DATA, SAMPLES

A. Shop Drawings

1. Shop drawings as specified in individual Sections include custom-prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the work,

2. All shop drawings submitted by suppliers and subcontractors shall be sent directly to the CONTRACTOR for checking. The CONTRACTOR shall be responsible for their submission at the proper time to prevent delays in delivery of materials.

3. Check all suppliers and subcontractors shop drawings regarding measurements, size of members, materials and details to make sure that they conform to the intent of the Drawings and related Sections. Return shop drawings found to be inaccurate or otherwise in error to the second tier subcontractors for correction.

4. All details on shop drawings shall show clearly the relation of the various parts to the main members and lines of the structure and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted.

B. Product Data

1. Product data specified in individual Sections include standard prepared data for manufactured products (sometimes referred to as catalog data) such as the manufacturer's product specification and installation instructions, availability of colors and patterns, manufacturer's printed statements of compliances and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational-range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing and printed product warranties, as applicable to the work.

C. Samples

1. Samples specified in individual Sections include, physical examples of the work such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols and units of work to be used by the CONTRACTOR or OWNER for independent inspection and testing, as applicable to the work.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Review shop drawings, product data and samples, including those by second tier subcontractors, prior to submission to determine and verify the following:

1. Field measurements
2. Field construction criteria
3. Catalog numbers and similar data
4. Conformance with related Sections

B. Each shop drawing, sample and product data submitted by the CONTRACTOR shall have affixed to it the following Certification Statement including the CONTRACTOR’s Company name and signed by the CONTRACTOR: "Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." Shop drawings and product data sheets 11-in x 17-in, and smaller, shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. $8^{11}2$ -in x 11-in sheets shall be the minimum sized submittal size. The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to the OWNER's Representative a copy of each transmittal sheet for shop drawings, product data and samples.

C. The CONTRACTOR shall utilize a 10-character submittal identification numbering system in the following manner:

1. The first character shall be a D, S, P or M which represents Shop/Working Drawing and other Product Data (D), Sample (S), Preliminary Submittal (P) or Operating/ Maintenance Manual (M).

2. The next five digits shall be the applicable Section Number.

3. The next three digits shall be the numbers 001 to 999 to sequentially number each initial separate item or drawing submitted under each specific Section Number.

4. The last character shall be a letter, A to Z, indicating the submission, or resubmission of the same Drawing, i.e., "A=1st submission, B=2nd submission, C=3rd submission, etc. A typical submittal number would be as follows:

D-03300-008-B

D	= Shop Drawing
03300	= Section for Concrete
008	= The eighth initial submittal under this section
B	= The second submission (first resubmission) of that particular shop drawing

D. Notify the ENGINEER in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.

E. The review and approval of shop drawings, samples or product data by the ENGINEER shall not relieve the CONTRACTOR from the responsibility for the fulfillment of the terms of the contract. All risks of error and omission are assumed by the CONTRACTOR and the ENGINEER will have no responsibility therefore.

F. No portion of the work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on-site construction accomplished which does not conform to approved shop drawings and data shall be at the CONTRACTOR's risk. The OWNER will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

G. Project work, materials, fabrication, and installation shall conform to approved shop drawings, applicable samples, and product data.

1.04 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule and in such sequence as to cause no delay in the Work or in the work of any other contractor.

B. Each submittal, appropriately coded, should allow 14 calendar days following receipt of submittal to the ENGINEER for review and return to the CONTRACTOR.

C. Number of submittals required:

1. Shop Drawings: Five copies.
2. Product Data: Five copies.
3. Samples: Submit the number stated in the respective Sections, two minimum for each submittal.

D. Submittals shall contain:

1. The date of submission and the dates of any previous submissions.
2. The Project title and number.
3. CONTRACTOR identification.
4. The names of:
   a. CONTRACTOR
   b. Supplier
   c. Manufacturer
5. Identification of the product, with the section number, page and paragraph(s).
6. Field dimensions, clearly identified as such.
7. Relation to adjacent or critical features of the work or materials.
8. Applicable standards, such as ASTM or Federal Standards numbers.
9. Identification of deviations from Design Documents.
10. Identification of revisions on resubmittals.
11. A blank space suitably sized for CONTRACTOR stamps.
12. Where calculations are required to be submitted by the CONTRACTOR, the calculations shall have been checked by a qualified individual other than the preparer. The submitted calculations shall clearly show the names of the preparer and of the checker.

1.05 REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES

A. The review of shop drawings, data and samples will be for general conformance with the design concept and Design Documents. They shall not be construed:

1. as permitting any departure from the design requirements;
2. as relieving the CONTRACTOR of responsibility for any errors, including details, dimensions, and materials;

3. as approving departures from details furnished by the ENGINEER, except as otherwise provided herein.

B. The CONTRACTOR remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.

C. If the shop drawings, data or samples as submitted describe variations and show a departure from the design requirements which CONTRACTOR finds to be in the interest of the OWNER and to be so minor as not to involve a change in Contract Price or Contract Time, the CONTRACTOR may return the reviewed drawings with the minor changes noted.

D. Submittals will be returned to the CONTRACTOR under one of the following codes.

Code 1 - "RETURNED WITH NO EXCEPTIONS" is assigned when there are no notations or comments on the submittal. When returned under this code the CONTRACTOR may release the equipment and/or material for manufacture.

Code 2 - "RETURNED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the CONTRACTOR. The CONTRACTOR may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 - "RETURNED AS NOTED/CO" - This combination of codes is assigned when a confirmation of the notations and comments IS required by the CONTRACTOR. The CONTRACTOR may, at his own risk, release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the ENGINEER within 14 calendar days of the date of the ENGINEER's transmittal requiring the confirmation.

Code 4 - "RETURNED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. This resubmittal is to address all comments, omissions and non-conforming items that were noted.

Code 5 - "REVISE AND RESUBMIT" is assigned when the submittal does not meet the intent of the Subcontract Documents. The CONTRACTOR must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Code 6 - "COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the CONTRACTOR.

Code 7 - "RECEIPT ACKNOWLEDGED" - This code is assigned to acknowledge receipt of a submittal that is not subject to the ENGINEER's review and approval; and, is being filed for informational purposes only. This code is generally used in acknowledging receipt of *means and methods of construction* work plan, field conformance test reports, and Health and Safety plans.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

E. Resubmittals will be handled in the same manner as first submittals. On resubmittals the CONTRACTOR shall identify all revisions made to the submittals, either in writing on the letter of transmittal or on the shop drawings by use of revision triangles or other similar methods. The resubmittal shall clearly respond to each comment made on the previous submission. Additionally, the CONTRACTOR shall direct specific attention to any revisions made other than the corrections requested on previous submissions.

F. Partial submittals may not be reviewed. The ENGINEER will be the judge as to the completeness of a submittal. Submittals not complete will be returned to the CONTRACTOR and will be considered "Not Approved" until resubmitted. The ENGINEER may at his option provide a list or mark the submittal directing the CONTRACTOR to the areas that are incomplete.

G. Repetitive Review

1. Shop drawings and other submittals will be reviewed no more than twice at the ENGINEER's expense. All subsequent reviews will be performed at times convenient to the ENGINEER and at the CONTRACTOR's expense, based on the ENGINEER's then prevailing rates. The CONTRACTOR shall reimburse the OWNER for all such fees invoiced to the OWNER by the ENGINEER. Submittals are required until they are acceptable to the ENGINEER.

2. Any need for more than one resubmission, or any other delay in obtaining ENGINEER's review of submittals, will not entitle CONTRACTOR to extension of the Contract Time.

H. If the CONTRACTOR considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the CONTRACTOR shall give written notice thereof to the ENGINEER at least 5 working days prior to release for manufacture.

1. When the shop drawings have been completed to the satisfaction of the ENGINEER the CONTRACTOR shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the ENGINEER.

1.06 DISTRIBUTION

A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and elsewhere as directed by the ENGINEER. Number of copies shall be as directed by the

ENGINEER but shall not exceed six.

1.07 PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

A. If specifically required in other related Sections, submit a P.E. (Professional Engineer) Certification for each item required, in the form attached to this Section, completely filled in and stamped.

1.08 GENERAL PROCEDURES FOR SUBMITTALS

A. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work of other related Sections, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. No extension of time will be authorized because of the CONTRACTOR's failure to transmit submittals sufficiently in advance of the Work.

END OF SECTION

SECTION 01720
PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.01 WORK INCLUDED

The Contractor shall obtain from the Engineer, one (1) set of blueline prints of the Contract Drawings. These prints shall be kept and maintained in good condition at the project site and a qualified representative of the Contractor shall enter upon these prints, from day-to-day, the actual "as-built" record of the construction progress. Entries and notations shall be made in a neat and legible manner and these prints shall be delivered to the Engineer upon completion of the construction. APPROVAL FOR FINAL PAYMENT WILL BE CONTINGENT UPON COMPLIANCE WITH THIS PROVISION.

The Contractor shall maintain at the site one record copy of all Plans in good order and annotated to show changes made during construction. Contractor shall meet monthly with the Engineer to review the record Plans and verify they correctly reflect all changes made during the month.

The Contractor shall keep an accurate record of the utility type, location, size, and material for all utilities installed including related appurtenances both above and below ground.

Final horizontal and vertical alignment of mains and related appurtenances shall be clearly shown and referenced to permanent surface improvements. Verified vertical and horizontal (VVH) alignment shall be surveyed and shown every 100 feet (or more often as circumstances dictate) or at any change (horizontal or vertical) in pipe direction. VVH's shall be recorded by an Alabama state registered/professional land surveyor with a GPS unit with sub-meter accuracy, reflecting locations tied to Alabama State Plane coordinates. VVH data may be presented in tabular form on the As-Built Plans. Plans shall clearly show all field changes of dimension and detail including changes made by the Engineer. Contractor shall not conceal any work until required information is recorded. Payment for as-built Plans shall be included as a separate line item.

As-built Plans are required for all systems to be accepted by the Engineer. As-builts will be prepared by a surveyor or an engineer registered in the State of Alabama and will contain the following information:

1. Northing and Easting of all valves, fittings, and connections to existing lines.
2. Location of mains from property easement lines or edge of pavement at intervals of 300 feet.
3. Elevations to the top of the pipe at intervals of 100 feet and at all drainage and sewer main crossings. Established and known bench marks shall be shown on As-Builts.
4. Pertinent easement information.

5. Certification by the surveyor or engineer accepting responsibility for accuracy of information supplied on the as-built Plans and a statement certifying that all mains are within easements and/or public rights-of-way.

   As-Builts will be drawn at the same scale as the original plans and shall be submitted as a pdf and AutoCAD files.

Prior to Final Acceptance, the Contractor shall deliver a complete set of original Plans and a copy of the pdf and CAD files. A transmittal letter in duplicate, containing the following shall be attached to the submittal:

1. Date
2. Project title and number
3. Contractor's name and address
4. Title and number of each As-Built Document
5. Certification that each document as submitted is complete and accurate
6. Signature of the Contractor or his authorized representative

1.02 RELATED REQUIREMENTS SPECIFIED ELSEWHERE:

A. Section 01300 - Submittals.

B. General Conditions.

1.03 MAINTENANCE OF DOCUMENTS

A. Maintain at job site, one copy of:

1. Contract Drawings
2. Specifications
3. Addenda
4. Reviewed Shop Drawings
5. Change Orders
6. Other Modifications to Contract

B. Store documents in approved location, apart from documents used for construction.

C. Provide files and racks for storage of documents.

D. Maintain documents in clean, dry legible condition.

E. Do not use record documents for construction purposes.

F. Make documents available at all times for inspection by Engineer and Owner.

1.04 MARKING DEVICES

Provide colored pencil or felt-tip marking pen for all marking.

1.05 RECORDING

A. Label each document "PROJECT RECORD" in 2-inch high printed letters.

B. Keep record documents current.

C. Do not permanently conceal any work until required information has been recorded.

D. Contract Drawings: Legibly mark to record actual construction:

1. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.

2. Location of internal utilities and appurtenances concealed in construction referenced to visible and accessible features of structure.

3. Field changes of dimension and detail.

4. Changes made by Change Order or Field Order.

5. Details not on original Contract Drawings.

E. Specifications and Addenda: Legibly mark up each Section to record:

1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.

2. Changes made by Change Order or Field Order.

3. Other matters not originally specified.

F. Shop Drawings: Maintain as record documents; legibly annotate Shop Drawings to record changes made after review.

1.06 SUBMITTAL

A. At completion of project, deliver record documents to Engineer.

B. 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. Certification that each Document as Submitted is Complete and Accurate.
6. Signature of Contractor, or his authorized Representative.

END OF SECTION

SECTION 01730
OPERATION AND MAINTENANCE DATA

PART 1 – GENERAL

1.01 SCOPE OF WORK

A. This Section includes procedural requirements for compiling and submitting operation and maintenance data required to complete the project.

1.02 RELATED WORK

A. Submittals are included in Section 01300.

1.03 SERVICES OF MANUFACTURERS' REPRESENTATIVE

A. Equipment furnished shall include the cost of a competent representative of the manufacturers of all equipment to supervise the installation, adjustment and testing of the equipment and to instruct the Owner's operating personnel on operation and maintenance. This supervision may be divided into two or more time periods as required by the installation program.

B. See the detailed specifications for additional requirements for furnishing the services of manufacturer's representatives.

C. A certificate in the form attached to this Section as Table 01730-1, from the manufacturer and signed by Owner's representative stating that the installation of the equipment is satisfactory, that the unit has been satisfactorily tested, is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication, and care of the unit shall be submitted for each piece of equipment in the Divisions indicated above.

D. For equipment furnished under other Divisions, furnish the services of accredited representatives of the manufacturer only when some evident malfunction or over-heating makes such services necessary in the opinion of the ENGINEER.

1.04 OPERATING MANUALS

A. Three (3) complete sets of final hard copy Operation and Maintenance Manuals and one (1) electronic copy on CD are to be provided to the OWNER. Additional copies required for CONTRACTOR review and use shall be in addition to the number listed above.

B. Operation and maintenance instructions covering all equipment furnished under shall be delivered at least 30 days prior to scheduled start-up directly to the CONTRACTOR.

1. The manual for each piece of equipment shall be a separate document with the following specific requirements:

   a. Contents:
      1) Table of contents and index
      2) Brief description of each system and components
      3) Equipment Attribute sheets for submittal of name plate data
      4) Starting and stopping procedures
      5) Special operating instructions
      6) Routine maintenance procedures
      7) Manufacturer's printed operating and maintenance instructions, parts list, illustrations and diagrams
      8) One copy of each wiring diagram
      9) One copy of each approved shop drawing and each Design Builder/Contractor's coordination and layout drawing
      l0) List of spare parts, manufacturer's price, and recommended quantity
      11) Name, address and telephone numbers of local service representatives.

   b. Material
      1) Loose leaf on 20 lb minimum, white punched paper
      2) Page size, 8½-in by 11-in
      3) Drawings and Diagrams
         a) Provide reinforced punched binder tab, bind in with text.
         b) Reduce larger drawings and fold to size of text pages but not larger than 11 inches x 17 inches or provide a suitable packet with drawing identification.
      4) Provide fly-leaf for each separate product, or each piece of operating equipment.
         a) Provide typed description of product, and major component parts of equipment.
         b) Provide indexed tabs.
      5) Cover: Identify each volume with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS." List:
         a) Title of project.
         b) Identity of separate structure or location as applicable.
         c) Identity of general subject matter covered in the manual.
      6) Binders:
         a) Commercial quality three-post binders with durable and cleanable plastic covers.
         b) Maximum post width: 2 inches
         c) When multiple binders are used, correlate the data into related consistent groupings.

   c. Submittals to the CONTRACTOR
      1) Four preliminary copies of manuals shall be submitted to the

CONTRACTOR, no later than 30 days following approval of the shop drawings for each piece of equipment. Provide number of final copies listed in Item 1.04-A above of complete manuals prior to testing.

d. Electronic Manuals
   1) Electronic Format - The Vendor provided equipment, sub-system, or system manuals shall be in PDF format, compliant with the Adobe PDF Specification, The manual shall be Searchable Image (formerly Image+Text). The Optical Character Recognition (OCR) of the image shall be at a 95% confidence level, using Adobe Acrobat® Capture® 3.x or an equivalent product. The manuals shall be organized and delivered as follows:
      a) Filed Division - One individual multi-page (where applicable) PDF file shall be provided for each equipment submittal as described Item 1.04-B-1-a.
      b) Table of Contents -- A table of contents will be developed for each of the vendor manual PDF files. The table of contents will be hierarchical in accordance with the contents specified in item 1.04-B-1-a.
      c) Bookmarks will be programmed and organized to match the table of contents. Each bookmark will link to the start of the corresponding subject in the body of the PDF file. No bookmark links will reference files external to the pdf file containing the bookmark links.
   2) Drawings - All drawings shall be in PDF format as specified in item 1.04-B-1-d-1. Drawings (CAD) - In addition, all drawings shall be provided in native format (i.e. AutoCAD-2010).
   3) All scanned materials shall be cleaned to remove all smudges, fingerprints, artifacts, and other extraneous marks. All notes, version stamps, etc., shall be preserved.
   4) Scanning shall be done in PDF format as indicated above. Scanning accuracy shall be as follows:
      a) Textual content shall be not less than 300 dots per inch (DPI) and not more than necessary to comply with the OCR specification in item 1.04-B-1-d-1.
      b) Color images and diagrams shall be scanned in not less than number of colors of the document or 256 colors whichever is greater. Resolution shall be not less than 300 dots per inch (DPI).
      c) Color photographs shall be saved in the full range of colors. Resolution shall be not less than 300 dots per inch (DPI).
      d) Black and white (non-text/table) shall be not less than 256 gray scale levels. Resolution shall be not less than 300 dots per inch (DPI).
   5) Electronic copies shall be provided on flash drives (USB) or external hard drive.

6) All media transmittals shall be accompanied by a detailed paper printout of the files on each media. This printout shall consist of the file name, file size, date of creation, submittal number, and a brief but accurate description of the files.
7) All files must be organized in an intuitive manner that directly corresponds to the order of the Table of Contents and nomenclature of the submittal log.

e. Equipment Attribute Sheets

1) Equipment Attribute Sheets as presented in Table 01730-3 shall be provided for all equipment as follows:
   a) An Equipment Attribute Sheet that includes nameplate data, manufacturer and supplier information, and information pertinent to the type of equipment shall be provided for each piece of equipment supplied under this contract. Where more than one of the same type of equipment is provided, an Equipment Attribute Sheet must be completed for each piece.
   b) Hard copies for each piece of equipment shall be attached to each specification and are to be completed and submitted to the OWNER with the operation and maintenance manuals.

1.05 CONTENTS, EACH VOLUME

A. Title Sheet: Provide title of project, names, addresses and telephone numbers of CONTRACTOR and SUPPLIER with name of responsible parties.

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

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

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

1.06 MANUAL FOR MATERIALS AND FINISHES

A. Building Products, Applied Materials and Finishes: Include product data with catalog number, size, composition and color and texture designations. Provide information for re-ordering custom manufactured products.

B. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and

methods, and recommended schedule for cleaning and maintenance.

C. Moisture Protection and Weather Exposed Products: Include product data listing, applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional Requirements: As specified in individual product specifications.

E. Provide a listing in Table of Contents for design data, if provided by CMAR, with tabbed fly sheet and space for insertion of data.

1.07 MANUAL FOR EQUIPMENT AND SYSTEMS

A. For each Item of Equipment and Each System provide the following:

1. Overview of System and description of unit or system, component parts, and nameplate data sheets for equipment. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with Engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

2. Panelboard Circuit Directories including electrical service characteristics, controls and communications, and color coded wiring diagrams as installed.

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

4. Maintenance Requirements

   a. Routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
   b. Servicing and lubrication schedule and list of lubricants required.
   c. Manufacturer's printed operation and maintenance instructions.
   d. Sequence of operation by controls manufacturer.
   e. Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

5. Control diagrams by controls manufacturer as installed.

6. Coordination drawings, with color coded piping diagrams as installed.

7. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

8. Bill of Materials

9. List of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

10. Test and balancing reports as specified.

11. Additional Requirements: As specified in individual product specification.

B. Provide a listing in Table of Contents for design data, if provided by CONTRACTOR, with tabbed fly sheet and space for insertion of data.

1.08 QUICK REFERENCE SHEETS FOR EQUIPMENT

A. For each item of equipment furnished provide the following:

1. A minimum of one 8½-inch x 11-inch laminated quick reference sheet. Sheets shall be three hole punched and may be double sided.

2. Each quick reference sheet shall include the following minimum information:

a. Brief descriptions of each piece of equipment and components
b. Starting and stopping procedures
c. Special operating instruction
d. Routine maintenance procedures
e. Calibration procedures
f. Pump curves
g. Trouble shooting procedures
h. Name, address, and telephone numbers of local service representative

3. Provide three copies of quick reference sheets to the ENGINEER for review.

4. After quick reference sheets have been approved, provide four copies of laminated quick reference sheets to the OWNER in one commercial coiled three-ring binder with durable and cleanable plastic cover.

1.09 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment and systems, at agreed upon times. The OWNER may video tape instructions while they are being given to OWNER's personnel.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

C. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.10 CONTRACTOR/ENGINEER O&M REVIEW CHECKLIST

The CONTRACTOR/ENGINEER will review Operation and Maintenance manuals on operating equipment for conformance with the requirement of this Section. The review will generally be based on the check list presented in Table 01730-2.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION {NOT USED)

END OF SECTION

TABLE 01730-1

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION TESTING AND INSTRUCTION

Owner: _____

Department Project: _____

Contract No. _____ Project No. _____

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

_____
(Print Manufacturer's Name)

_____
(Print equipment name and model with serial No.)

installed for the subject project [has] [have] been installed in a satisfactory manner, [has] [have] been satisfactorily tested, [is] [are] ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit[s] on Date: _____ Time: _____

Certified By: _____ DATE: _____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

[I] [We] the undersigned, authorized representatives of the _____ and/or Plant Operating Personnel have received classroom and hands on instruction on the operation, lubrication, and maintenance of the subject equipment and [am] [are] prepared to assume normal operational responsibility for the equipment:

_____ DATE: _____

_____ DATE: _____

_____ DATE: _____

TABLE 01730-2

0 & M REVIEW CHECKLIST

EQUIPMENT SUBMITTED _____ DATE OF SUBMITTAL _____

MANUFACTURER _____ DEGREE OF APPROVAL _____

SPECIFICATION SECTION _____ DRAWING NUMBER _____

_____ Is submittal correct for model series/configuration originally submitted with shop drawings?

_____ Is binding correct with assigned color/printing etc. and pertains to final three volumes?

_____ Is submittal properly indexed?

_____ Does submittal pertain only to equipment being furnished?

_____ Is submittal easily understood and instructively arranged?

_____ Does submittal include start-up, shutdown and troubleshooting procedures?

_____ Are sufficient drawings and schematics included to supplement written descriptions?

_____ Is listing of nameplate data for each piece of equipment supplied provided and attached?

_____ Are all drawings provided printed on paper which is 11 inches high and folded to 8½ inches wide?

_____ Is proper and complete instructions for servicing included?

_____ Is there a suggested operating log sheet for equipment?

_____ Is schedule for lubrication provided?

_____ Is there a recommended preventive maintenance schedule?

_____ Are necessary safety precautions clearly indicated where they relate to the equipment?

_____ Is area representative information provided, i.e., Name, Address, Telephone

Number?

_____ Are specified spare parts indicated and listed?

_____ Are Equipment Attribute Sheets provided as specified?

The following are points of rejection necessitating resubmittal by CONTRACTOR:

_____

_____

_____

END OF SECTION

SECTION 02050
DEMOLITION

PART 1 GENERAL

1.01 WORK INCLUDED

A. The demolition indicated on the drawings and required by the specifications do not profess to show or indicate every detail necessary to complete this project. The drawings and Specifications indicate the overall intent. The contractor shall provide the labor, construction equipment, materials and incidentals, and new equipment necessary to meet the intent of the contract documents. Demolition of existing equipment shall include: the removal of all equipment and related support appurtenances (such as conduit, electrical boxes, and pipe); and the patching of all holes resulting from the removal of equipment. Demolition required to alter or remove all or parts of existing structures shall be conducted in a manner that protects the existing structures and those facilities to remain in service, and the proper disposal of all construction debris. The Contractor shall also provide the means to maintain the plant's ability to treat wastewater within present limits at all times while the demolition and renovation takes place.

B. Included, but not limited to, are demolition and removals of existing materials, equipment, or work necessary to install the new work as shown and specified and to connect same with existing work in an approved manner. Demolition includes, but is not necessarily limited to, structural steel, structural concrete, miscellaneous metal, piping, equipment, attachments, appurtenances, and similar existing facilities.

C. Demolitions and removals which may be specified under other sections shall conform to requirements of this section.

D. All work shall comply with all federal, state, and local codes and regulations regarding safety.

1.02 SUBMITTALS

Contractor shall submit for review proposed methods, equipment, and operations sequence. Include coordination for shut-off capping, temporary services, continuation of utility services, and other applicable items to ensure no interruption of Owner's operations.

1.03 JOB CONDITIONS

A. Protection

1. Contractor shall execute the demolition and removal work to prevent damage or injury to structures, occupants thereof and adjacent features

which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from, adjacent structures.

2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways unless approved by the Engineer.

3. Contractor shall erect and maintain barriers, lights, sidewalk sheds, and other required protective devices.

4. Contractor shall repair damage done to facilities to remain, or to any property belonging to the Owner or occupants of the facilities at no additional cost to the Owner.

B. Scheduling

1. Contractor shall carry out his operations so as to avoid interference with operations and work in the existing facilities.

C. Notification

1. At least 48 hours prior to commencement of a demolition or removal, Contractor shall notify the Engineer in writing of his proposed schedule. Owner shall inspect the existing equipment and identify and mark those items which are to remain the property of the Owner. No removals shall be started without the written permission of the Engineer.

D. Explosives

1. Do not bring explosives on site nor use explosives for demolition.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. All materials and equipment removed from existing work shall become the property of the Contractor, except for those which the Owner has identified and marked for its use. All materials and equipment marked by the Owner to remain its property, or designated to be relocated, shall be carefully removed by the Contractor so as not to be damaged, and then cleaned and stored on or adjacent to the site in a protected place specified by the Engineer or loaded onto trucks provided by the Owner.

B. Contractor shall dispose of all demolition materials, equipment, debris, and all other items not marked by the Owner to remain as its property off the site and in conformance with all existing applicable laws and regulations.

C. Surfaces of walls, floors, ceilings, or other areas which are exposed by any of the removals specified herein, and which will remain as architecturally finished surfaces and which have holes, scars, chipped or other damaged surfaces revealed by the removal shall be repaired by the Contractor with the same or matching materials as the existing surface or as may be otherwise approved by the Engineer.

D. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.

1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

2. Clean adjacent structures, facilities, and improvements of dust, dirt and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the work.

3.02 STRUCTURAL REMOVALS

A. Existing structures which are designated to be demolished shall be removed in their entirety unless noted otherwise on the drawings.

B. All concrete, concrete block, reinforcement, plaster, wire mesh and other items contained in or upon the structures shall be removed and taken from the site, unless otherwise approved by the Engineer. Demolished items shall not be used in backfill adjacent to structures or in pipeline trenches.

C. All structural and miscellaneous metals designated to remain the property of the Owner shall be removed and stored on or adjacent to the site in a protected place specified by the Owner or loaded onto trucks provided by the Owner.

D. After removal of parts or all of masonry walls, slabs and like work which tie into new work or existing work, the point of junction shall be neatly repaired so as to leave only finished edges and surface exposed.

E. After removing the demolished structures, remaining cavities shall be backfilled with soil unless otherwise noted on the drawings.

3.03 PIPE REMOVED

A. Piping removals shall consist of dismantling and removing of existing piping, valves and other appurtenances as specified, shown, or required for the completion of the work. It shall include cutting, capping, and plugging as required.

B. Excavate all necessary material to remove the pipe which has been designated for removal. Dispose of the excavated material and remove the pipe. The pipe shall be relocated where indicated on the drawings. Pipe not scheduled to be relocated shall become the property of the contractor and shall be removed from the project site. Seal all holes left in walls of structures or manholes that are to remain in place.

C. The trench resulting from the removal of pipe shall be backfilled except when the trench lies within the limits of subsequent excavation.

D. Where existing piping is not removed in its entirety, the remaining abandoned portion of the pipe will be sealed with precast, vitrified, or concrete stoppers or with masonry of a type and thickness acceptable to the Engineer.

E. Where existing piping through demolished structures is to remain in service, pipes shall be connected through the structures with new pipe of a type and in a manner acceptable to the Engineer without additional cost to the Owner.

F. After connecting across or sealing the existing pipes remaining, cavities shall be backfilled with soil. When connecting pipes are used, suitable backfill shall be carefully tamped solidly under and around the pipe.

3.04 MANHOLES ABANDONED

A. Existing manholes which are designated to be abandoned shall be removed to a minimum of one foot below the ground surface in a manner that will not damage pipes that are to remain.

B. Castings shall remain the property of the Owner and shall be carefully removed and stored within the project limits for pickup by the Owner.

3.05 ELECTRICAL REMOVAL

A. Electrical removal shall consist of the removal of Owner's existing control panels, pumps and motors, conduits and wires, poles and overhead wiring, and miscellaneous electrical equipment all as shown, specified, or required to perform the work.

B. All existing electrical equipment and fixtures to be removed shall be removed with such care as may be required to prevent unnecessary damage, to keep existing systems in operation, and to keep the integrity of the grounding system.

3.06 CLEAN UP

Contractor shall remove from the site all debris resulting from the demolition operations as it accumulates. Upon completion of the work, all materials, equipment, waste, and debris of every sort shall be removed. The premises shall be left clean, neat and orderly.

END OF SECTION

SECTION 02101
CIVIL SITEWORK

PART 1 GENERAL

1.01 WORK INCLUDED

A. This Section covers the Work necessary to complete the sitework for the project. Civil sitework includes clearing, grading for roads and driveways, chain link fencing and gates, and finish grading and grassing.

1.02 GENERAL

A. RELATED WORK SPECIFIED IN OTHER SECTIONS

1. See Sections EARTHWORK and ROADS AND DRIVEWAYS for additional requirements.

B. See CONDITIONS OF THE CONTRACT and Section GENERAL REQUIREMENTS, for information and requirements that apply to the Work specified herein and are mandatory for this project.

PART 2 PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired only. Products of other manufacturers will be considered in accordance with the General Conditions.

2.02 SEEDING AND MULCHING

A. Topsoil: Topsoil shall be a natural, friable soil, representative of product soils in the vicinity. It shall be well-drained, free from admixture of subsoil and foreign matter, objects larger than two (2) inches in diameter, toxic substances, and any other deleterious material that may be harmful to plant growth and be a hindrance to grading, planting, and maintenance operations. Soil excavated on site may be used provided it meets the requirements of topsoil.

B. Seed shall meet the requirements of these Specifications and comply with the Alabama Seed Law Act No. 424, General Acts, 1963 Vol. 2, Page 931, latest revision. The type of quick growing seed used shall be appropriate to provide an early ground cover during the particular season when planting is done. The rate of spread shall be as specified in Section 3.01D.

C. Mulch shall meet the material requirements of the State of Alabama Department of Transportation Standard Specifications for Highway's and Bridges, latest revision.

D. For areas requiring sod it shall be Tifton Bermuda free of weeds and other undisuable grasses. Minimum ½ yard cuts.

E. Fertilizer: Commercial plant food containing eight (8%) percent nitrogen, eight (8%) percent available phosphate, and eight (8%) percent potassium, uniform in composition, dry, free-blowing, and delivered in containers bearing manufacturer's guaranteed analysis.

F. For areas requiring erosion control matting see Section 02490 EROSION CONTROL MATTING.

2.03 ROADS AND DRIVEWAYS

A. Roads and driveways shall be as specified in Section ROADS AND DRIVEWAYS.

2.04 CHAIN LINK FENCING

A. Materials shall be new and products of recognized, reputable manufacturers. Used, rolled, or regalvanized materials are not acceptable.

B. All materials shall be treated wood, or wood of natural resistance to decay, hot-dipped galvanized steel, or aluminum. Steel posts and other appurtenances shall have a minimum zinc coating of 1.2 ounces per square foot of surface.

C. Chain Link Fabric: Chain link fence fabric, seventy-two (84) inches high, woven of No. 9 gauge wire, in standard two (2)-inch diamond-mesh pattern, selvages twisted and barbed, galvanized after weaving with 1.2 ounce zinc coating meeting the requirements of ASTM A392, Class 1.

D. Posts: Federal Specification RR-F-191, fence posts, gates, and accessories, except as hereinafter modified. Standard lengths for setting in ground or in concrete as required for conditions shown. Wooden posts shall conform to the details and dimensions indicated in the drawings, and shall be straight, sound and seasoned with ends sawed off square or as indicated. All knots shall be trimmed flush with the surface.

E. Line Posts: For fences up to eight (8)-feet zero (0)-inches high, use 2½-inch outside diameter, ASTM A120, Schedule 40 steel pipe, weight 3.65 pounds per linear foot.

F. End, Corner, Angle, and Pull Posts: Use 2 7/8-inch outside diameter standard weight steel pipe, weight 5.79 pounds per linear foot.

G. Gate Posts: For single swing gates up to six (6)-feet wide, use 2 7/8-inch outside diameter steel pipe, 5.79 pounds per foot. For single swing gates six (6)-feet wide to thirteen (13)-feet wide, use four (4)-inch outside diameter steel pipe, 9.1 pounds per foot. For other sizes, follow manufacturer's recommendations.

H. Post Tops: Post tops shall be pressed steel, or malleable iron, designed as a weathertight closure cap for tubular posts. Provide one (1) cap for each post, unless equal protection is afforded by combination post top cap and barbed wire supporting arm where barbed wire is required. Where top rail is used, provide tops to permit passage of top rail.

I. Tension Wire: Tension wire shall be zinc or aluminum-coated coil spring steel wire not less than No. 7 gauge (0.177 inch diameter). Provide tie clips of manufacturer's standard as approved for attaching the wire to the fabric, at intervals not exceeding twenty-four (24)-inches.

J. Stretcher Bars and Bands: Stretcher bars shall be one-piece lengths equal to full height of fabric with a minimum cross-section of 3/16 inch by ¾-inch. Provide one (1) stretcher bar for each gate and end post and two (2) for each corner and pull post. Bar bands shall be heavy-pressed steel, spaced not over fifteen (15)-inches on center to secure stretcher bars to tubular end, corner, pull, and gate posts.

K. Top Rail: Not less than eighteen (18)-foot-long tubular steel, 1 5/8-inch outside diameter, weight 2.27 pounds per linear foot. Couplings to be outside-sleeve type and at least six (6)-inches long. Top rail to extend through line post tops to form continuous brace from end-to-end of each stretch of fence.

L. Braces: Brace pipe shall be the same material as the top rail and shall be installed midway between the top rail and extend from the terminal post to the first adjacent line post. Braces shall be securely fastened to the posts by heavy-pressed steel and malleable fittings, then securely trussed from line post to base of terminal post with a 3/8-inch truss rod and tightener.

M. Fittings: Malleable steel, cast iron, or pressed steel galvanized to meet the requirements of ASTM A153. Fittings to include extension arms for barbed wire, stretcher bars and clamps, clips, tension rods, brace rods, hardware, fabric bands and fastenings, and all accessories. Provide forty-five (45) degree bracket type supports to accommodate three (3) strands of barbed wire as shown.

N. Barbed Wire: Four-point pattern with three strands of No. 12-½ gauge wire, and one (1) inch barbs five (5)-inches apart. Zinc-coated barbed wire shall meet the requirements of ASTM A121, Class 3.

O. Chain Link Fence Gates:

1. Gates shall swing as indicated, complete with latches, stops, keepers, and hinges.

2. Gate frames shall be constructed of tubular members welded at all corners or assembled with fittings. Fabricate frames of standard weight steel pipe, 1.90-inch outside diameter, weight 2.72 pounds per linear foot. Welds shall be painted with zinc-based paint. Where corner fittings are used, gates shall have truss rods of 5/16-inch minimum nominal diameter to prevent sag or twist. Gate leaves shall have vertical intermediate bracing as required, spaced so that no members are more than eight (8)-feet apart. Gate leaves ten (10)-feet or over shall be extended one (1)-foot above the top horizontal member to which (3) three strands of barbed wire, uniformly spaced, shall be attached by use of bands, clips, or hook bolts.

3. Gate fabric shall be the same type as used in the fence construction. The fabric shall be attached securely to the gate frame at intervals not exceeding fifteen (15) inches.

4. Gate hinges shall be of adequate strength for gate and with large bearing surfaces for clamping into position. The hinges shall not twist or turn under the action of the gate. The gates shall be capable of being opened and closed easily by one (1) person.

5. Gate latches, stops, and keepers shall be provided for all gates. Latches shall have a plunger-bar arranged to engage the center stop, except that for single gates of openings less than ten (10) feet wide a forked latch may be provided. Latches shall be arranged for locking with padlocks. Center stops shall consist of a device arranged to be set in concrete and to engage a plunger-bar of the latch of double gates. No stop is required for single gates. Keepers shall consist of a mechanical device for securing the free end of the gate when in the full position.

6. For double gates, the size and configuration shall be as indicated on the Drawings. Provide gate stops for all double gates, consisting of mushroom type or flush plate with anchors. Set in concrete to engage the center drop rod or plunger bar. Provide locking device and padlock eyes as an integral part of the latch, requiring one (1) padlock for locking both gate leaves.

7. Provide keepers for all vehicle gates, which automatically engages the gate leaf and holds it open in the OPEN position until manually released.

PART 3 EXECUTION

3.01 GRADING, SEEDING AND MULCHING (For non landscaped areas)

A. Pre-Finish Grading: Complete rough grading to grades indicated on the Drawings or to accomplish adequate drainage patterns required by the site layout. Rough grading shall allow for the addition of materials needed to accomplish finish grading. Fill areas required during subgrade preparation shall be compacted to eighty-five (85%) percent of the relative maximum density.

Topsoil shall be spread over the prepared rough grade using a rubber-tired tractor with grader blade or equivalent.

B. Fertilizing: Apply commercial fertilizer at the rate of nine hundred twenty (920) pounds per one-acre or at a rate determined from soil tests, distributing uniformly with a rotary mechanical spreader. Apply soil additives such as lime if the soil pH requires adjustment.

C. Finish Grading: After placing topsoil and applied materials, rake the topsoil to a uniform grade so that all areas drain, as indicated on the grading plan or as required to complete drainage patterns. Lightly compact with a cultipacker before planting grass. Remove all trash from the area prior to planting grass.

D. Seeding

1. Seeding and mulching operations will not be permitted when wind velocities exceed fifteen (15) miles per hour. Seed shall be sown only when the soil is moist and in proper condition to induce growth. No seeding shall be done when the ground is unduly wet or otherwise not in a tillable condition.

2. Whenever a suitable amount of area has been graded, it shall be made ready and grassed as specified in this Section. Grassing shall be incorporated into the project at the earliest practical time in the life of the Contract.

E. The several operations involved in the work shall proceed in the following sequence: preparation of the ground; seeding; spreading of mulch; cutting-in mulch; and rolling or preparation of the ground; installation of erosion control matting, placing soil; hydroseeding; placing excelsior mat.

F. The ground over which the seed is to be sown shall be prepared by diskharrowing and thoroughly pulverizing the soil to a suitable depth. The prepared soil shall be loose and reasonably smooth. It shall be reasonably free of large clods, roots, and other material, which will interfere with the work or subsequent mowing and maintenance operations. Apply lime at two (2) tons per acre, and 8,8,8 commercial fertilizer at nine hundred twenty (920 lbs.) pounds per acre.

G. While the soil is still loose and moist, the seed shall be scattered uniformly over the grassing area. The rate of spread for the seed mixture shall be per schedule.

August through February	**Winter**
Kentucky 31	30 lbs/acre
Reseeding Crimson Clover	15 lbs/acre
Bermuda Grass (Unhulled)	30 lbs/acre
Perennial Rye Grass	30 lbs/acre

March through July	**Spring**
Kentucky 31	30 lbs/acre
Kobe Lespedeza (Var. Tenn)	30 lbs/acre
Bermuda Grass (Cynodon Ductylon)	20 lbs/acre (Hulled)

H. Approximately two (2) inches, loose thickness of mulch material shall be applied uniformly over the seeded area, and the mulch material cut into the soil with equipment specified, to produce a loose mulched thickness of three (3) to four (4) inches. Care shall be exercised that the materials are not cut too deeply into the soil.

I. Immediately after completion of the seeding, the entire mulched area shall be rolled thoroughly with the equipment specified. At least two (2) trips of the entire area will be required.

J. Maintenance:

1. Water to keep surface soil moist. Repair washed out areas by filling with topsoil, liming, fertilizing, and seeding. Replace mulch on banks when washed or blown away. Mow grass to two (2) inches after grass reaches at least three (3) inches in height, and mow frequently enough to keep grass from exceeding 3 ½ inches.
2. If a satisfactory stand of grass has not been established in eight (8) weeks, the Contractor shall renovate and reseed the grass or unsatisfactory portions thereof immediately. A satisfactory stand of grass is defined as having no bare spots larger than three (3) square feet and not more than ten (10%) percent of total area with bare spots larger than one (1) square foot.
3. The seeded areas shall be watered to provide optimum growth conditions for the establishment of the grass. In no case, however, shall the period of maintaining such moisture be less than two weeks after the planting. Manual watering shall continue at least every four (4) days until the end of the growing season.

K. See Section 02490 for installation of EROSION CONTROL MATTING where required.

L. The Contractor shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include filing, leveling, and repairing of any washed or eroded areas. Replant any areas in which the establishment of the grass stand does not develop satisfactorily.

M. Clean-up the job site following seeding and mulching. Remove rubbish, excess materials, temporary structures, and equipment. Leave the work in a neat and presentable condition.

1. Bermuda Sod shall be installed in all swales, ditches, all slopes 3:1 or greater, within 10′ of all building structures, and within 3′ of all walkways and driveways.

3.02 ROADS AND DRIVEWAYS

A. Proposed access roads and driveways shall be of the type specified in Section ROADS AND DRIVEWAYS and shall be constructed to the lines and grade shown on the Drawings. All roads and driveways shall include two (2%) percent slopes away from a centerline crown. If required, adjacent grades shall include drainage ditches along the shoulder of the road.

B. Subgrade preparation of roads and driveways shall comply with Section 230 of the State of Alabama Highway Department Standard Specifications, except as modified herein.

C. Excavated areas beneath sidewalks, roads, driveways, curbs and gutters shall be backfilled with suitable fill material and compacted to a minimum ninety-eight (98%) percent of the maximum relative density. The final subgrade surface shall be compacted to an even density and shall be smooth and true to line and grade prior to placing road surfacing.

END OF SECTION

SECTION 02140
DEWATERING

PART 1 GENERAL

1.01 WORK INCLUDED

Furnish all labor and equipment required to dewater all excavations. Dewatering of all excavations shall be the responsibility of the Contractor, and no additional compensation will be allowed for same.

1.02 RELATED WORK

Earthwork is included in Section 02200.

Slope protection and erosion control is included in Section 02270.

1.03 SUBMITTALS

None.

PART 2 PRODUCTS

None in this Section.

PART 3 EXECUTION

3.01 GENERAL

Dewatering of many of the construction excavations shall be required as necessary to provide a dry work environment as indicated by the geotechnical report, drawings and these specifications. Dewatering equipment shall be of adequate size and quantity to assure maintaining proper conditions for installing pipe, concrete, backfill or other material or structure in the excavation. Dewatering shall include proper removal of any and all liquid, regardless of its source, from the excavation and the use of all practical means available to prevent surface runoff from entering any excavation.

Extra pumps shall be maintained on site for use in the event of a breakdown of operating pumps.

END OF SECTION

SECTION 02200
EARTHWORK

PART 1 GENERAL

1.01 WORK INCLUDED

A. Clear, excavate, dewater, sheet, backfill, and do related Work necessary to complete Work shown or specified.

B. Codes, Specifications, and standards referred to by number or title shall form a part of this Specification to the extent required by the references thereto. Latest revisions as of the date of bid opening shall apply, unless otherwise specified.

1.02 DEFINITIONS

A. Excavation

1. Removal of earth and rock to form cavities for the construction of foundations and structures and to form trenches for the installation of piping.
2. Cavity formed by the removal of earth and rock.

B. Earth

Unconsolidated material in the crust of the earth derived by weathering and erosion. Includes:

1. Materials of both inorganic and organic origin.
2. Boulders less than 1/3 cubic yard in volume, gravel, sand, silt, and clay.
3. Materials which can be excavated with backhoe, trenching machine, dragline, clam shell, bulldozer, highlift, or similar excavating equipment without the use of explosives, rock rippers, rock hammers, or jack hammers.

C. Rock

A natural aggregate of mineral particles connected by strong and permanent cohesive forces. Rock includes any combination of the following:

1. Limestone, sandstone, dolomite, granite, marble, and lava.
2. Boulders 1/3 cubic yard or more in volume.
3. Materials which cannot be excavated by equipment, which is used to remove earth overburden without the use of explosives, rock rippers, rock hammers, or jack hammers.

4. Materials which cannot be excavated with a trackhoe, trenching machine, dragline, clam shell, bulldozer, highlift, or similar excavating equipment without the use of explosives, rock rippers, rock hammers, or jack hammers.

5. Maximum rock size for pipe zone material and one (1) foot above pipe zone shall not be larger than six (6) inches in diameter. Maximum rock size for trench backfill starting one (1) foot above the pipe shall not be larger than 1/4 cubic yard in volume or greater than two (2) feet in any direction.

D. Undercutting

1. Excavation of rock and unsuitable earth below the bottom of a foundation, structure, or pipe to be constructed or installed.

E. Subgrade

1. Undisturbed bottom of excavation.

F. Pipe Bedding

1. Material required from invert of pipe to bottom of trench.

G. Pipe Zone Backfill

1. Material required from invert of pipe to top of pipe.

H. Pipe Cover

1. Material required from top of pipe to top of trench.

I. Topsoil

1. Earth containing sufficient organic materials to support the growth of grass, free from rocks, roots and debris.

1.03 QUALITY ASSURANCE

A. Owner reserves the right to hire an independent testing laboratory to perform specified services and necessary field density tests to ensure that proper compaction is obtained.

1.04 JOB CONDITIONS

A. Maintain bench marks, monuments, and other reference points. Replace any disturbed or destroyed bench marks, monuments, or other reference points.

B. Selected information from subsurface investigations performed by other consultants may be shown on the Drawings. Should the Contractor encounter

subsurface or latent conditions at the site materially differing from those shown on the Drawings he shall immediately give notice to the Engineer of such conditions before they are disturbed. The Engineer will thereupon investigate the conditions; and if he finds that they materially differ from those shown on the Drawings or indicated in the Specifications, he will make such changes in the Drawings, the Specifications, or the Drawings and Specifications as he may find necessary. Any increase or decrease of cost resulting from such changes will be adjusted in the manner provided in the GENERAL CONDITIONS.

1.05 BURNING OF MATERIALS

A. The Contractor shall obtain approval from the State or local authorities having jurisdiction over the Air Pollution Control.

B. Burning shall be strictly controlled. Fires shall be attended at all times.

1.06 DISPOSAL OF CLEARING DEBRIS

A. The Contractor shall dispose of construction debris resulting from clearing, grubbing, excavation, rock removal, demolition, dewatering and pavement replacement removal, in a landfill approved by the Engineers.

B. Materials used for silt barriers shall be removed and disposed of upon acceptance of restoration of grounds.

1.07 EXCAVATED MATERIALS IN PAVED ROADS

A. Materials excavated in areas of pavement shall be removed by the Contractor from the job site during the excavation process.

B. Materials excavated shall be disposed of in a landfill approved by the Engineers.

1.08 EROSION CONTROL AND PREVENTION OF STREAM POLLUTION

A. The Contractor shall control soil erosion and prevent pollution of streams, storm drains, and watercourses by means of installing silt fences, silt barriers and sediment pools or other means which can be required by the Engineers, state, local or federal agencies involved. The Contractor shall comply with the Owner's Stormwater Permit and Title 33 of the CFR Part 330, Appendix A regarding erosion control and the protection of floodplains and wetlands.

B. The Contractor shall comply with all applicable local, State, and Federal codes and Agencies in controlling erosion and preventing stream pollution.

1.09 OWNERSHIP - ANYTHING OF VALUE EXCAVATED

A. Excavated materials having value will become the property of the Owner as determined by the Engineers and Owner.

PART 2 PRODUCTS

2.01 PIPE BEDDING, BACKFILL AND FOUNDATION BACKFILL

A. Pipe trench backfill for ductile iron pipe and shall adhere to Type 2 laying condition, as per AWWA C150, with four (4) inches loose bedding material.

B. Pipe Bedding

1. Native soil excavated from the trench, free of rocks, foreign materials, and frozen earth.

C. Pipe Zone Backfill

1. Native soil material free from rocks, foreign material, and frozen earth, lightly consolidated to top of pipe.
2. Topsoil is not acceptable as pipe zone backfill.
3. Imported material will only be required where native material is inadequate.

D. Pipe Cover

1. Native soil material free from rocks, foreign material, and frozen earth, compacted as necessary to prevent settlement and erosion.

1.01 STRUCTURE FOUNDATION

A. Structure Bedding

1. Crushed limestone or crushed dolomite meeting or exceeding minimum standards for gradation of the AHD #57.

2. Crushed limestone or crushed dolomite shall meet or exceed the minimum standards for deleterious substances as follows:

		Maximum Allowable Percentage by Weight
a.	Coal and lignite	0.25%
b.	Clay lumps	0.25%
c.	Material passing #200 sieve	1.00%
d.	Thin or elongated pieces	1.00%
e.	Other deleterious material	2.00%
f.	Maximum total of a,b,c, and e	6.00%

3. Crushed limestone or crushed dolomite shall be free of foreign material when placed in pipe trench.

B. Structure Foundation Backfill

1. Crushed limestone or crushed dolomite meeting or exceeding minimum standards for gradation of the AHD #1 for conditions of excessive undercutting rock or soil.
2. Spoil rock or blasted rock from quarry in sized (4) four inches to four (4) feet for conditions of sinkholes or voids filled with soupy saturated materials.
3. Type of materials and mixtures of various sized materials shall be as directed by the Engineers.

1.02 EARTH BACKFILL

A. Backfill shall be earth of such gradation and moisture content that the soil will compact to the specified density and remain stable.

B. Pipe cover material shall consist of durable particles ranging in size from fine to coarse (No. 200 to one (1) inch) in a substantially uniform combination. Bedding material may be used for cover material in locations other than under paving, sidewalks, driveways or as directed by the Engineers.

C. Suitable backfill shall be the following soils, classified by the Unified Soil Classification System, ASTM D-2487:

Group Symbols	Typical Names
GW	Well-graded gravel and gravel-sand mixtures, little or no fines
GP	Poorly graded gravel and gravel-sand mixtures, little or no fines
GM	Silty gravel, gravel-sand-clay mixtures
GC	Clayey gravel, gravel-sand-clay mixtures
SW	Well-graded sand and gravelly sands, little or no fines
SP	Poorly graded sands and gravelly sands, little or no fines
SM	Silty sands, sand-silt mixtures
SC	Clayey sands, sand-clay mixtures
ML	Inorganic silts, very fine sands, rock floor, silty or layey fine sands.
CL	Inorganic clays of low to medium plasticity gravelly clays, sandy clays, silty clays, Lean clays.

D. Materials which are unsuitable for backfill include rocks greater than eight (8) inches in their largest dimension, and pavement spoil, rubbish, construction debris, wood, metal, plastics, and the following soils, classified by the Unified Soil Classified System, ASTM D-2487:

Group Symbols	Typical Names
OL.....	Organic silts and organic silty clays of low plasticity
MH.....	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts
CH.....	Inorganic clays of high plasticity, fat clays
OH.....	Organic clays of medium to high plasticity
PT.....	Peat, muck, and other highly organic soils

PART 3 EXECUTION

3.01 EXISTING STRUCTURES, PIPING, AND WIRING

A. All poles, fences, sewer, gas, water, or other pipes, cables, wires, conduits, and manholes, buildings, and structures shall be supported and protected from injury by the Contractor.

B. The Contractor shall proceed with caution during excavation so the exact location of underground utilities and structures, both known and unknown, may be determined. The Contractor shall be responsible for the repair of utilities and structures when broken or otherwise damaged.

C. Whenever, in the opinion of the Engineer, it is necessary to explore and excavate to determine the location of underground structures, the Contractor shall make exploration and excavations for such purpose.

D. Wherever sewer, gas, water, or other pipes or conduits cross the excavation, the Contractor shall support said pipes and conduits without damage to them and without interrupting this Contract. The manner of supporting such pipes and conduits shall be subject to the approval of the Engineer.

E. When utility lines that have to be removed or relocated are encountered within the areas of operations, the Contractor shall notify the Utility Company in ample time for the necessary measure to be taken to prevent interruption of the service.

F. The Contractor shall conduct the Work in such a way that no equipment, material, or debris will be placed or allowed to fall upon private property in the vicinity of the Work, unless he shall have first obtained the property owner's

written consent thereto and shall have shown said written consent to the Engineer.

G. All excavated material shall be piled in a manner that will avoid obstructing walkways and driveways. Hydrants under pressure, valve pit covers, valve boxes, curb stop boxes, or other utility drainage ways shall be kept clear or other satisfactory provisions made for drainage.

3.02 CLEARING

A. Clear and remove logs, stumps, brush, vegetation, rubbish, and other perishable matter from the project site.

B. Do not remove or damage trees that do not interfere with the finished Work. Completely remove trees required to be removed, including stumps and roots. Properly treat damaged trees which can be saved.

3.03 STRIPPING AND STOCKPILING OF TOPSOIL

A. Strip topsoil and vegetation from the excavated areas. Stockpile clean topsoil in location designated by the Engineer.

B. Do not intermix grass, weeds, roots, root mat, brush, and stones larger than three (3) inches with stockpiled topsoil.

3.04 DEWATERING

A. Provide sufficient dewatering equipment and make proper arrangements for the disposal of water from dewatering operation. Dewatering shall not damage property, create nuisances, or interfere with other Work. Do not use sanitary sewers for the disposal of water from dewatering operations.

3.05 EXCAVATING

A. Make excavations to elevations and dimensions necessary to permit erection of forms and inspection of foundation and to install piping. Completely remove unsuitable material.

B. Trees, boulders, and other surface encumbrances, located so as to create a hazard to employees in excavation Work or in the vicinity thereof at any time during operations, shall be removed or made safe before excavating is begun.

C. Contractor shall be responsible for the determination of the angle of repose of the soil in which the excavating is to be done. Excavate all slopes to at least the angle of response except for areas where solid rock allows for line drilling or pre-splitting.

D. It is the Contractor's responsibility to control the Work such that sides, slopes, and faces of all excavations shall meet accepted OSHA requirements by scaling,

benching, barricading, rock bolting, wire meshing, or other equally effective means. Give special attention to slopes, which may be adversely affected by weather or moisture content.

E. The Contractor should flatten the excavation sides when an excavation has water conditions, silty materials, loose boulders, and areas where erosion, deep frost action, and slide planes appear.

F. The Contractor should shore or otherwise support sides of excavations in hard or compact soil in compliance with all OSHA, State, and local safety codes.

G. Use diversion ditches, dikes, or other suitable means to prevent surface water from entering an excavation and to provide adequate drainage of the area adjacent to the excavation. Do not allow water to accumulate in an excavation. If possible, the grade should be away from excavation.

H. The Contractor shall provide protection against slides and cave-ins, as required by OSHA, State and local codes.

I. Store and retain materials as to prevent materials from falling or sliding back into the excavation. Install substantial stop log or barricades when mobile equipment is utilized adjacent to excavations.

J. The limits of excavation for structures shall be the external dimensions of the structure plus the space necessary for the construction and removal of the forms and construction of masonry Work.

K. The width of trenches for pipe shall provide a clearance as required by OSHA, State and local codes.

L. The Contractor is reminded to test the air in excavations in locations where oxygen deficiency or gaseous conditions are possible.

M. The Contractor is reminded to provide ladders where employees are required to be in excavations as required by OSHA, State and local codes.

N. The Contractor is reminded to provide adequate barriers and physically protect excavations. Barricade or cover all wells, pits, shafts, and similar excavations. Backfill temporary wells, shafts, and similar excavations upon completion of exploration and similar operations.

3.06 SHEETING

A. The Contractor has the option of sheeting excavations.

B. Supporting system, such as piling, cribbing, shoring, and bracing, shall be designed by a qualified Contractor's representative and meet accepted OSHA requirements.

C. Materials used for sheeting, sheet piling, cribbing, bracing, shoring, and underpinning should be in good, serviceable conditions. Timbers should be sound, free from large or loose knots, and of proper dimensions.

D. Brace the side of the excavation as necessary to resist the extra pressure due to superimposed loads.

E. Provide shoring, bracing, or underpinning as necessary to ensure the safety of adjoining buildings or walls. Such shoring, bracing or underpinning shall be inspected daily or more often, as conditions warrant, by a competent contractor's representative and the protection effectively maintained.

F. The Contractor shall be held responsible for the sufficiency of all sheeting and bracing used, and for all damage to persons or property resulting from the improper quality, strength, placing, maintaining, or removing of the same. This includes damage to trees, sidewalks, and to other property on the project site, as well as on private grounds.

G. Drive sheeting ahead of excavation. Do not remove sheeting until the excavation backfill has reached within two (2) feet of the top of the excavation, except that the lower course of sheeting may be removed from a double sheeted excavation. When sheeting is drawn, completely fill all cavities remaining in or adjoining the excavation. When sheeting is left in place, completely fill all cavities behind such sheeting.

3.07 STORAGE AND REMOVAL OF EXCAVATED MATERIAL

A. Suitable excavated material required for filling and backfilling operations may be stockpiled on the job site.

B. Remove unsuitable materials from the job site as unsuitable materials are excavated. Remove surplus suitable materials from the job site as excavations are back-filled. Dispose of excess excavated material in a suitable, approved location.

3.08 SUBGRADE

A. Compact the existing disturbed earth below subgrades which will support structures. Compact existing earth with a vibratory compactor, and maintain moisture content within + or - two (2%) percent of optimum moisture content during compaction. Compact existing earth to not less than ninety-five (95%) percent of the Modified Proctor Density, as determined by ASTM D1557.

B. Do not construct foundations, footings, slabs, or piping on loose soil, mud, or other unsuitable soil.

C. Fill excess cuts under foundations, footings, and slabs with structure foundation backfill.

D. Fill excess cuts under piping with compacted pipe foundation bedding.

3.09 TEMPORARY PLUGS

A. Prevent foreign matter from entering pipe while it is being installed.

B. Do not place debris tools, clothing, or other material in this pipe.

C. Close the open ends of pipe by watertight plugs when pipe laying is not in progress.

D. Remove any earth or other material that enters pipe, lateral pipe, or appurtenances through any open end.

E. Remove earth and other materials at no additional cost to the Owner.

3.10 BACKFILLING EXCAVATIONS UNDER PAVEMENTS, FOUNDATIONS, AND STRUCTURES

A. Owner reserves the right to employ an independent testing laboratory to perform field density tests to ensure proper compaction.

B. Remove debris and other unsuitable materials from excavations before backfilling is started.

C. Backfill excavations in areas to be paved with pipe bedding material. Place pipe bedding material in layers six (6) inches loose thickness. Compact each lift of backfill to not less than ninety-five (95%) percent of the maximum dry density as determined in accordance with AASHTO T99, Method A (Std. Proctor). Compaction shall be by hand tamping or approved mechanical tamping devices, or in larger excavation by approved rollers.

D. Backfill excavations and fill beneath footings or structures with pipe bedding material. Backfill directly over and around structures with pipe bedding material. Place backfill in lifts no greater than six (6) inches in loose depth. Backfill and fill shall be within + or - two (2%) percent optimum moisture content. Compact backfill and fill to not less than ninety-five (95%) percent of the Modified Proctor Density, as determined by ASTM D1557.

E. Provide additional material, if required, to complete backfill and fill. Additional backfill and fill material shall be provided at no additional cost to the Owner.

F. Do not use the following materials for backfill:

1. Unsuitable materials

2. Materials which are too wet or too dry to be compacted to the densities specified in this Article.

G. Do not place fill over wet or muddy subgrade.

H. Place backfill and fill in a manner which will not overload foundations or structures. Place backfill and fill evenly on all sides of foundations and structures. Do not use equipment that will overload foundations or structures during filling or backfilling.

I. Do all cutting, filling, and grading necessary to bring the entire area around foundations and outside of structures to the following subgrade levels:

1. To finished grade for areas not to be paved with drives or walks.

3.11 BACKFILLING PIPING TRENCHES

A. Do not backfill trenches and excavations until all utilities have been inspected by the Engineer and until all underground utilities and piping systems are installed in accordance with the requirements of the Specifications and the Drawings.

B. Place and tamp bedding and backfill in a manner which will not damage pipe coating, wrapping, or encasement.

C. Bedding procedures shall be as specified in the Section for the applicable pipe material.

D. Place pipe backfill material in eight (8) inch layers from the top of bedding to depths as required for particular application. Compact pipe backfill material to the density required to allow backfill material over the pipe to be compacted to the density specified in this Article.

E. Do not use the following materials for backfill:

1. Unsuitable materials
2. Materials which are too wet or dry to be compacted to the densities specified in this Article.

F. Do not place fill over wet or muddy subgrade.

G. Backfill trenches across paved roadways with pipe bedding material, compacting each lift to ninety-five (95%) percent of the Modified Proctor Density. Backfill trenches across gravel roadways, driveways, utility crossings, along driveways, and in areas to be paved, or subjected to traffic with pipe bedding material. Compact each lift of backfill to equivalent of not less than eighty-five (85%) percent of the Modified Proctor Density. Place backfill in six (6) inch loose lifts. Compaction shall be by hand tamping or approved mechanical tamping devices, or in larger excavations by approved rollers. Do not compact backfill by puddling.

H. Backfill trenches not requiring pipe bedding material with suitable pipe cover material as required by the Engineers. Place and compact backfill to produce an adequate foundation for seeding. The top twelve (12) inches of backfill shall not contain stones or other objects larger than one (1) inch in maximum dimension. Mound backfill above finish grade to allow for settlement. Fill and restore any settlement of the backfill. Grade area to be restored to finish grade after settlement of backfill.

3.12 CLEANUP AND MAINTENANCE

A. Cleanup the job site as backfilling is completed. Remove excess earth, rock, bedding, materials, and backfill materials. Remove unused piping materials, structure, components and appurtenances. Restore items moved, damaged, or destroyed during construction.

B. Maintain the job site until the Work has been completed and accepted. Fill excavations, which settle when settlement is visible. Restore items damaged by construction or improper restoration.

C. Control soil erosion, stream and drain pollution resulting from silt or soil runoff or any material from construction operations. Use silt fences, silt barriers and sedimentation pools as required. Submit plan to control soil erosion, stream and drain pollution before clearing site.

END OF SECTION

SECTION 02270
SLOPE PROTECTION AND EROSION CONTROL

PART 1 GENERAL

1.01 WORK INCLUDED

A. The Contractor shall do all work and take all measures necessary to control soil erosion resulting from construction operations, shall prevent the flow of sediment from the construction site, and shall contain construction materials (including excavation and backfill) within his protected working area so as to prevent damage to adjacent property.

B. The Contractor shall not employ any construction method that violates a rule, regulation, guideline or procedure established by Federal, State or local agencies having jurisdiction over the environmental effects of construction. The Contractor shall be responsible for obtaining all associated permits.

C. Pollutants such as chemicals, fuels, lubricants, bitumen, raw sewage and other harmful waste shall not be discharged into or alongside of any body of water or into natural or man-made channels leading thereto.

PART 2 PRODUCTS

2.01 MATERIALS

A. Temporary Slope Protection and Erosion Control: Bales may be hay or straw, and shall be reasonably clean and free of noxious weeds and deleterious materials. Filter fabric for sediment traps shall be of suitable materials acceptable to the Engineer.

B. Permanent Slope Protection and Erosion Control: On slopes 2H:1V and steeper, and where shown on the drawings place Type A Dumped Rock Fill with a 24-inch minimum thickness over non-woven geotextile filter fabric.

PART 3 EXECUTION

3.01 METHODS OF CONSTRUCTION

A. The Contractor shall use any of the acceptable methods necessary to control soil erosion and prevent the flow of sediment to the maximum extent possible. These methods shall include, but not be limited to, the use of water diversion structures, diversion ditches and settling basins.

B. Construction operations shall be restricted to the areas of work indicated on the Drawings and to the area which must be entered for the construction of temporary or permanent facilities. The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing,

excavation, borrow and fill operations and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of the wetlands and adjacent watercourses. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats, or other control devices or methods as necessary to control erosion.

C. Excavated soil material shall not be placed adjacent to the wetlands or watercourses in a manner that will cause it to be washed away by high water or runoff. Earth berms or diversions shall be constructed to intercept and divert runoff water away from critical areas. Diversion outlets shall be stable or shall be stabilized by means acceptable to the Engineer. If for any reason construction materials are washed away during the course of construction, the Contractor shall remove those materials from the fouled areas as directed by the Engineer.

D. For work within easements, all materials used in construction such as excavation, backfill, roadway, and pipe bedding and equipment shall be kept within the limits of the easements.

E. The Contractor shall not pump silt-laden water from trenches or other excavations into the wetlands, or adjacent watercourses. Instead, silt-laden water from his excavations shall be discharged within areas surrounded by baled hay or into sediment traps to ensure that only sediment-free water is returned to the watercourses. Damage to vegetation by excessive watering or silt accumulation in the discharge area shall be avoided.

F. Prohibited construction procedures include, but are not limited to, the following:

1. Dumping of spoil material into any streams, wetlands, surface waters, or unspecified locations.

2. Indiscriminate, arbitrary, or capricious operation of equipment in wetlands or surface waters.

3. Pumping of silt-laden water from trenches or excavations into surface waters, or wetlands.

4. Damaging vegetation adjacent to or outside of the construction area limits.

5. Disposal of trees, brush, debris, paints, chemicals, asphalt products, concrete curing compounds, fuels, lubricants, insecticides, washwater from concrete trucks or hydroseeders, or any other pollutant in wetlands, surface waters, or unspecified locations.

6. Permanent or unauthorized alteration of the flow line of any stream.

7. Open burning of debris from the construction work.

G. Any temporary working roadways required shall be clean fill approved by the Engineer. In the event fill is used, the Contractor shall take every precaution to prevent the fill from mixing with native materials of the site. All such foreign fill materials shall be removed from the site following construction.

3.02 EROSION CHECKS

The Contractor shall furnish and install baled hay or straw erosion checks in all locations indicated on the Drawings, surrounding the base of all deposits of stored excavated material outside of the disturbed area, and where indicated by the Engineer. Checks, where indicated on the Drawings, shall be installed immediately after the site is cleared and before trench excavation is begun at the location indicated. Checks located surrounding stored material shall be located approximately 6 ft. from that material. Bales shall be held in place with two 2 in. by 2 in. by 3 ft. wooden stakes. Each bale shall be butted tightly against the adjoining bale to preclude short circuiting of the erosion check.

END OF SECTION

SECTION 02480
SEEDING AND MULCHING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish and install seed and mulch and do related work necessary to complete work shown or specified.

B. The Contractor shall repair or replace lawn areas, trees, and ornamental plants damaged or destroyed during construction of the work included in this Contract, unless otherwise shown on the drawings.

1.02 QUALITY ASSURANCE

A. Codes, specifications, and standards referred to by number or title shall form a part of this specification to the extent required by the reference thereto. Latest revisions as of the date of bid opening shall apply, unless otherwise shown or specified.

B. Package standard products with manufacturer's certified analysis. For other materials, provide analysis by a recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with Section **GENERAL REQUIREMENTS** and the requirements of this section.

B. Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall be responsible for the delivery, storage, and handling of products.

B. Promptly remove damaged products from the job site. Replace damaged products with undamaged products.

C. Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

1.05 JOB CONDITIONS

A. Do not sow seed during adverse weather conditions. Do not broadcast seed during high wind. Do not sow seed when the moisture content of the soil is too low or two high for seed germination.

B. Proceed with and complete seeding and mulch work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required.

PART 2 PRODUCTS

2.01 SEEDING AND MULCHING

A. Topsoil: Topsoil shall be a natural, friable soil, representative of product soils in the vicinity. It shall be well-drained, free from admixture of subsoil and foreign matter, objects larger than two (2) inches in diameter, toxic substances, and any other deleterious material that may be harmful to plant growth and be a hindrance to grading, planting, and maintenance operations. Soil excavated on site may be used provided it meets the requirements of topsoil.

B. Seed shall meet the requirements of these Specifications and comply with the Alabama Seed Law Act No. 424, General Acts, 1963 Vol. 2, Page 931, latest revision. The type of quick growing seed used shall be appropriate to provide an early ground cover during the particular season when planting is done. The rate of spread shall be as specified in Section 3.01D.

C. Mulch shall meet the material requirements of the State of Alabama Department of Transportation Standard Specifications for Highway's and Bridges, latest revision.

D. For areas requiring sod it shall be Tifton Bermuda free of weeds and other undesirable grasses. 118 minimum ½ yard cuts.

E. Fertilizer: Commercial plant food containing eight (8%) percent nitrogen, eight (8%) percent available phosphate, and eight (8%) percent potassium, uniform in composition, dry, free-blowing, and delivered in containers bearing manufacturer's guaranteed analysis.

F. For areas requiring erosion control matting see Section 02490 EROSION CONTROL MATTING.

2.02 EQUIPMENT

A. The seed spreader shall be an approved mechanical hand spreader or other approved type of spreader.

B. The mulching equipment shall be of a type capable of cutting the specified materials uniformly into the soil and to the required depth. Harrows will not be allowed.

C. Cultipacker, traffic roller, or other suitable equipment will be required for rolling the grassed areas.

PART 3 EXECUTION

3.01 GRADING, SEEDING AND MULCHING

A. Pre-Finish Grading: Complete rough grading to grades indicated on the Drawings or to accomplish adequate drainage patterns required by the site layout. Rough grading shall allow for the addition of materials needed to accomplish finish grading. Fill areas required during subgrade preparation shall be compacted to eighty-five (85%) percent of the relative maximum density. Topsoil shall be spread over the prepared rough grade using a rubber-tired tractor with grader blade or equivalent.

B. Fertilizing: Apply commercial fertilizer at the rate of nine hundred twenty (920) pounds per one-acre or at a rate determined from soil tests, distributing uniformly with a rotary mechanical spreader. Apply soil additives such as lime if the soil pH requires adjustment.

C. Finish Grading: After placing topsoil and applied materials, rake the topsoil to a uniform grade so that all areas drain, as indicated on the grading plan or as required to complete drainage patterns. Lightly compact with a cultipacker before planting grass. Remove all trash from the area prior to planting grass.

D. Seeding

1. Seeding and mulching operations will not be permitted when wind velocities exceed fifteen (15) miles per hour. Seed shall be sown only when the soil is moist and in proper condition to induce growth. No seeding shall be done when the ground is unduly wet or otherwise not in a tillable condition.

2. Whenever a suitable amount of area has been graded, it shall be made ready and grassed as specified in this Section. Grassing shall be incorporated into the project at the earliest practical time in the life of the Contract.

E. The several operations involved in the work shall proceed in the following sequence: preparation of the ground; seeding; spreading of mulch; cutting-in mulch; and rolling or preparation of the ground; installation of erosion control matting, placing soil; hydroseeding; placing excelsior mat.

F. The ground over which the seed is to be sown shall be prepared by diskharrowing and thoroughly pulverizing the soil to a suitable depth. The prepared soil shall be loose and reasonably smooth. It shall be reasonably free of large clods, roots, and other material, which will interfere with the work or subsequent mowing and maintenance operations. Apply lime at two (2) tons per acre, and 8,8,8 commercial fertilizer at nine hundred twenty (920 lbs.) pounds per acre.

G. While the soil is still loose and moist, the seed shall be scattered uniformly over the grassing area. The rate of spread for the seed mixture shall be per schedule.

August through February	**Winter**
Kentucky 31	30 lbs/acre
Reseeding Crimson Clover	15 lbs/acre
Bermuda Grass (Unhulled)	30 lbs/acre
Perennial Ryegrass	30 lbs/acre
March through July	**Spring**
Kentucky 31	30 lbs/acre
Kobe Lespedeza (Var. Tenn)	30 lbs/acre
Bermuda Grass (Cynodon Ductylon)	20 lbs/acre (Hulled)

H. Approximately two (2) inches, loose thickness of mulch material shall be applied uniformly over the seeded area, and the mulch material cut into the soil with equipment specified, to produce a loose mulched thickness of three (3) to four (4) inches. Care shall be exercised that the materials are not cut too deeply into the soil.

I. Immediately after completion of the seeding, the entire mulched area shall be rolled thoroughly with the equipment specified. At least two (2) trips of the entire area will be required.

J. Maintenance:

1. Water to keep surface soil moist. Repair washed out areas by filling with topsoil, liming, fertilizing, and seeding. Replace mulch on banks when washed or blown away. Mow grass to two (2) inches after grass reaches at least three (3) inches in height, and mow frequently enough to keep grass from exceeding 3 ½ inches.

2. If a satisfactory stand of grass has not been established in eight (8) weeks, the Contractor shall renovate and reseed the grass or unsatisfactory portions thereof immediately. A satisfactory stand of grass is defined as having no bare spots larger than three (3) square feet and not more than

ten (10%) percent of total area with bare spots larger than one (1) square foot.

3. The seeded areas shall be watered to provide optimum growth conditions for the establishment of the grass. In no case, however, shall the period of maintaining such moisture be less than two weeks after the planting. Manual watering shall continue at least every four (4) days until the end of the growing season.

K. See Section 02490 for installation of EROSION CONTROL MATTING where required.

L. The Contractor shall maintain the planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include filing, leveling, and repairing of any washed or eroded areas. Replant any areas in which the establishment of the grass stand does not develop satisfactorily.

M. Clean-up the job site following seeding and mulching. Remove rubbish, excess materials, temporary structures, and equipment. Leave the work in a neat and presentable condition.

N. Install Tifton Bermuda Sod in all swales, ditches, all slopes 3:1 or greater, within 10′ of each building structure and within 3′ of all walkways and driveways.

PART 4 PAYMENT

4.01 GENERAL

A. Payment for all work in this Section will be included as part of the lump sum bid amount or unit prices stated in the Proposal.

END OF SECTION

SECTION 02515
ROADS AND DRIVEWAYS

PART 1 GENERAL

1.01 WORK INCLUDED

A. Work necessary to complete the roads and driveways, including asphalt paving, and drainage structures.

1.02 GENERAL

A. See CONDITIONS OF THE CONTRACT and Section GENERAL REQUIREMENTS, for information and requirements that apply to the Work specified herein and are mandatory for this Project.

1.03 SUBMITTALS

A. Submittals shall be made in accordance with Section GENERAL REQUIREMENTS, and the requirements of this Section.

B. Provide the following submittals:

1. Certification, test results, and source for asphalt concrete material.
2. Product cut sheets for cast drainage structures and grating.

1.04 SYSTEM DESCRIPTION

A. Paving: Designed for movement and parking of trucks up to thirty-thousand (30,000) Lbs.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with the current edition of the State of Alabama Department of Transportation Standard Specifications for Highway Construction ("Standard Specifications"). In case of conflict, the Standard Specifications shall prevail.

PART 2 PRODUCTS

2.01 PAVEMENT MATERIALS

A. Asphalt concrete shall conform to Section 416 of the Standard Specifications.

B. Aggregate shall meet the requirements of Section 801, 802, and 416 Standard Specifications.

C. Filler, if required, shall meet the requirements of Section 805 of the Standard Specifications.

D. The asphalt cement to be mixed with the mineral aggregates at the central plant shall be AC-20 paving asphalt conforming to the requirements of Section 804 of the Standard Specifications.

E. The job-mix formula shall indicate the gradation of each of the aggregate constituents to be used in the mixture and shall establish the exact proportion of each constituent to be used to produce a combined gradation of aggregate within the appropriate limits stated above.

2.02 BASE COURSE MATERIALS

A. Materials for base course shall conform to Type B crushed aggregate as specified in Section 825 of the Standard Specifications.

2.03 CATCH BASINS AND DRAINAGE CULVERTS

A. Catch basins shall be as shown on the Drawings or pre-cast units conforming to ASTM C478 except that dimensions shown on the Drawings shall take precedence.

B. Culvert pipes shall be bell and spigot reinforced concrete conforming to ASTM C76 and meeting the requirements for Class IV reinforcing. Joints shall be rubber gasketed type furnished by the pipe manufacturer.

PART 3 EXECUTION

3.01 BASE CONSTRUCTION

A. Construct base course at the location and to the grades and cross sections shown on the Drawings. A prime coat shall be applied to the base course in accordance with Section 401 of the Standard Specifications.

B. Once the drive area is at grade, the area shall be thoroughly proofrolled. Any soft or loose areas shall be undercut and replaced with compacted fill.

C. The base shall be compacted to a minimum of 98 percent maximum dry density as determined by a Standard Proctor at a moisture content that is within 2 percentage points of the optimum moisture content.

3.02 ASPHALT PAVEMENT CONSTRUCTION

A. Asphalt for prime coat shall not be applied when the ground temperature is lower than fifty (50) degrees F without permission of the Engineer. Asphalt concrete shall not be placed when the atmosphere temperature is lower than

forty (40) degrees F nor during heavy rainfall nor when the surface upon which it is to be placed is thirty-two (32) degrees F or lower.

B. Lay asphalt concrete over the base course to the compacted depth shown on the Drawings. The method of proportioning, mixing, transporting, laying, processing, rolling the material, and the standards of workmanship shall conform to the applicable requirements of Section 410 of the Standard Specifications. At no time shall the coarse aggregate segregated from the mix from hand spreading or raking of joints be scattered across the paved mat.

C. Roll each lift of the asphalt concrete and compact to the density specified in the referenced Standard Specifications. Asphalt or asphalt stains, which are noticeable upon surfaces of concrete or materials, which will be exposed to view shall be promptly and completely removed.

D. Where the asphalt pavement is to be connected with an existing roadway surface, the Contractor shall modify the existing roadway profile to produce a smooth riding connection between new and existing paving. Where it is necessary to remove existing asphalt surfaces, burn or chip the existing surface to provide a minimum 2 1/2-inch depth of asphalt concrete. The edges of meet line cuts shall be straight and vertical. Existing asphalt edges shall be painted with tack coat before placing new asphalt.

E. The completed surface of the asphalt pavement shall be of uniform texture, smooth, uniform as to crown and grade, and free from defects of all kinds. The completed surface shall not vary more than 1/8-inch from the lower edge of a ten (10)-foot straightedge placed on the surface parallel to the centerline. The transverse slope shall not vary more than 1/4-inch in ten (10)-feet from the rate of transverse slope shown on the Drawings.

3.03 CATCH BASINS AND DRAINAGE STRUCTURES

A. Construct inlets, catch basins, and headwalls at the locations shown and in accordance with the Drawings. Chamfer corners of all structures.

B. Compact upper twelve (12)-inches of the subgrade for pre-cast units to ninety-five (95%) percent relative compaction.

C. Set frames and grates at elevations indicated or as determined in the field and in conformance with the Drawings.

D. The Contractor shall prevent sediments or debris from entering the catch basins, inlets, and headwalls during the construction period by placing erosion control devices around the catch basins, inlets, and at the upstream headwalls. Upon completion, clean each structure of all silt, debris, and foreign matter.

3.04 CULVERTS

A. Place culverts and drain pipes at grade shown on the Drawings. Do not permit mud and foreign material to get into the pipe. After completion, completely flush or clean all parts of the system. Culvert entrances shall not be blocked by any mud or silt and ditch grades downstream of culverts shall not be greater than the pipe invert.

END OF SECTION

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. SECTION INCLUDES:

Section	Title
1.2	References
1.3	Work Included
1.4	Submittals
1.5	Quality Assurance
1.6	Delivery, Storage, and Handling
2.1	General
2.2	Concrete Materials
2.3	Forms
2.4	Reinforcement
2.5	Concrete Mix Design
3.1	Measuring Materials
3.2	Mixing and Transporting
3.3	Concrete Appearance
3.4	Placing and Compacting
3.5	Curing and Protection
3.6	Removal of Forms
3.7	Inspection and Field Testing
3.8	Concrete Finishing
3.9	Failure to Meet Requirements
3.10	Patching and Repairs
3.11	Concrete Schedule

1.2 REFERENCES

A. Drawings and general provisions of the Contract, including general and supplementary conditions and Division 1 Specification Sections, apply to this section.

B. American Society for Testing and Materials (ASTM)

1. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field
2. C33 - Standard Specification for Concrete Aggregates
3. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

4. C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
5. C94 - Standard Specification for Ready-Mixed Concrete
6. C143 - Standard Test Method for Slump of Hydraulic Cement Concrete
7. C150 - Standard Specification for Portland Cement
8. C171 - Standard Specification for Sheet Materials for Curing Concrete
9. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
10. C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
11. C260 - Standard Specification for Air-Entraining Admixtures for Concrete
12. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
13. C494 - Standard Specification for Chemical Admixtures for Concrete
14. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
15. C1017 - Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete

C. American Concrete Institute (ACI)

1. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete
2. ACI 305R - Hot Weather Concreting
3. ACI 306.1 - Standard Specification for Cold Weather Concreting
4. ACI 318 - Building Code Requirements for Structural Concrete
5. ACI 350R - Environmental Engineering Concrete Structures

D. Where reference is made to one of the above Standards, the revision in effect at the time of bid opening shall apply.

1.3 WORK INCLUDED

A. The Contractor shall, under this item, furnish all materials, tools, labor, and equipment to place all cast-in-place concrete, including all reinforcing steel and formwork, in the structures shown on the Contract Drawings, and such other concrete as may be found necessary to fully complete the Work indicated under this Contract, or as directed by OWNER.

1.4 SUBMITTALS

A. Submit for approval all working drawings and schedules of materials and methods proposed to be followed in the execution of the Work under this item.

1. Mix Design

    a. Concrete mix for each formulation of concrete proposed for use including constituent quantities per cubic yard, water-cementitious materials ratio, concrete slump, type and manufacturer of cement. Provide either 1) or 2) below for each mix proposed.

        1) Standard deviation data for each proposed concrete mix based on statistical records.

        2) The curve of water-cementitious materials ratio versus concrete cylinder strength for each formulation of concrete proposed based on laboratory tests. Provide the cylinder strength for the average of the 28 day cylinder strength test results for each mix. Provide results of 7 and 14 day tests.

2. Product Data

    a. Sources of cement, pozzolan and aggregates.

    b. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.

    c. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM Standards.

    d. Water-reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.

    e. High-range water-reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations of use.

    f. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.

    g. Liquid curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM Standards. Identify proposed locations of use.

3. Samples

    a. Fine and coarse aggregates if requested by the Engineer.

4. Certificates

    a. Certify admixtures used in the same concrete mix are compatible with each other and the aggregates.

    b. Certify admixtures are suitable for use in contact with potable water after 30 days of concrete curing.

    c. Certify curing compound is suitable for use in contact with potable water after 30 days (non-toxic and free of taste or odor).

5. Test and Evaluation Reports

a. Fine aggregates – sieve analysis, physical properties, and deleterious substance.

b. Coarse aggregates – sieve analysis, physical properties, and deleterious substances.

c. Cements – chemical analysis and physical properties for each type.

d. Pozzolans – chemical analysis and physical properties.

e. Proposed concrete mixes – compressive strength, slump and air content.

f. Shrinkage Test Results – In accordance with ASTM C157 as modified hereinafter.

6. Field Quality Control Submittals

a. Field test reports.

b. Concrete Delivery/Batch Tickets:

1) For each batch of concrete before unloading at Site.

2) In accordance with ASTM C94/C94M, Section 14 including requirements 14.2.1 through 14.2.10.

3) Indicate the amount of mixing water withheld, and maximum amount that may be permitted to be added at Project Site.

7. Special Procedure Submittals

a. Detailed plan for cold weather curing and protection of concrete placed and cured in weather below 40 degrees F.

b. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F.

c. If Contractor chooses to use self-consolidating concrete: Detailed plan of modified procedures for handling, placing, and finishing.

1.5 QUALITY ASSURANCE

A. Comply with ACI 318, the recommendations of ACI 350R and other stated requirements, codes and standards. The most stringent requirement of the codes, standards and this Section apply when conflicts exist.

B. Use only one source of cement and aggregates on any one structure. Provide concrete of uniform color and appearance.

C. A minimum of 14 days in advance of placing concrete, discuss with the Engineer the sources of individual materials and batched concrete proposed for use. Discuss placement methods, waterstops and curing. Propose methods of hot and cold weather concreting as required. Discuss the properties and techniques of batching and placing plasticized concrete prior to the placement of any concrete containing a high-range water-reducing admixture (plasticizer). Include the plasticizer manufacturer in the discussions.

D. If, during the progress of the work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the desired properties. Make all changes ordered at the Contractor's expense.

E. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, provide all materials, labor, and equipment, at the Contractor's expense, necessary to perform new acceptance tests as were originally required using the new materials prior to their incorporation in the work. If the tests are specified to be conducted by others, the costs of these tests shall be borne solely by the Contractor.

F. Qualifications

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or an approved equivalent program.

2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in the jurisdiction of the Work. Requirements may be waived if the individual is Contractor's Licensed Design Engineer.

3. Installers: Unless otherwise permitted, at least one person on the finishing crew must be certified as an ACI Flatwork Finisher, or equivalent.

G. Preconstruction Testing

1. Have the following materials tested to verify conformity with this Specification Section and the stated ASTM Standards.

a. Fine aggregates for conformity with ASTM C33 – sieve analysis, physical properties, and deleterious substances.

b. Coarse aggregates for conformity with ASTM C33 – sieve analysis, physical properties, and deleterious substances.

c. Cements for conformity with ASTM C150 – chemical analysis and physical properties.

d. Pozzolans for conformity with ASTM C618 – chemical analysis and physical properties.

e. Proposed concrete mix designs – compressive strength, slump and air content.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Cement: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination and to minimize warehouse set.

2. Aggregate: Arrange and use stockpiles to avoid excessive segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding 3-ft in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.

3. Sand: Arrange and use stockpiles to avoid contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen aggregates.
4. Admixtures: Store in closed containers to avoid contamination, evaporation or damage. Provide suitable agitating equipment to assure uniform dispersion of ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.
5. Pozzolan: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination.
6. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.
7. Liquid Curing Compounds: Store in closed containers.

PART 2 PRODUCTS

2.1 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired. Such reference is not intended to indicate a restrictive preference on the part of OWNER for that particular manufacturer or product, or to prohibit the use of equivalent products or equally qualified manufacturers.

B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.2 CONCRETE MATERIALS

A. Cementitious Materials

1. Portland Cement
   a. In accordance with requirements of ASTM C150.
   b. Brand: Subject to approval of Engineer. Use one brand throughout the Work.
   c. Alkalies: Maximum 0.60 percent.
   d. Nonhydraulic above grade structures: Type I or Type II.
   e. Hydraulic and below grade structures and sewers: Type II
2. Supplementary Cementitious Materials
   a. Fly Ash (Pozzolan): Class F or Class N fly ash in accordance with ASTM C618, except as modified herein:
      1) Produced from process that does not use hazardous or potentially hazardous materials.

2) ASTM C618, Table 1, Loss on Ignition: Maximum 3 percent.

3) ASTM C618, Table 2, Water Requirement: Maximum 100 percent of control.

4) ASTM C618, Table 3, Effectiveness in Controlling Alkali-Silica Reaction: Maximum 100 percent expansion of test mixture as a percentage of low-alkali cement control at 14 days.

5) ASTM C618, Table 3, Expansion of Test Mixture: Evaluate results using either Procedure A or Procedure B as follows:

a) Procedure A after 6-month sulfate exposure, maximum 0.10 percent.

b) Procedure B, expansion of test mixture as a percentage of sulfate resistance cement control, after at least 6-month exposure, maximum 100 percent.

6) Where fly ash is specified to be used with Type I cement, have fly ash meet one of the following requirements:

a) CaO: Maximum 15 percent.

b) Test cementitious materials as follows:

(1) In accordance with ASTM C1012.

(2) Furnish test data confirming fly ash in combination with cement used meets strength requirements, is compatible with air-entraining agents and other additives, provides increased sulfate resistance equivalent to or better than Type II cement.

(3) Conduct tests using proposed fly ash and cement samples together with control samples using Type II cement without fly ash.

b. Slag Cement: In accordance with ASTM C989, Grades 100 or 120.

3. Tricalcium Aluminate

a. Content of Cementitious Materials: Maximum 8 percent.

B. Aggregates: Furnish from one source.

1. Natural Aggregates

a. Free from deleterious coatings and substances and conforming to requirements of ASTM C33, except as modified herein.

b. Free from materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.

2. Nonpotentially Reactive: In accordance with ASTM C33, Appendix XI, Paragraph X1.1.

3. Aggregate Soundness: Test for fine and coarse aggregates in accordance with ASTM C33 and ASTM C88 using sodium sulfate solution.

4. Fine Aggregates

a. Clean, sharp, and natural sand.

b. ASTM C33.

c. Material Passing 200 Sieve: 4 percent maximum.

d. Limit deleterious substances in accordance with ASTM C33, Table 1 with material finer than 20 sieve limited to 3 percent, coal and lignite limited to 0.5 percent.

5. Coarse Aggregates

a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).

b. Materials Passing 200 Sieve: 0.5 percent maximum.

c. Limit deleterious substances in accordance with ASTM C33, Table 3 for exposed concrete.

C. Admixtures: Unless otherwise permitted, furnish from one manufacturer.

1. Characteristics

a. Compatible with other constituents in mix.

b. Free of chlorides and alkalis (except for those attributable to water).

c. Do not use admixtures known to be toxic after concrete has cured for 30 days.

d. Furnish type of admixtures as recommended by manufacturer for anticipated temperature ranges.

e. Proportion and mix in accordance with manufacturer's recommendations.

2. Air-Entraining Admixture: ASTM C260

3. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.

4. Retarding Admixture: ASTM C494/C494M, Type B.

5. High Range Water Reducing Admixture (Superplasticizer): ASTM C494/C494M, Type F or G. Use only when approved by Engineer.

6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II. Use only when approved by Engineer.

a. Use of viscosity modifier if intent is to achieve self-consolidating concrete.

7. Do not use calcium chloride as an admixture.

D. Water and Ice: Use potable water for mixing water for concrete and water used to make ice, unless alternative sources of water are permitted.

1. Water from alternative sources: Comply with requirements of ASTM C1602/C1602M and contain less than:

a. 1,000 ppm of chlorides.

b. 3,000 ppm sulfate as SO_4.

c. 600 ppm alkalis as (Na_2O + 0.658 K_2O).

d. 50,000 ppm total solids by mass.

2.3 FORMS

A. The Contractor shall furnish all labor and materials for all forms required for the construction of the Work.

B. Either metal or wood forms may be used.

C. All forms shall be true to the required shape, clean, of sufficient strength, and well braced so that they shall maintain their proper position during the placing and vibrating of the concrete.

2.4 REINFORCEMENT

A. All steel reinforcement bars, wire, and dowel bars shall be in accordance with GDOT Standard Specifications for Construction of Road and Bridges, latest edition, Section 853.

B. Steel reinforcement shall be designed, detailed, fabricated and placed in conformance with all applicable requirements of ACI 318, and the CRSI Manual of Standard Practice.

C. No concrete shall be placed until all steel reinforcement to be covered has been inspected in place and approved by OWNER or the Engineer.

2.5 CONCRETE MIX DESIGN

A. Use an independent testing laboratory acceptable to the Engineer for development of mix designs and testing.

B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper workability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.

C. Base the design mix on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if such data is not available, be developed by a testing laboratory, acceptable to the Engineer, engaged by and at the expense of the Contractor. Acceptance of mixes based on standard deviation shall be based on the modification factors for standard deviation tests contained in ACI 318.

D. The water content of the concrete mix, determined by laboratory testing, shall be based on a curve showing the relation between water cementitious ratio and 7 and 28 day compressive strengths of concrete made using the proposed materials. The curves shall be determined by four or more points, each representing an average value of at least three test specimens at each age. The curves shall have a range of values sufficient to yield the desired data, including the specified design strengths as modified below, without extrapolation. The water content of the concrete mixes to be used, as determined from the curve, shall correspond to strengths 16 percent greater than the specified design strengths. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content as specified in Table 1.

E. Compression Tests: Provide testing of the proposed concrete mix or mixes to demonstrate compliance with the specified design strength requirements in conformity with the above paragraphs.

F. Entrained air, as measured by ASTM C231, as shown in Table 1.

1. If the air-entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal.

G. Slump of the concrete as measured by ASTM C143, as shown in Table 1. If a high-range water-reducer (plasticizer) is used, measure the slump before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 to 10-in.

H. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of each other.

TABLE 1
CONCRETE MIX REQUIREMENTS

Class	Design Strength (1)	Cement (2)	Fine Aggregate (2)	Coarse Aggregate (3)	Cementitious Content (4)
B	2500	C150 Type II	C33	57	440 min.
A	3000	C150 Type II	C33	57	480 min.
AA	4000	C150 Type II	C33	57	560 min.
AAA	5000	C150 Type II	C33	56	600 min.

Class	W/C Ratio (5)	Fly Ash	AE Range (6)	WR (7)	HRWR (8)	Slump Range Inches
B	0.62 max	--	3.5 to 5	Yes	*	1-4
A	0.54 max	--	3.5 to 5	Yes	*	1-3
AA	0.44 max	25% max	3.5 to 5	Yes	*	3-5
AAA	0.40 max	--	3.5 to 5	Yes	*	3-5

NOTES:

2. Minimum compressive strength in psi at 28 days
3. ASTM designation
4. Size Number in ASTM C33
5. Cementitious content in lbs/cu yd
6. W/C is Water-Cementitious ratio by weight
7. AE is percent air-entrainment
8. WR is water-reducer admixture
9. HRWR is high-range water-reducer admixture
10. *HRWR used at contractor's option

PART 3 EXECUTION

3.1 MEASURING MATERIALS

A. Compose concrete of portland cement, fine aggregate, coarse aggregate, water and admixtures as specified. Use a batch plant acceptable to the Engineer for concrete production. Batch all constituents, including admixtures, at the plant except a high-range water-reducer may also be added in the field.

B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Have scales certified by the local Sealer of Weights and Measures within 1 year of use.

C. Measure the amount of free water in fine aggregates within 0.3 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as-batched on printed batching tickets.

D. Dispense admixtures either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.
   1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.

2. Inject multiple admixtures separately during the batching sequence.

3.2 MIXING AND TRANSPORTING

A. Provide ready-mixed concrete produced by equipment acceptable to the Engineer. No hand-mixing will be permitted. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.

B. Transport ready-mix concrete to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.

C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be directed by the Engineer. Incorporate added water by additional mixing of at least 35 revolutions. Meter all added water with the amount of water added shown on each delivery ticket.

D. All central plant and rolling stock equipment and methods shall comply with ACI 318 and ASTM C94.

E. Select equipment of size and design to ensure continuous flow of concrete at the delivery end. Use metal or metal-lined non-aluminum discharge chutes with slopes not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.

F. Retempering (mixing with or without additional cement, aggregate, or water) of concrete or mortar which has reached initial set will not be permitted.

G. Handle concrete from mixer to placement as quickly as practicable while providing concrete of required quality in the placement area. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms.

H. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Clearly indicate the weight of fine and coarse aggregate, cement and water in each batch, the quantity delivered, the time any water is added, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of the truck mixer.

I. Temperature and Mixing Time Control

1. In cold weather, do not allow the as-mixed temperature and concrete temperature at the time of placement in the forms to drop below 40 degrees F.

2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.

3. In hot weather, cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. If necessary, substitute well-crushed ice for all or part of the mixing water.
4. Do not exceed the values shown in Table 2 for the maximum time interval between the addition of mixing water and/or cement to the batch and the placing of concrete in the forms.

TABLE 2
MAXIMUM TIME TO DISCHARGE OF CONCRETE

Air or Concrete Temperature (whichever is greater)	Maximum Time
80 to 90 Degrees F (27 to 30 Degrees C)	45 Minutes
70 to 79 Degrees F (21 to 26 Degrees C)	60 Minutes
40 to 69 Degrees F (5 to 20 degrees C)	90 Minutes

a. If an approved high-range water-reducer (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

3.3 CONCRETE APPEARANCE

A. Remix concrete mix showing either poor cohesion or poor coating of the coarse aggregate with paste. If this does not correct the condition, reject the concrete. If the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed, obtain changes in the concrete mix only by adjusting one or more of the following:

1. The gradation of aggregate.
2. The proportion of fine and coarse aggregate.
3. The percentage of entrained air, within the allowable limits.

B. Provide concrete for the work that results in a homogeneous structure which, when hardened, will have the required strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing. When concrete surfaces are stripped, the concrete, when viewed in good lighting from 10-ft away, shall be pleasing in appearance, and at 20-ft shall show no visible defects.

3.4 PLACING AND COMPACTING

A. Placing

1. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, excess water, dirt and other foreign materials from forms. Confirm that reinforcement and other embedded items are securely in place. Have a competent workman at the location of the placement who can assure that reinforcing steel and embedded items remain in designated locations while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Seal extremely porous subgrades in an approved manner.
2. Deposit concrete as near its final position as possible to avoid segregation due to rehandling or flowing. Place concrete continuously at a rate which ensures the concrete is being integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.
3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes suitable for pumping and submit for approval.
4. Remove temporary spreaders from forms when the spreader is no longer useful. Temporary spreaders may remain embedded in concrete only when made of galvanized metal or concrete and if prior approval has been obtained.
5. Do not place concrete for supported elements until concrete previously placed in the supporting element (columns, slabs and/or walls) has reached adequate strength.
6. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms with a suitable tool to bring the full surface of the mortar against the form. Prevent the formation of excessive surface voids.
7. Slabs
    a. After suitable bulkheads, screeds and jointing materials have been positioned, place the concrete continuously between construction joints beginning at a bulkhead, edge form, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.
    b. Avoid delays in casting. If there is a delay in casting, thoroughly spade and consolidate at the edge of that previously placed and the concrete placed after the delay to avoid cold joints. Then bring concrete to correct level and strike off with a straightedge. Use bullfloats or darbies to smooth the surface, leaving it free of humps or hollows.
    c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow 1 hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist so as to prevent cold joints.
8. Formed Concrete

a. Place concrete in forms using tremie tubes and taking care to prevent segregation. Bottom of tremie tubes shall preferably be in contact with the concrete already placed. Do not permit concrete to drop freely more than 4-ft. Place concrete for walls in 12 to 24-inch lifts, keeping the surface horizontal. If plasticized concrete is used, the maximum lift thickness may be increased to 7-ft and the maximum free fall of concrete not exceeding 15-ft.

9. Perform underwater concreting in conformity with the recommendations of ACI 304R. The tremie system shall be used to place underwater concrete. Use tremie pipes in the range of 8 to 12-inch in diameter and space at not more than 16-ft on centers nor more than 8-ft from an end form. Where concrete is being placed around a pipe, provide at least one tremie pipe on each side of each pipe. Where the tremie system is not practical, direct pumped concrete for underwater placement may be used subject to approval of the system including details by the Engineer.

B. Compacting

1. Consolidate concrete by vibration, puddling, spading, rodding or forking so that concrete is thoroughly worked around reinforcement, embedded items and openings and into corners of forms. Continuously perform puddling, spading, etc, along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting or planes of weakness.

2. Place and compact all concrete with mechanical vibrators. Obtain approval of the number, type and size of the units from the Engineer in advance of placing operations. Do not order concrete until sufficient approved vibrators (including standby units in working order) are on the job.

3. A minimum frequency of 7000 rpm is required for mechanical vibrators. Insert vibrators and withdraw at points from 18 to 30-in apart. At each insertion, vibrate sufficiently to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep a spare vibrator on the site during concrete placing operations.

4. Concrete Slabs: Consolidate concrete for slabs less than 8-in thick with vibrating screeds; slabs 8 to 12-in thick with internal vibrators and (optionally) with vibrating screeds. Always place vibrators into concrete vertically and do not lay horizontally or over.

5. Walls and Columns: Use internal vibrators (rather than form vibrators) unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. Insert the vibrators vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.

6. Amount of Vibration: Vibrators are to be used to consolidate properly placed concrete. Do not use vibrators to move or transport concrete in the forms. Continue vibration until:

a. Frequency returns to normal.

b. Surface appears liquefied, flattened and glistening.

c. Trapped air ceases to rise.

d. Coarse aggregate has blended into surface, but has not disappeared.

3.5 CURING AND PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B. Curing Methods

1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain specified temperature at the surface for a minimum of 7 days after placement. Use the following curing methods.

a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin wet cure as soon as concrete attains an initial set and maintain wet cure 24 hours a day.

b. Sheet Material Curing: Cover entire surface with sheet material. Securely anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.

c. Liquid Membrane Curing: Apply over the entire concrete surface except for surfaces to receive additional concrete. Curing compound shall NOT be placed on any concrete surface where additional concrete is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Apply curing compound as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Comply with the manufacturer's application recommendations.

2. Specified applications of curing methods.

a. Slabs for Water Containment Structures: Water curing only.

b. Slabs on Grade and Footings (not used to contain water): Water curing, sheet material curing or liquid membrane curing.

c. Structural Slabs (other than water containment): Water curing or liquid membrane curing.

d. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water curing.

e. Formed Surfaces: None if nonabsorbent forms are left in place 7 days. Water cure if absorbent forms are used. Sheet cured or liquid membrane cured if forms are removed prior to 7 days. Water cure exposed horizontal surfaces of formed walls or columns for 7 days or until next placement of concrete is made.

f. Concrete Joints: Water cured or sheet material cured.

C. Protect finished surfaces and slabs from the direct rays of the sun to prevent checking and crazing.

D. Cold Weather Concreting:

1. "Cold weather" is defined as a period when for more than 3 successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate the average daily temperature as the average of the highest and the lowest temperature during the period from midnight to midnight.

2. Conform cold weather concreting to ACI 306.1 and the additional requirements specified herein. Record temperatures at the concrete placement at 12 hour intervals (minimum).

3. Discuss a cold weather work plan with the Engineer. Discuss the methods and procedures proposed for use during cold weather including the production, transportation, placement, protection, curing and temperature monitoring of the concrete. Also discuss the procedures to be implemented upon abrupt changes in weather conditions or equipment failures. Do not begin cold weather concreting until the work plan is acceptable to the Engineer. Approval of the work Plan by the Engineer shall not relieve the Contractor of their sole responsibility for the quality of the concrete work produced.

4. During periods of cold weather, protect concrete to provide continuous warm, moist curing (with supplementary heat when required) for a total of at least 350 degree-days of curing.

a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (eg: 5 days at an average 70 degrees F = 350 degree-days).

b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.

5. Salt, manure or other chemicals shall not be used for protection.

6. Do not terminate the protection period for concrete being water cured during cold weather until at least 24 hours after water curing has been terminated.

E. Hot Weather Concreting

1. "Hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation estimated in accordance with ACI 305R, approaching or exceeding 0.2 lbs/sqft/hr.

2. Concrete placed during hot weather, shall be batched, delivered, placed, cured and protected in compliance with the recommendations of ACI 305R and the additional requirements specified herein.

a. Do not exceed 90 degrees F for the temperature of concrete being placed. The temperature of the concrete shall be such that it will cause no difficulties from loss of slump, flash set or cold joints.

b. Take all necessary precautions to promptly deliver, to promptly place the concrete upon its arrival at the job and to provide vibration immediately after placement.

c. The Engineer may direct the Contractor to immediately cover plastic concrete with sheet material.

3. Provide the Engineer with a work plan describing the methods and procedures proposed to use for concrete placement and curing during hot weather periods. Do not begin hot weather concreting until the work plan is acceptable to the Engineer. Approval of the work plan by the Engineer shall not relieve the Contractor of their sole responsibility for the quality of the concrete work produced.

3.6 REMOVAL OF FORMS

A. Except as otherwise specifically authorized by the Engineer, do not remove forms before the concrete has attained a strength of at least 30 percent of its specified design strength, nor before reaching the following number of day-degrees of curing (whichever is the longer):

TABLE 3
MINIMUM TIME TO FORM REMOVAL

Forms for	Degree Days
Beams and slabs	500
Walls / Vertical surfaces	100

(See definition of degree-days in Paragraph 3.5.D above).

B. Do not remove shores until the concrete has attained at least 70 percent of its specified design strength and has achieved sufficient strength to support safely its own weight and construction live loads.

3.7 INSPECTION AND FIELD TESTING

A. The batching, mixing, transporting, placing and curing of concrete are subject to the inspection of the Engineer at all times. Advise the Engineer of readiness to proceed at least 24 hours prior to each concrete placement. The Engineer or OWNER will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing steel and the alignment, cleanliness and tightness of formwork. Do not place concrete without the inspection and acceptance of the Engineer or OWNER.

B. Sets of field control cylinder specimens will be taken by the Engineer or OWNER Materials Testing Representative during the progress of the work, in compliance with ASTM C31. Take a minimum of one set of concrete test cylinders per day, one set for each 150 cubic yards of concrete, or one set for each 5,000 sq ft of surface area for slabs or walls of each class of concrete placed each day.

1. A "set" of test cylinders consists of five cylinders: one to be tested at 7 days and two to be tested and their strengths averaged at 28 days. The other two may be used for special tests at 3 days or to verify strength after 56 days if 28-day test results are low.

2. When the average 28-day compressive strength of the cylinders in any set falls below the specified design strength or below proportional minimum 7-day strengths (where proper relation between seven and 28-day strengths have been established by tests), change proportions, water content, or temperature conditions to achieve the required strengths.

C. Cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations, and furnish material and labor required for the purpose of taking concrete cylinder samples. Provide an appropriate number of curing boxes acceptable to the Engineer.

D. Slump tests will be made in the field immediately prior to placing the concrete. Make such tests in accordance with ASTM C143. Reject concrete if the slump is greater than the specified range.

E. Air Content: Test for air content shall be made on a fresh concrete samples. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If lightweight aggregates or aggregates with high absorptions are used, the latter test method shall be used.

F. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work.

G. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Perform coring and collect core samples at the locations indicated by the Engineer and repair all core holes. The testing of the cores will be at the expense of OWNER. OWNER will pay for collection and repair of cores if the test results meet the required specifications.

3.8 CONCRETE FINISHING

A. Walls

1. Type W-1 (Ordinary Wall Finish)

a. Patch tie holes.

b. Surface tolerance Class C as specified in ACI 117.

c. Knock off projections larger than ½-inch.

d. Patch defective areas.

2. Type W-2 (Smooth Wall Finish)

a. Patch tie holes.

b. Surface tolerance Class B as specified in ACI 117.

c. Grind off projections larger than ¼-inch.

d. Patch defective areas and repair rough spots resulting from form release agent failure or other reasons to provide smooth uniform appearance.

3. Type W-3 (Smooth Rubbed Wall Finish)

a. Surface tolerance Class A as specified in ACI 117.

b. Remove projections larger than 1/8-inch.

c. Only water curing will be permitted on walls being rubbed.

d. Perform rubbing while green concrete can be physically worked and smoothed without adding other materials, if structurally possible, the day following placement. Finish no later than 3 days after placement has been completed.

e. Remove forms at such a rate that finishing, form tie filling, removal of projections, and patching can be completed on same day forms are removed while curing wall.

f. After pointings have set sufficiently to permit working on surface, thoroughly saturate entire surface with water for period of 3 hours and rub until uniform surface is obtained.

g. Rub either by hand with carborundum stone of medium-coarse grade or abrasive of equal quality, or mechanically operated carborundum stone.

h. Obtain Engineer approval of mechanically operated carborundum stones before concrete finishing.

i. Do not use cement grout, other than cement paste drawn from the concrete itself by rubbing process.

j. Finishing past formed by rubbing by either brushing or floating as follows:

1) Brushing:

a) Carefully strike with clean brush.

b) Brush in long direction of surface being finished.

2) Floating:

a) Spread uniformly over surface and allow to reset.

b) Finish by floating with canvas, carpet face, or cork float, or rub down with dry burlap.

k. Continue water curing of wall during finishing operation in areas not being rubbed.

l. Move water curing onto rubbed areas as soon as water will not erode rubbed surface.

B. Slabs

1. General

a. Finish slab concrete per the requirements of ACI 302.1R.

b. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.

c. Do not use "jitterbugs" or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer or mortar, which will be weak and cause cracks or delamination, to accumulate.

d. Do not dust surface with dry materials.

e. Use evaporation retardant.

f. Round off edges of slabs with steel edging tool, except where cove finish is shown. Use a steel edging tool with a ¼-inch radius for slabs subject to wheeled traffic.

2. Type S-1 (Steel Troweled Finish)

a. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation. Use evaporation retardant.

b. While concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, wood float to true, even plane with no coarse aggregate visible.

c. Use sufficient pressure on wood floats to bring moisture to surface.

d. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.

e. Burnish surface with an additional troweling. Final troweling shall produce ringing sound from trowel.

f. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.

g. Power Finishing:

1) Approved power machine may be used in lieu of hand finishing in accordance with directions of machine manufacturer.

2) Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots in slab.

3) Do first steel troweling for slab S-1 finish by hand.

3. Type S-2 (Wood Float Finish)

a. Finish slab to receive fill and mortar setting bed by screeding with straightedges to bring surface to required finish plane.

b. Wood float finish to compact and seal surface.

c. Remove laitance and leave surface clean.

d. Coordinate with other finish procedures.

4. Type S-3 (Underside Elevated Slab Finish)

a. When forming is removed, grind off projections on underside of slab and patch defective areas.

5. Type S-4 (Broomed Finish)

a. Finish as specified for Type S-1 floor finish, except omit final troweling and finish surface by drawing fine-hair broom lightly across surface.

b. Broom in same direction and parallel to expansion joints, or, in the case of inclined slabs, perpendicular to slope, except for round roof slab.

6. Type S-5 (Sidewalk Finish)

a. Slope sidewalk down ¼-inch per foot away from structures, unless otherwise shown.

b. Strike off surface by means of strike board and float with wood or cork float to true plane, then flat steel trowel before brooming.

c. Broom surface at right angles to direction of traffic or as shown.

d. Lay out sidewalk surface in blocks, as shown or as directed by Engineer, with grooving tool.

C. Beams and Columns

1. General: Inject cracks with crack repair epoxy. Patch and repair defective areas.

2. Type B-1: Match wall Type W-1.

3. Type B-2: Match wall Type W-2.

4. Type B-3:

a. Repair rock pockets.

b. Fill air voids.

c. Match wall Type W-3.

5. Type C-1: Match wall Type W-1.

6. Type C-2: match wall Type W-2.

7. Type C-3:

a. Repair rock pockets.

b. Fill air voids.

c. Match wall Type W-3.

3.9 FAILURE TO MEET REQUIREMENTS

A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer has the right to require changes in proportions outlined to apply to the remainder of the work. Furthermore, the Engineer has the right to require additional curing on those portions of the structure represented by the test specimens which failed. The cost of such additional curing shall be at the Contractor's expense. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer has the right to require strengthening or replacement of those portions of the structure which fail to develop the required strength. The cost of all such core borings and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be entirely at the expense of the Contractor. In such cases of failure to meet strength requirements confer with the Engineer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in ASTM C94 is the Contractor in this Section.

B. When the tests on control specimens of concrete fall below the specified strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In the case of cores not indicating adequate strength, the Engineer, in addition to other recourses, may require, at the Contractor's expense, load tests on any of the slabs, beams, piles, caps, and columns in which such concrete was used. Tests need not be made until concrete has aged 60 days.

C. Should the strength of test cylinders fall below 60 percent of the required minimum 28-day strength, the concrete shall be rejected and shall be removed and replaced.

D. Any concrete found to be defective from any cause whatsoever, at any time prior to Final Acceptance of the Work, shall be removed and replaced, or repaired at the expense of the Contractor.

3.10 PATCHING AND REPAIRS

A. It is the intent of this Section to require quality work, including adequate forming, proper mixture and placement of concrete and curing, so completed surfaces will require no patching.

B. Repair defective concrete and honeycombed areas using methods complying with industry standards which meet the approval of the Engineer.

C. As soon as the forms have been stripped and the concrete surfaces exposed, remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete, to approval of the Engineer.

D. Immediately after removal of forms remove plugs and break off metal ties. Promptly fill holes upon stripping as follows: Moisten the hole with water, followed by a 1/16-in brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spiderweb. Trowel smooth with heavy pressure. Avoid burnishing.

E. When patching exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color if necessary by addition of proper amounts of white cement. Rub lightly with a fine Carborundum stone at an age of 1 to 5 days if necessary to bring the surface down with the parent concrete. Exercise care to avoid damaging or staining the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

3.11 CONCRETE SCHEDULE

A. The following (Table 4) are the general applications for the various concrete classes and design strengths:

TABLE 4
CONCRETE SCHEDULE

Class	Design Strength (psi)	Description
A	3,000	Thrust blocking, slabs, curbs, and pavements
AA	4,000	Walls, beam systems, columns, and all other structural concrete
AAA	5,000	Pre-stressed concrete

END OF SECTION 03300

SECTION 03600
GROUTING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 0130, shop drawings and product data showing materials of construction and details of installation for:

1. Commercially manufactured nonshrink cementitious grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.

2. Commercially manufactured nonshrink epoxy grout. The submittal shall include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to required ASTM standards and Material Safety Data Sheet.

3. Cement grout. The submittal shall include the type and brand of the cement, the gradation of the fine aggregate, product data on any proposed admixtures and the proposed mix of the grout.

4. Concrete grout. The submittal shall include data as required for concrete and for fiber reinforcement as delineated in these Specifications. This includes the mix design, constituent quantities per cubic yard and the water/cement ratio.

B. Laboratory Test Reports

1. Submit laboratory test data as required under Section 03300 for concrete to be used as concrete grout.

C. Certifications

1. Certify that commercially manufactured grout products and concrete grout admixtures are suitable for use in contact with potable water after 30 days curing.

D. Qualifications

1. Grout manufacturers shall submit documentation that they have at least 10 years experience in the production and use of the proposed grouts which they will supply.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes

2. ASTM C579 - Standard Test Method for Compressive Strength of Chemical Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes

3. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures

4. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

B. U.S. Army Corps of Engineers Standard (CRD)

1. CRD C-621 - Corps of Engineers Specification for Nonshrink Grout

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Qualifications

1. Grout manufacturer shall have a minimum of 10 years experience in the production and use of the type of grout proposed for the work.

B. Pre-installation Conference

1. Well in advance of grouting, hold a pre-installation meeting to review the requirements for surface preparation, mixing, placing and curing procedures for each product proposed for use. Parties concerned with grouting shall be notified of the meeting at least 10 days prior to its scheduled date.

C. Services of Manufacturer's Representative

1. A qualified field technician of the nonshrink grout manufacturer, specifically trained in the installation of the products, shall attend the pre-installation conference and shall be present for the initial installation of each type of nonshrink grout. Additional services shall also be provided, as required, to correct installation problems.

D. Field Testing

1. All field testing and inspection services required shall be provided by the Owner. The Contractor shall assist in the sampling of materials and shall provide any ladders, platforms, etc, for access to the work. The methods of testing shall comply in detail with the applicable ASTM Standards.

2. The field testing of Concrete Grout shall be as specified for concrete in Section 03300.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.

B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 6 months or the manufacturer's recommended storage time, whichever is less.

C. Material which becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional expense to the Owner.

D. Nonshrink cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.

E. Nonshrink epoxy grouts shall be delivered as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

1.07 DEFINITIONS

A. Nonshrink Grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

PART 2 PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.

B. Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.02 MATERIALS

A. Nonshrink Cementitious Grout

1. Nonshrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD C-621. Grouts shall be portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Nonshrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.
   a. General purpose nonshrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; MasterFlow 100 by Master Builders Solutions,; Gilco Construction Grout by Gifford Hill & Co.; Euco NS by The Euclid Chemical Co.; NBEC Grout by U. S. Grout Corp. or equal.
   b. Flowable (Precision) nonshrink cementitious grout shall conform to the standards stated above and shall be Masterflow 928 by Master Builders Solutions; Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by

Sika Corp.; Supreme Grout by Gifford Hill & Co.; Five Star Grout by U. S. Grout Corp. or equal.

B. Nonshrink Epoxy Grout

1. Nonshrink epoxy-based grout shall be a pre-proportioned, three component, 100 percent solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in 7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of 30×10^{-6} when tested in conformity with ASTM C531. The grout shall be Ceilcote 648 CP by Master Builders Solutions; Five Star Epoxy Grout by U.S. Grout Corp.; Sikadur 42 Grout-Pak by Sika Corp.; High Strength Epoxy Grout by the Euclid Chemical Co. or equal.

C. Cement Grout

1. Cement grouts shall be a mixture of one part portland cement conforming to ASTM C150, Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout

1. Concrete grout shall conform to the requirements of Section 033000 except as specified herein. It shall be proportioned with cement, pozzalan, coarse and fine aggregates, water, water reducer and air entraining agent to produce a mix having an average strength of 2900 psi at 28 days, or 2500 psi nominal strength. Coarse aggregate size shall be 3/8-in maximum. Slump should not exceed 5-in and should be as low as practical yet still retain sufficient workability.

2. Synthetic reinforcing fibers shall be added to the concrete grout mix at the rate of 1.5 lbs of fibers per cubic yard of grout. Fibers shall be added from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

E. Water

1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

PART 3 EXECUTION

3.01 PREPARATION

A. Grout shall be placed over cured concrete which has attained its full design strength unless otherwise approved by the Engineer.

B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may effect the bond or performance of the grout.

C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the air line to prevent oil from being blown onto the surface.

D. Remove all loose rust, oil or other deleterious substances from metal embedments or bottom of baseplates prior to the installation of the grout.

E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the Engineer. Upon completion of the 24 hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the Engineer for each specific location of grout installation.

F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.

G. Construct grout forms or other leakproof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.

1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.

H. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.

I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Engineer.

3.02 INSTALLATION - GENERAL

A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.

B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.

C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and for at least 24 hours thereafter or as recommended by the grout manufacturer, whichever is longer. Take precautions to

minimize differential heating or cooling of baseplates and grout during the curing period.

D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 60 and 90 degrees F range.

E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.

F. Reflect all existing underlying expansion, control and construction joints through the grout.

3.03 INSTALLATION - CEMENT GROUTS AND NONSHRINK CEMENTITIOUS GROUTS

A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Engineer.

B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is recommended. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.

C. Placements greater than 3-in in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.

D. Place grout into the designated areas in a manner which will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement should proceed in a manner which will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

E. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.

F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise approved by the Engineer. Finish this surface with a wood float (brush) finish.

G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION - NONSHRINK EPOXY GROUTS

A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not overmix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.

B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.

C. Place grout into the designated areas in a manner which will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.

D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.

E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.

F. Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

3.05 INSTALLATION - CONCRETE GROUT

A. Screed underlying concrete to the grade shown on the Drawings. Provide the surface with a broomed finish, aligned to drain. Protect and keep the surface clean until placement of concrete grout.

B. Remove the debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Wash the slab using a strong jet of water. Flushing of debris into drain lines will not be permitted.

C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout. Saturation may be maintained by ponding, by the use or soaker hoses, or by other methods acceptable to the Engineer. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in thick cement paste. (A bonding grout composed of 1 part portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.)

D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to ensure high and low spots are eliminated. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.

E. Provide grout control joints as indicated on the Drawings.

F. Finish and cure the concrete grout as specified for cast-in-place concrete.

3.06 SCHEDULE

A. The following list indicates where the particular types of grout are to be used:

1. General purpose nonshrink cementitious grout: Use at all locations where non shrink grout is called for on the plans except for base plates greater in area than 3-ft wide by 3-ft long and except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.

2. Flowable nonshrink cementitious grout: Use under all base plates greater in area than 3-ft by 3-ft. Use at all locations indicated to receive flowable nonshrink grout by the Drawings. The Contractor, at his/her option and convenience, may also substitute flowable nonshrink grout for general purpose nonshrink cementitious grout.

3. Nonshrink epoxy grout: Use for the setting of anchor rods, anchor bolts and reinforcing steel in concrete and for all locations specifically indicated to receive epoxy grout.

4. Cement grout: Cement grout may be used for grouting of incidental base plates for structural and miscellaneous steel such as post base plates for platforms, base plates for beams, etc. It shall not be used when nonshrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.

END OF SECTION 03600

SECTION 05120
STRUCTURAL STEEL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Structural steel framing members, base plates and angles.

1.02 SUBMITTALS

A. Submittals shall be made in accordance with Section GENERAL REQUIREMENTS, and the requirements of this Section.

B. Shop Drawings: Indicate sizes, spacing, and locations of structural members, bolted connections, and welded connections.

1.03 QUALITY ASSURANCE

A. Fabricate structural steel members in accordance with AISC – Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.

B. Perform design under direct supervision of a Professional Structural Engineer licensed in the State of Alabama.

C. Shop Drawings shall be stamped by a Professional Engineer registered in the State of Alabama.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural Steel Members: ASTM A36.

B. Bolts, Nuts, and Washers: ASTM A325.

C. Anchor Bolts: ASTM A307.

D. Welding Materials: AWS D1.1; type required for materials being welded.

E. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi at 28 days.

F. Shop and Touch-up Primer: SSPC 15, Type 1, Red Oxide.

G. Finish Paint shall be in accordance with **Section 09900 PAINTING.**

2.02 FABRICATION

A. Continuously seal joined members by continuous welds. Grind exposed welds smooth.

2.03 FINISH

A. Perform preparation and coating of structural steel in accordance with **Section PAINTING.**

B. Prepare structural component surfaces in accordance with SSPC SP 2.

C. Shop prime and finish paint structural steel members. Do not prime surfaces that will be field welded. See **Section 09900 PAINTING** for finish coat. Finish coat color to be selected by owner.

PART 3 EXECUTION

3.01 EXECUTION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 ERECTION

A. Allow for erection loads. Provide temporary bracing to maintain framing in alignment until completion of erection and installation of permanent bridging and bracing.

B. Field weld components indicated on drawings.

C. Do not field cut or alter structural members without approval of Engineer.

D. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.

E. Grout under base plates.

3.03 FIELD QUALITY CONTROL

A. Field inspection of members, connections, and torquing.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Steel framing and supports for ceiling-hung toilet compartments.
2. Steel framing and supports for operable partitions.
3. Steel framing and supports for overhead doors and grilles.
4. Steel framing and supports for mechanical and electrical equipment.
5. Steel framing and supports for applications where framing and supports are not specified in other Sections.
6. Prefabricated building columns.
7. Shelf angles.
8. Metal ladders.
9. Ladder safety cages.
10. Metal floor plate[and supports].
11. Structural-steel door frames.
12. Miscellaneous steel trim including steel angle corner guards, steel edgings, and loading-dock edge angles.
13. Metal bollards.
14. Vehicular barrier cable systems.
15. Abrasive metal [nosings] [treads] [and] [thresholds].

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where

they are not specified in other Sections.

C. Related Requirements:

1. Section 04200 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.

2. Section 05120 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.

1.03 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.04 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.

2. Fasteners.

3. Shop primers.

4. Shrinkage-resisting grout.

5. Prefabricated building columns.

6. Slotted channel framing.

7. Manufactured metal ladders.

8. Ladder safety cages.

9. Alternating tread devices.

10. Metal bollards.

11. Vehicular barrier cable systems.

12. Abrasive metal [nosings] [treads] [and] [thresholds].

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for ceiling-hung toilet compartments.
2. Steel framing and supports for operable partitions.
3. Steel framing and supports for overhead doors and grilles.
4. Steel framing and supports for countertops.
5. Steel tube reinforcement for low partitions.
6. Steel framing and supports for mechanical and electrical equipment.
7. Steel framing and supports for applications where framing and supports are not specified in other Sections.
8. Steel shapes for supporting elevator door sills.
9. Steel girders for supporting wood frame construction.
10. Steel pipe columns for supporting wood frame construction.
11. Prefabricated building columns.
12. Shelf angles.
13. Metal ladders.
14. Ladder safety cages.
15. Metal floor plate and supports.
16. Elevator pit sump covers.
17. Structural-steel door frames.
18. Miscellaneous steel trim including steel angle corner guards, steel edgings and loading-dock edge angles.
19. Metal bollards.
20. Loose steel lintels.
21. Vehicular barrier cable systems.

C. Samples for Verification: For each type and finish of extruded nosing and tread.

D. Delegated-Design Submittal: For ladders and vehicular barrier cable systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

B. Mill Certificates: Signed by stainless steel manufacturers, certifying that products

furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Research Reports: For post-installed anchors.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.07 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Structural Performance of Aluminum Ladders: Ladders, including landings, shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

B. Structural Performance of Alternating Tread Devices: Alternating tread devices shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load: 100 lbf/sq. ft.
2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Alternating Tread Device Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Comply with applicable railing loadings in Section 05 52 13 "Aluminum Railings."

2.02 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Stainless Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 316L.

D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 316L..

E. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

F. Rolled-Stainless Steel Floor Plate: ASTM A793.

G. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.

H. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

I. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

J. Zinc-Coated Steel Wire Rope: ASTM A741.

1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

K. Stainless Steel Wire Rope: Wire rope manufactured from stainless steel wire complying with ASTM A492, Type 316.

1. Wire Rope Fittings: Stainless steel connectors, Type 316, with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

L. Steel Prestressing Strand: ASTM A416/A416M, Grade 270, low-relaxation, seven-wire, with 0.9-lb/sq. ft.zinc coating.

1. Steel Prestressing Strand Fittings: Hot-dip galvanized-steel anchors and connectors with capability to sustain, without failure, a load equal to minimum breaking strength of steel prestressing strand with which they are used.

2. Material: Galvanized steel, ASTM A653/A653M, structural steel, with G90 coating; 0.108-inch nominal thickness.

M. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

N. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.

O. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.

P. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.

Q. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

R. Bronze Extrusions: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).

S. Bronze Castings: ASTM B584, Alloy UNS No. C83600 (leaded red brass) or UNS No. C84400 (leaded semired brass).

T. Nickel Silver Extrusions: ASTM B151/B151M, Alloy UNS No. C74500.

U. Nickel Silver Castings: ASTM B584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.03 FASTENERS

A. General: Unless otherwise indicated, provide Type 316 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum stainless steel.
2. Provide bronze fasteners for fastening bronze.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers

D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 2.

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2] stainless steel bolts, ASTM F593, and nuts, ASTM F594.

2.04 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 09 90 00 Painting and Coatings

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.05 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.06 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts for units installed after concrete is placed.

C. Fabricate supports for operable partitions from continuous steel beams of sizes [indicated] [recommended by partition manufacturer] with attached bearing plates, anchors, and braces as [indicated] [recommended by partition manufacturer]. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Provide bearing plates welded to beams where indicated.

2. Drill or punch girders and plates for field-bolted connections where indicated.

E. Galvanize miscellaneous framing and supports where indicated.

F. Prime miscellaneous framing and supports with [zinc-rich primer] where indicated.

2.07 PREFABRICATED BUILDING COLUMNS

A. Source Limitations: Obtain prefabricated building column from single source from single manufacturer.

B. General: Provide prefabricated building columns consisting of load-bearing structural-steel members protected by concrete fireproofing encased in an outer non-load-bearing steel shell. Fabricate connections to comply with details shown or as needed to suit type of structure indicated.

C. Fire-Resistance Ratings: Provide prefabricated building columns listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for ratings indicated, based on testing in accordance with ASTM E119.

1. Fire-Resistance Rating: [4 hours] [3 hours] [2 hours] [As indicated].

2.08 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

1. Provide mitered and welded units at corners.

2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize [and prime] shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with [zinc-rich primer.]

2.09 METAL LADDERS

A. General:

1. Comply with ANSI A14.3[, except for elevator pit ladders].

2. For elevator pit ladders, comply with ASME A17.1/CSA B44.

B. Aluminum Ladders:

1. Source Limitations: Obtain aluminum ladders from single source from single manufacturer.

2. Siderails: Continuous extruded-aluminum channels or tubes, not less than 2-1/2 inches deep, 3/4 inch wide, and 1/8 inch thick.

3. Rungs: Extruded-aluminum tubes, not less than 3/4 inch deep and not less than 1/8 inch thick, with ribbed tread surfaces.

4. Fit rungs in centerline of siderails; fasten by welding or with stainless steel fasteners or brackets and aluminum rivets.

5. Provide platforms as indicated fabricated from pressure-locked aluminum bar grating or extruded-aluminum plank grating, supported by extruded- aluminum framing. Limit openings in gratings to no more than 1/2 inch in least dimension.

6. Provide minimum 72-inch- high, hinged security door with padlock hasp at foot of ladder to prevent unauthorized ladder use.

7. All ladders into vaults, tanks or pits shall have dual side safety rail extensions posts to a minimum of 36" above the access level of the ladder.

2.10 LADDER SAFETY CAGES

A. General:

1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless steel fasteners.
2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches
o.c. between primary hoops.
3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless steel fasteners unless otherwise indicated.

B. Ladder Safety Cages:

1. Primary Hoops: 1/4-by-4-inch flat bar hoops.
2. Secondary Intermediate Hoops: 1/4-by-2-inch flat bar hoops.
3. Vertical Bars: 1/4-by-2-inch flat bars secured to each hoop.

2.11 METAL SHIPS' LADDERS AND PIPE CROSSOVERS

A. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.

1. Treads shall be not less than 5 inches exclusive of nosing or less than 8-1/2 inches including the nosing, and riser height shall be not more than 9-1/2 inches.
2. Fabricate ships' ladders including railings from aluminum.
3. Fabricate treads and platforms from extruded- aluminum grating. Limit openings in gratings to no more than 1/2 inch in least dimension.
4. Comply with applicable railing requirements in Section 05 52 13 "Aluminum Railings."

2.12 METAL FLOOR PLATE

A. Fabricate from [rolled-steel floor] [rolled-stainless steel floor] [rolled-aluminum-alloy tread] [abrasive-surface floor] plate of thickness indicated below:

1. Thickness: [1/8 inch] [3/16 inch] [1/4 inch] [5/16 inch] [3/8 inch] [As indicated].

B. Provide grating sections where indicated, fabricated from [welded or pressure-locked steel bar] [pressure-locked stainless-steel bar] [pressure-locked aluminum bar] [extruded-aluminum plank] grating. Limit openings in gratings to no more than [1/2 inch] [3/4 inch] [1 inch] in least dimension.

C. Provide [steel] [stainless steel] [aluminum] angle supports as indicated.
D. Include [steel] [stainless steel] [aluminum] angle stiffeners, and fixed and removable sections as indicated.

E. Provide flush [steel] [stainless steel] [aluminum] bar drop handles for lifting removable sections, one at each end of each section.

2.13 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.

1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Galvanize[and prime] [exterior]steel frames.

D. Prime [exterior]steel frames with [zinc-rich primer.]

2.14 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize[and prime] [exterior]miscellaneous steel trim.

D. Prime [exterior]miscellaneous steel trim with [zinc-rich primer.]

2.15 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe.

2.16 PIPE & DOWNSPOUT GUARDS

A. Fabricate [pipe] [downspout] guards from 3/8-inch- thick by 12-inch- wide, [steel] [stainless steel, ASTM A480/A480M, No. 4 finish] plate, bent to fit flat against the wall or column at both ends and to fit around pipe with 2-inch clearance between pipe and pipe guard. Drill each end for two 3/4-inch anchor bolts.

B. Galvanize[and prime] steel [pipe] [downspout] guards.

C. Prime steel [pipe] [downspout] guards with [zinc-rich primer.]

2.17 ABRASIVE METAL [NOSINGS] [TREADS] [AND] [THRESHOLDS]

A. Cast-Metal Units: Cast [iron] [aluminum] [bronze (leaded red or semired brass)] [nickel silver (leaded nickel bronze)], with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Source Limitations: Obtain units from single source from single manufacturer.
2. Nosings: Cross-hatched units, 4 inches wide with [1/4-inch] [1-inch] lip, for casting into concrete.
3. Treads: Cross-hatched units, full depth of tread with 3/4-by-3/4-inch nosing, for application over bent plate treads or existing stairs.
4. Thresholds: Fluted-saddle-type units, 5 inches wide by 1/2 inch high, with tapered edges.

B. Extruded Units: Aluminum with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

1. Source Limitations: Obtain units from single source from single manufacturer.
2. Provide ribbed units, with abrasive filler strips projecting 1/16 inch above aluminum extrusion.
3. Nosings:
   a. Square-back units, [1-7/8 inches] [3 inches] [4 inches] wide, for casting into concrete steps.
   b. Beveled-back units, [3 inches] [4 inches] wide with 1-3/8-inch lip, for surface mounting on existing stairs.
   c. Two-piece units, 3 inches wide, with subchannel for casting into concrete steps.
4. Treads: [Square] [Beveled]-back units, full depth of tread with 1-3/8-inch lip, for application over existing stairs.

C. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise

indicated. Provide closer spacing if recommended by manufacturer.

1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.

D. Apply bituminous paint to concealed surfaces of cast-metal units.

E. Apply clear lacquer to concealed surfaces of extruded units.

2.18 METAL DOWNSPOUT BOOTS

A. Source Limitations: Obtain downspout boots from single source from single manufacturer.

B. Provide downspout boots made from cast [iron] [aluminum] in heights indicated with inlets of size and shape to suit downspouts. Provide units with flanges and holes for countersunk anchor bolts.

1. Outlet: [Vertical, to discharge into pipe] [Horizontal, to discharge into pipe] [At 35 degrees from horizontal, to discharge onto splash block or pavement].

C. Prime cast-iron downspout boots with [zinc-rich primer.]

2.19 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with zinc-rich primer.

2.20 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.21 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.22 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 3, "Power Tool Cleaning." UNO below.

1. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.23 ALUMINUM FINISHES Verify with Arch

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size

limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.03 INSTALLATION OF PREFABRICATED BUILDING COLUMNS

A. Install prefabricated building columns to comply with ANSI/AISC 360, "Specifications for Structural Steel Buildings," and with requirements applicable to listing and labeling for fire-resistance rating indicated.

3.04 INSTALLATION OF METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

1. Do not fill removable bollards with concrete.

B. Anchor bollards to existing construction with anchor bolts] [through bolts. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least 4 inches in concrete.

C. Anchor internal sleeves for removable bollards in concrete by inserting in pipe sleeves preset into concrete. Fill annular space around internal sleeves solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward internal sleeve.

D. Anchor internal sleeves for removable bollards in place with concrete footings. Center and align sleeves in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace sleeves in position until concrete has cured.

E. Place removable bollards over internal sleeves and secure with 3/4-inch machine bolts and nuts. After tightening nuts, drill holes in bolts for inserting padlocks. Owner furnishes padlocks.

3.05 INSTALLATION OF NOSINGS, TREADS, AND THRESHOLDS

A. Center nosings on tread widths unless otherwise indicated.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

C. Seal thresholds exposed to exterior with elastomeric sealant to provide a watertight installation.

3.06 INSTALLATION OF CAST-IRON WHEEL GUARDS

A. Anchor wheel guards to concrete or masonry construction to comply with manufacturer's written instructions. Fill cores solidly with concrete.

3.07 INSTALLATION OF BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.08 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to

comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 90 00 Painting and Coating

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

SECTION 09900
PAINTING

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes surface preparation and field painting of the following:

1. Exposed exterior items and surfaces.

2. Exposed interior items and surfaces.

3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.

B. Paint exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Engineer or Owner will select from standard colors and finishes available.

1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.

1. Prefinished items include the following factory-finished components:

a. Finished mechanical and electrical equipment.

b. Light fixtures.

c. Distribution cabinets.

2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:

3. Finished metal surfaces include the following:

    a. Anodized aluminum.

4. Operating parts include moving parts of operating equipment and the following:

    a. Valve and damper operators.

    b. Linkages.

    c. Sensing devices.

    d. Motor and fan shafts.

5. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

D. Alternates: Refer to Division 1 Section "Alternates" for description of Work in this Section affected by alternates.

1.03 DEFINITIONS

A. General: Standard Coating Terms defined in ASTM D 16 apply to this Section.

1. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.

2. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.

3. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.

4. Full gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.04 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.

1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.

3. Performance Criteria: Provide a side by side comparison of performance data should the Contractor propose to use materials other than those listed in the standard of quality.

B. Samples for Verification: Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.

1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.

2. Provide a list of materials and applications for each coat of each sample. Label each sample for location and application.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.

B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:

1. Product name or title of material.

2. Product description (generic classification or binder type).

3. Manufacturer's stock number and date of manufacture.

4. Contents by volume, for pigment and vehicle constituents.

5. Thinning instructions.

6. Application instructions.

7. Color name and number.

8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.07 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products in the paint schedules.

B. Manufacturers Names: The following manufacturers are referred to in the paint schedules by use of shortened versions of their names, which are shown in parentheses:

1. Tnemec Company, Inc.

2. Or approved Equal

Technical information may be obtained from the following:

SteelCon Coating Systems, Inc.
2100 3rd Ave South
Irondale, Alabama 35210
Phone: 205-951-2086

2.02 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

C. Colors: Provide custom colors of the finished paint as indicated on the Room Finish Schedule and Legend and the Piping Schedule in Section PIPING AND ACCESSORIES.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.

1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.

2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify the Engineer about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Provide barrier coats over incompatible existing coatings or remove and re-prime.

2. Cementitious Materials Non-Submerged: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.

a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.

b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.

3. Concrete – Submerged or Intermittently Submerged

a. Allow concrete to cure for not less than 30 days prior to painting.

b. Abrasive blast to remove all curing compounds, hardeners, laitance, and provide an adequate surface profile (Reference SSPC-SP 13 / ICRI CSP 5).

4. Concrete – Secondary Containment (Previously Painted)

a. Pressure wash to remove all contaminants. Verify that the substrate and remaining coatings are a neutral PH.

b. Mechanically in accordance with SSPC-SP 7 Bush-Off Blast Cleaning to remove all loose existing coating and to provide a angular profile to the remaining intact coating.

c. Rout our cracks to sound material.

3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.

a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.

b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases, and paneling.

c. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.

d. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.

4. Ferrous Metals:

a. New Steel – Non Immersion Service (Shop or Field Primed): Prior to abrasive blasting all surfaces shall be cleaned of all oil, grease, as well as any other foreign matter in accordance with SSCP-SP 1 Solvent Cleaning. All surfaces shall be abrasive blast cleaned in accordance with SSPC-SP 6 Commercial Blast Cleaning. All surfaces shall be clean and dry and have a surface profile of 1.5 – 2.5 mils. Cleaned surfaces shall be primed within eight hours of surface preparation and prior to the formation or corrosion by products. After erection and prior to application of the finish coat(s) all surface shall be cleaned of all dirt, dust, oil, grease as well as any other foreign matter. All areas of damage to the shop

primer shall be cleaned in accordance with SSPC-SP 6 Commercial Blast Cleaning. All edges shall be feathered. Damaged shop primer shall be spot primed with the same primer specified for use on the item.

b. New Steel – Immersion Service (Shop or Field Primed): Prior to abrasive blasting all surfaces shall be cleaned of all oil, grease, as well as any other foreign matter in accordance with SSCP-SP 1 Solvent Cleaning. All surfaces shall be abrasive blast cleaned in accordance with SSPC-SP 10 Near White Blast Cleaning. All surfaces shall be clean and dry and have a surface profile of 1.5 – 2.5 mils. Cleaned surfaces shall be primed within eight hours of surface preparation and prior to the formation or corrosion by products. After erection and prior to application of the finish coat(s) all surface shall be cleaned of all dirt, dust, oil, grease as well as any other foreign matter. All areas of damage to the shop primer shall be cleaned in accordance with SSPC-SP 10 Near White Blast Cleaning. All intact shop primer shall be brush blasted to provide a uniform surface profile of at least 1.0 mil. All edges shall be feathered. Damaged shop primer shall be spot primed with the same primer specified for use on the item.

c. Previously Painted Ferrous Metal (Non-Immersion Service): All surfaces shall be high pressure water washed (minimum 3,500 psi with rotating 0° tip) to remove all dirt, dust, chalk, loose paint, as well as any other foreign matter. All areas of failing paint and corrosion shall be prepared in accordance with SSPC-SP 11 Power Tool Cleaning to Bare Metal. All edges shall be feathered. Spot primer shall be applied within eight hours of surface preparation and prior to the formation of corrosion by products.

5. Ductile Iron Pipe:

a. New Ductile Iron Pipe – Non Immersion Service (Shop Primed): Ductile Iron Pipe shall not have ever been coated with asphalt. Prior to abrasive blasting all surfaces shall be cleaned of all oil, grease, as well as any other foreign matter in accordance with SSPC-SP 1 Solvent Cleaning. Uniformly abrasive blast the entire exterior surface using angular abrasive to an NAPF 500-03-04: "External Pipe Surface Condition". When viewed without magnification, the exterior surfaces shall be free of all visible dirt, dust, loose annealing oxide, loose mold coating, rust and other foreign matter. Tightly adherent annealing oxide, mold coating and rust staining may remain on the surface provided they cannot be removed by lifting with a dull putty knife. Any area where rust reappears before application shall be re-blasted.

b. Previously Painted Ductile Iron Pipe (Non-Immersion Service): All surfaces shall be high pressure water washed (minimum 3,500 psi with rotating 0° tip) to remove all dirt, dust, chalk, loose paint, as well as any other foreign matter. All areas of failing paint and corrosion shall be prepared in accordance with SSPC-SP 11 Power Tool Cleaning to Bare Metal. All edges shall be feathered. Spot primer shall be applied within eight hours of surface preparation and prior to the formation of corrosion by products.

6. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Abrasive blast to remove passivation and to provide a uniform 1.0 mil anchor profile.

D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.

1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.

2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.

3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.03 APPLICATION

A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.

1. Paint colors, surface treatments, and finishes are indicated in the schedules.

2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

3. Provide finish coats that are compatible with primers used.

4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.

5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.

7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.

9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.

10. Sand lightly between each succeeding enamel or varnish coat.

B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.

2. Omit primer on metal surfaces that have been shop primed and touchup painted.

3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.

4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.

2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.

3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.

D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.

F. Mechanical items to be painted include, but are not limited to, the following:

1. Piping, pipe hangers, and supports.

4. Heat Exchangers

5. Tanks

6. Ductwork

7. Insulation

6. Motors and mechanical equipment.

7. Accessory items.

G. Electrical items to be painted include, but are not limited to, the following:

1. Conduit and fittings.

2. Switchgear.

3. Panelboards.

H. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

I. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

J. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.

K. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

L. Pipe Identification Painting:

1. Color code nonsubmerged metal and plastic piping except electrical conduit. Paint fittings and valves the same color as pipe.

2. Piping Color Coding: Suggested colors are shown on the Piping Schedule. The Owner shall make final color selections. Provide colors selected by the Owner at no additional cost.

3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center, with identification labels applied to each exposed run of pipe as specified herein.

4. Pipe Supports: Pipe supports shall be painted the same color as the piping they support.

M. Piping Labels:

1. Identification labels shall bear full piping system name as specified in the Piping Schedule shown.

2. Install separate flow directional arrows with each label.

3. Include black lettering on OSHA safety yellow self-adhesive vinyl or vinyl cloth.

4. Lettering Height: Meet ANSI A13.1.

5. Label and Adhesive: Long lasting, resistant to moisture, oils, solvents, and weathering, meeting OSHA requirements.

6. Locate labels at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 18 feet on center, with at least one label applied to each exposed run of pipe.

7. Manufacturers:

   a. W.H. Brady Co., Milwaukee, WI.

   b. Seton Nameplate Corp., New Haven, CT.

3.04 FIELD QUALITY CONTROL

A. Apply coatings in accordance with manufacturer's printed data sheets. Allow sufficient time between coats to insure complete curing of previously applied coatings.

B. Dry Film Thickness Testing:

1. Check each coat for correct millage. Do not take DFT measurements until coatings have cured a minimum of eight (8) hours.

2. After repaired and recoated areas have cured sufficiently, final tests will be conducted by the Engineer, measuring coating thickness, as specified in mils, with a magnetic type dry film thickness gauge as specified per SSPC-PA2. The Contractor shall furnish the gauge.

3. Test finish coats (except zinc primers, galvanized, and elastomeric coatings in excess of 25.0 mils MDFT), for holidays and discontinuities using a low voltage, wet sponge holiday detector (Tinker & Rasor M-1 or equal) per manufacturer's instructions. Contractor shall furnish the holiday detector.

4. Testing of finish coats in excess of 25.0 mils MDFT, where required, shall be done using a high voltage holiday detector (Tinker & Rasor Model AP or equal) per manufacturer's instructions. Contractor shall furnish the holiday detector.

C. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with manufacturer's recommendations.

2. Repair fusion bonded coatings as recommended by original applicator. Applicator shall provide liquid repair kits for this purpose as recommended by coating manufacturer.

3. Apply finish coats, including touch-up and damage-repair coats, in a manner which will present a uniform texture and color-matched appearance.

D. Unsatisfactory Application:

1. If an item has improper finish color or insufficient film thickness, clean and recoat the surface with specified paint material to obtain specified color and coverage. Obtain specific preparation information from coating manufacturer.

2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat in accordance with the specifications. Depending on extent of repair, finish sanding and additional coats may be required.

3. Evidence of runs, drips, sags, dry-spray, lap marks, blisters, or other imperfections shall be cause for rejection.

4. Repair defects in coating system per written recommendations of coating manufacturer.

5. Leave all staging up until the Engineer has inspected the surface or coating.

6. Replace staging removed prior to approval of the Engineer.

3.05 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.06 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.07 EXTERIOR PAINT SCHEDULE

A. Concrete, Stucco, and Masonry (Other than Concrete Masonry Units): Provide the following finish systems over exterior concrete, stucco, and brick masonry surfaces:

1. Surface Preparation: Brush blast or high pressure water blast to remove glaze and provide a uniform anchor profile (Reference SSPC-SP 13, ICRI CSP 1 – 2)

2. Block Filler: Tnemec Series 130 applied at 60 – 80 square feet per gallon.

3. First and Second Coats: Tnemec Series 156 Envirofill applied at a rate to achieve 6.0 – 8.0 mils DFT per coat.

B. Non-Submerged Ferrous Metal:

1. Surface Preparation: See Section 3.2 - 4 – a.

2. Primer: Tnemec Series 91 H20 Hydro-Zinc applied a rate to achieve 2.5 – 3.5 mils DFT.

3. Field Touch-Up: Tnemec Series 91 H20 Hydro-Zinc applied a rate to achieve 2.5 – 3.5 mils DFT.

4 Intermediate: Tnemec Series 66 Epoxoline applied at a rate to achieve 3.0 – 5.0 mils DFT

5. Finish: Tnemec Series 1094 Endura-Shield applied at a rate to achieve 2.0 – 3.0 mils DFT.

C. Previously Painted Non-Submerged Ferrous Metal and Ductile Iron Pipe:

1. Surface Preparation: See Section 3.2 - 4 – c.

2. Spot Primer: Tnemec Series 135 Chembuild applied a rate to achieve 3.0 – 5.0 mils DFT.

3. Full Prime: Tnemec Series Chembuild applied at a rate to achieve 3.0 – 5.0 mils DFT

4. Finish: Tnemec Series 1094 Endura-Shield applied at a rate to achieve 2.0 – 3.0 mils DFT.

D. Non-Submerged Galvanized:

1. Surface Preparation: See Section 3.2, C, 6.

2. Primer: Tnemec Series 66 Epoxoline applied at a rate to achieve 3.0 – 5.0 mils DFT

3. Finish: Tnemec Series 1094 Endura-Shield applied at a rate to achieve 2.0 – 3.0 mils DFT.

E. Wood

1. Surface Preparation: Clean and dry. Sand to achieve smooth finish. Fill voids

2. Primer: Tnemec Series 10-99W Primer applied at a rate to achieve 2.0 – 3.0 mils DFT

3. Finish: Two coats of Tnemec Series 1029 Enduratone applied at a rate to achieve 2.0 – 3.0 mils DFT per coat.

F. Non-Submerged Ductile Iron Pipe

1. Surface Preparation:

2. Primer: Tnemec Series N140-1211 Pota-Pox Plus applied a rate to achieve 6.0 – 8.0 mils DFT.

3. Field Touch-Up: Tnemec Series N140-1211 Pota-Pox Plus applied a rate to achieve 6.0 – 8.0 mils DFT.

4. Intermediate: Tnemec Series 66 Epoxoline applied at a rate to achieve 3.0 – 5.0 mils DFT

5. Finish: Tnemec Series 1094 Endura-Shield applied at a rate to achieve 2.0 – 3.0 mils DFT.

3.08 INTERIOR PAINT SCHEDULE

A. Concrete and Concrete Masonry Units: Provide the following paint system:

1. Surface Preparation: Clean and Dry.

2. Block Filler: Tnemec Series 130 applied at 60 – 80 square feet per gallon.

3. Intermediate Coat: Tnemec Series 113 Tneme-Tufcoat applied at a rate to achieve 4.0 – 6.0 mils DFT.

4. Finish: Tnemec Series 297 Enviro-Glaze applied at a rate to achieve 2.0 – 3.0 mils DFT.

B. Concrete and Concrete Masonry Units: Provide the following paint system:

1. Surface Preparation: Clean and Dry.

2. Block Filler: Tnemec Series 130 applied at 60 – 80 square feet per gallon.

3. Intermediate Coat: Tnemec Series 113 Tneme-Tufcoat applied at a rate to achieve 4.0 – 6.0 mils DFT.

4. Finish: Tnemec Series 297 Enviro-Glaze applied at a rate to achieve 2.0 – 3.0 mils DFT.

B. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:

1. Primer: Tnemec 51-792 Primer applied at a rate to achieve 1.0 – 2.0 mils DFT.

2. Finish: Two coats of Tnemec Series 1026 Enduratone applied at a rate to achieve 2.0 – 3.0 mils DFT per coat.

C. Wood

1. Surface Preparation: Clean and dry. Sand to achieve smooth finish. Fill voids.

2. Primer: Tnemec Series 10-99W Primer applied at a rate to achieve 2.0 – 3.0 mils DFT

3. Finish: Two coats of Tnemec Series 1029 Enduratone applied at a rate to achieve 2.0 – 3.0 mils DFT per coat.

D. Non-Submerged Ferrous Metal:

1. Surface Preparation: See Section 3.2, C, 4, a.

2. Primer: Tnemec Series 91 H20 Hydro-Zinc applied a rate to achieve 2.5 – 3.5 mils DFT.

3. Field Touch-Up: Tnemec Series 91 H20 Hydro-Zinc applied a rate to achieve 2.5 – 3.5 mils DFT.

4 Intermediate: Tnemec Series 66HS Epoxoline applied at a rate to achieve 3.0 – 5.0 mils DFT

5. Finish: Tnemec Series 1094 Endura-Shield applied at a rate to achieve 2.0 – 3.0 mils DFT.

E. Non-Submerged Galvanized:

1. Surface Preparation: See Section 3.2, C, 6.

2. Primer: Tnemec Series 66 Epoxoline applied at a rate to achieve 3.0 – 5.0 mils DFT

3. Finish: Tnemec Series 1094 Endura-Shield applied at a rate to achieve 2.0 – 3.0 mils DFT.

F. Concrete Sealer: Provide the following finish system over concrete and masonry to be sealed:

1. Clear or pigmented acrylic sealer.

a. Surface Preparation: Brushoff blast and/or acid etching.

b. Coverage: As recommended by manufacturer.

G. Non-Submerged Ductile Iron Pipe

1. Surface Preparation: 3.2, C, 5, a

2. Primer: Tnemec Series N140-1211 Pota-Pox Plus applied a rate to achieve 6.0 – 8.0 mils DFT.

3. Field Touch-Up: Tnemec Series N140-1211 Pota-Pox Plus applied a rate to achieve 6.0 – 8.0 mils DFT.

4 Intermediate: Tnemec Series 66HS Epoxoline applied at a rate to achieve 3.0 – 5.0 mils DFT

5. Finish: Tnemec Series 1094 Endura-Shield applied at a rate to achieve 2.0 – 3.0 mils DFT.

3.09 IMMERSION SERVICE COATINGS

A. Submerged Concrete – Filters

1. Surface Preparation: See Section 3.2, C, 3

2. Surfacer: Tnemec Series 218 MortarClad applied at a rate to achieve 1/8" minimum dry film thickness. All voids, bug holes and other defects shall be filled with a smooth surface obtained.

3. Primer: Tnemec Series 20 Pota-Pox applied at a rate to achieve 4.0 – 6.0 mils DFT. Spray and backroll.

4. Lining: Tnemec Series 22 Epoxoline applied at a rate to achieve 25.0 – 35.0 mils DFT.

B. Submerged Ductile Iron Pipe (Potable Water)

1. Surface Preparation: 3.2, C,5,a

2. Primer: Tnemec Series N140-1211 Pota-Pox Plus applied a rate to achieve 6.0 – 8.0 mils DFT.

3. Field Touch-Up: Tnemec Series N140-1211 Pota-Pox Plus applied a rate to achieve 6.0 – 8.0 mils DFT.

4 Intermediate: Tnemec Series 20Pota-Pox applied at a rate to achieve 4.0 – 6.0 mils DFT

5. Finish: Tnemec Series 141 Epoxoline applied at a rate to achieve 10.0 – 12.0 mils DFT.

C. Submerged Ferrous Metal (Potable Water):

1. Surface Preparation: See Section 3.2 , C, 4, b

2. Primer: Tnemec Series 91 H20 Hydro-Zinc applied a rate to achieve 2.5 – 3.5 mils DFT.

3. Field Touch-Up: Tnemec Series 91 H20 Hydro-Zinc applied a rate to achieve 2.5 – 3.5 mils DFT.

4 Intermediate: Tnemec Series 20 Pota-Pox applied at a rate to achieve 3.0 – 5.0 mils DFT

5. Finish: Tnemec Series 141 Epoxoline applied at a rate to achieve 8.0 – 10.0 mils DFT.

3.10 OTHER COATINGS

A. Dielectric Insulation (including aluminum and concrete):

1. Surface Preparation: Clean and dry or SP-3.

2. Tnemec Series 46H-413 Hi-Build Tneme-Tar @ 8.0-12.0 mils DFT.

B. PVC and Plastic:

1. Surface Preparation: Sanding with medium grit.

2. Primer: Tnemec Series 66HS Epoxoline applied at a rate to achieve 3.0-5.0 mils DFT.

3. Finish: Tnemec Series 1095 Endura-Shield applied at a rate to achieve 2.0 – 3.0 mils DFT.

C. Launder Coating System:

1. Surface Preparation: Abrasive blast or mechanically abrade to remove all laitance, curing compounds, hardeners as well as any other contaminants and to provide a surface profile (Reference SSPC-SP 13/ICRI CSP 5). Lining shall terminate 2′ below the waterline and as shown on the drawings below the waterline. Provide a neat transition line.

2. Primer/Surfacer: Tnemec / Epoxytec Ceramico applied at 1/8″ minimum DFT to fill all voids, bugholes and to seal the surface.

3. Lining: Tnemec / Epoxytec CPP Trowel-Liner applied at a rate to achieve 125 mils DFT. Apply lining 6″ onto bare concrete to seal the edge. Featheredge transition onto bare concrete.

3.11 Product Performance Criteria

Provide the following product information and **manufacturers published performance** data should coatings or coating system be submitted in lieu of the standard of quality established in the project documents. Should the data not be available in a published format, or if the duration of the test does not meet the specified requirement, please respond in the appropriate space with NT (Not Tested).

A. Steel Primer

1. Standard of Quality: Tnemec Series 91 H20 Hydro-Zinc

2. Generic Type: Organic Zinc Rich Urethane Primer

3. Solids By Volume: 63%

4. Zinc Content: 83% by weight. ASTM D520 Type III Zinc Dust

5. Salt Spray (Fog): ASTM B 117, Scribed Panels, 50,000 hours exposure.

6. Adhesion: ASTM 4541 Elcometer Adhesion.

7. Humidity: ASTM D 4585. 4,000 hours exposure.

8. Cathodic Disbondment: ASTM G8, Method A. Days Exposure

9. Immersion: ASTM D 870 Potable Water Immersion. 7 years immersion.

10. Prohesion: ASTM G 85 Prohesion Cabinet. 15,000 hours exposure.

B. NSF Approved Polyamide Epoxy (Locations as Specified)

1. Standard of Quality: Tnemec Series 20 Pota-Pox
2. Generic Type: Polyamide Epoxy
3. Special Qualifications: NSF Std 61 approved for tanks 6,000 gallons capacity or greater
4. Solids By Volume: 56%.
5. Salt Spray (Fog): ASTM B 117. Result after 10,000 hours exposure (plane rust, rust at scribe and blistering).
6. Immersion: ASTM D 870. 140° Deionized Water – 2,000 hours
7. Abrasion: ASTM 4060 (CS-17 Wheel, 1,000 gram load, 1,000 cycles)
8. Adhesion: ASTM 4541 Elcometer Adhesion.
9. Humidity: ASTM D 4585. 15,000 hours.
10. Immersion: ASTM D 870. 7 Years.

C. Polyamide Epoxy (Locations as Specified)

1. Standard of Quality: Tnemec Series 66 Epoxoline
2. Generic Type: Polyamide Epoxy
3. Solids By Volume: 56%.
4. Salt Spray (Fog): ASTM B 117. Result after 10,000 hours exposure (plane rust, rust at scribe and blistering).
5. Immersion: ASTM D 870. 140° Deionized Water – 2,000 hours
6. Abrasion: ASTM 4060 (CS-17 Wheel, 1,000 gram load, 1,000 cycles)
7. Adhesion: ASTM 4541 Elcometer Adhesion.
8. Humidity: ASTM D 4585. 15,000 hours.
9. Immersion: ASTM D 870. 7 Years.

D. NSF Approved Modified Polyamine Epoxy (Locations as Specified)

1. Standard of Quality: Tnemec Series 141 Epoxoline

2. Generic Type: Modified Polyamine Epoxy

3. Solids By Volume: 82%.

4. Salt Spray (Fog): ASTM B 117. Result after 10,000 hours exposure (plane rust, rust at scribe and blistering).

5. Immersion: ASTM D 870. 140° Deionized Water – 2,000 hours

6. Abrasion: ASTM 4060 (CS-17 Wheel, 1,000 gram load, 1,000 cycles)

7. Adhesion: ASTM 4541 Elcometer Adhesion.

8. Humidity: ASTM D 4585. 2,000 hours.

E. NSF Approved 100% Solids Modified Polyamine Epoxy (Filter Basins)

1. Standard of Quality: Tnemec Series 22 Epoxoline

2. Generic Type: Modified Polyamine Epoxy

3. Special Qualifications: Meets the health effects requirements of NSF/ANSI/CAN 600 according to the requirements of NSF/ANSI/CAN 61 for potable water tanks of 50 gallons or greater. Also meets the requirements set forth for AWWA C-210-07 testing

4. Solids By Volume: 100%.

5. Cyclic Salt Fog/UV: ASTM D 5894. Result after 10,000 hours exposure (plane rust, and blistering).

6. Immersion: ASTM D 870. 140° Deionized Water – 2,000 hours.

7. Immersion: ASTM D 870. 200^{o} potable water for 6 months.

8. Abrasion: ASTM 4060 (CS-17 Wheel, 1,000 gram load, 1,000 cycles)

9. Adhesion: ASTM 4541 Elcometer Adhesion.

10. Adhesion: ASTM 4541 Elcometer Adhesion. After 6 months immersion in crude oil at 275^{o} F.

11. Humidity: ASTM D 4585. 2,000 hours.

F. Aliphatic Acrylic Polyurethane with Added UV Absorbers (Locations as Specified)

1. Standard of Quality: Tnemec Series 1094 Endura-Shield

2. Generic Type: Aliphatic Acrylic Urethane with added UV Protection

3. Solids By Volume: 66%.

4. Salt Spray (Fog): ASTM B 117. Result after 5,000 hours exposure (plane rust, rust at scribe and blistering).

5. Cyclic Salt Fog/UV: ASTM D 5894. 5,000 hours

6. Adhesion: ASTM 4541 Elcometer Adhesion.

   QUV: ASTM D 4587. Result after 6,000 hours exposure. Report color retention and gloss retention.

G. Fluoropolymer Urethane (Chemical Storage Tank Exterior)

1. Standard of Quality: Tnemec Series 700 HydroFlon

2. Generic Type: Fluoropolymer Urethane

3. Solids By Volume: 60%.

4. Salt Spray (Fog): ASTM B 117. Result after 10,000 hours exposure (plane rust, rust at scribe and blistering).

5. Adhesion: ASTM 4541 Elcometer Adhesion.

   QUV: ASTM D 4587. Result after 25,000 hours exposure. Report color retention and gloss retention.

6. EMMAQUA; ASTM D 4141. Results after 1,500 mj/m2 Exposure. Report color retention and gloss retention.

7. EMMAQUA; ASTM D 4141. Results after 2,000 mj/m2 Exposure. Report color retention and gloss retention.

8. EMMAQUA; ASTM D 4141. Results after 3,500 mj/m2 Exposure. Report color retention and gloss retention.

END OF SECTION

SECTION 11206
HORIZONTAL SPLIT CASE PUMPS

PART 1 General

A. This specification covers e-XC single-stage, double-suction, horizontal split case pumps for municipal and industrial applications such as power generation, oil and gas, manufacturing, water utilities, recreational facilities, and mining. Pumps will be manufactured by Xylem Water Solutions with 10.0" diameter discharge and 12.0" diameter suction. Each unit shall be furnished with a pump, base, coupling, coupling guard and driver unless otherwise specified.

1.01 Performance

A. The pump(s) shall be designed for and operated continuously under normal service.

B. Pump performance shall be ANSI/HI 14.6 and ISO 9906:2012 (Grade 2B) compliant.

C. Operation criteria:

Booster Pump Station	Pump 1	Pump 2	Pump 3
Model	Goulds e-XC	Goulds e-XC	Goulds e-XC
Station Feed Power	460 V/60Hz/3pH	460 V/60Hz/3pH	460 V/60Hz/3pH
Pump Motor Power	460V/60hz/3pH	460V/60hz/3pH	460V/60hz/3pH
Single Pump Design Flow	3,150 GPM	3,150 GPM	3,150 GPM
Design Head	95.0'	95.0'	95.0'
Maxiumn HP (Non-Overloading)	125HP	125HP	125HP
Max Stages	1	1	1
Suction Manifold (customer connection)	12.0"	12.0"	12.0"
Discharge Manifold (customer connection)	10.0"	10.0"	10.0"

D. The pumped liquid is potable water with a specific gravity of 1.000.

1.02 Product Specifications

A. Rotation when looking at the pump from the pump end.

1. Counterclockwise

B. Impeller

1. The impeller shall be double-suction enclosed type, hydraulically and dynamically balanced, keyed to the shaft, and fixed in the axial position. Impeller shall be fit with two impeller wear rings of material identical to the impeller. Wear rings shall be easily replaceable.

2. Impeller shall be made of A743-CF8 (304 Stainless Steel) accurately cast, machined, filed and polished; and impellers shall be statically and dynamically balanced. Impeller material shall be the following for each set of pumps:

3. Impeller shall be capable of passing solids having a maximum sphere size of 0.25".

C. Motor

1. Motor shall by Inverter Duty with shaft grounding ring and insulated bearing.

D. Volute Casing

1. The volute shall be of horizontal split case design with mounting feet integral cast into the bottom half of the casing. Suction and discharge flanges shall be on a common centerline in both horizontal and vertical planes. The volute shall include a priming port, gauge ports at inlet and discharge nozzles, drain ports, and a venting port. The upper casing shall be capable of being removed without disturbing piping connections or electrical motor connections. The casing shall be fitted with ASTM B584 C90300 bronze wear rings.

2. The casing shall be of sufficient strength, weight, and thickness to ensure long life and reliable operation. The volute shall have smooth fluid passages large enough at all points to pass any size solid which can pass through the impeller and provide smooth unobstructed flow. The casing shall be hydrostatically tested to 1.5 times the maximum working pressure for 10 minutes.

3. Volute shall be made of: ASTM a48 Cast Iron Class 35.

4. Casing flanges shall support the max working pressure and design condition of the pump.

   a. Flange sizes below 28" shall be drilling per ANSI B16.1

      standards.

   b. Flange sizes equal to or greater than 28" shall be drilling per AWWA C207 (Classes D and F) standards.

E. External Flush Lines

1. The pump shall be furnished with external flush lines mounted to the vent port located atop the upper casing. Flush lines shall feed directly to the seal chamber to lubricate and cool seal elements. Flush line elements shall be made of 304 stainless steel.

F. Shaft and Shaft Sleeves

1. Dry Shaft Configuration

   a. The impeller shaft shall be rigid with a non-stepped design and provide high resistance to shaft deflection. The impeller shaft shall be AISI

standard 4140 steel and protected by 304 stainless steel shaft sleeves. The shaft sleeves shall completely protect the shaft from fluid handled by the pump. A seal shall be established by an FKM rubber O-ring and PTFE gasket. The shaft sleeves shall be keyed to the shaft and locked in place axially with a sleeve nut that is threaded onto the shaft. Shaft sleeves as standard shall be made of ASTM A743 CF8 stainless steel (304)..

G. Bearing Housings

1. Bearing housings shall support heavy duty, single-row, ball bearings. Bearings shall be regreasable. The inboard bearing will absorb thermal expansive forces while the outboard bearing will be locked into place to absorb radial and thrust loads. Bearings shall be replaceable without disturbing the system piping.
2. Both bearing housings shall contain two drilled ports for temperature monitoring and three ports for dual-axis vibration monitoring.
3. Bearings shall be designed for an L10 life of 100,000 hours at shutoff point.
4. Bearing housings shall be sealed with cast iron labyrinth seals.
5. The gap between the bearing housing and pump shall be fitted with a sheet metal shaft guard.

H. Baseplate

1. Baseplate shall be structural steel or fabricated steel channel with fully closed sides and ends. Cross members shall be securely welded and the grouting area shall be fully open.
2. Baseplate shall be field grouted.
3. The combined pump, motor and baseplate assembly shall be sufficiently stiff to limit vibration.
4. Baseplate shall be fitted with (8) motor alignment screws for standard motors above 215 frame size.

I. Coupling and Guard

1. Couplings shall be flexible non-spacer type.
2. Couplings shall be shielded by an ANSI B11.19-2010, OSHA 1910.219, and ISO 14120:2015 compliant coupling guard. The guard shall be sheet metal, painted orange and completely protect all rotating elements between the motor and pump.
3. Coupling shall be factory aligned prior to shipment.

J. Pump Sealing

1. Seal sizes equal to or below 4 in.
   a. Pump shall be equipped with a pair of externally flushed mechanical seal assemblies.
   b. Seal assemblies shall be unbalanced unitized rubber bellow type.
   c. Seal assemblies shall be Carbon/Silicon Carbide/EPDM where a carbon face rotates against a stationary Silicon Carbide face. Seal elastomers shall be made of EPDM rubber. Seal housing shall be 304 stainless steel construction.

d. The seal shall be rated for 175 psig (12 BAR) working pressure.

2. Other

a. Pump shall be equipped with a pair of externally flushed mechanical seal assemblies.

b. Seal assemblies shall be mechanical cartridge seal type.

c. Seal assemblies shall be a cartridge seal where a silicon carbide face rotates against a stationary silicon carbide face. Seal elastomers shall be made of epdm rubber. Seal housing shall be stainless steel construction.

d. The seal shall be rated for 150 PSIG.

K. Paint

1. Pumps shall be painted with at least one coat of high-grade paint prior to shipment.

L. Testing

1. Pumps shall be factory hydrostatically tested per Hydraulic Institute standards and name- plated before shipment.

M. NSF/ANSI 61 & NSF/ANSI 372 – CSA Group Certified[1]

1. NSF/ANSI/CAN 61 (Drinking Water System Components – Health Effects) are certification standards for products that come into contact with drinking water which ensure a product is safe for potable water applications.

2. CSA Group File Number: 009553_0_000

3. CSA Group Class Number: 6861-08

4. NSF/ANSI/CAN 372 (*Drinking Water System Components — Lead Content*) verifies the lead content within drinking water products to ensure they are safe as defined by the Safe Drinking Water Act. These requirements are based on EPA and Health Canada requirements.

5. CSA Group File Number: 009553_0_000

6. CSA Group Class Number: 6853-01

7. Standard construction (dry shaft) cast iron, ductile iron or CF8 (316 SS) enclosed e-XC pumps, fitted with either CF8 (304 SS) or CF8M (316 SS) impeller and impeller wear rings, and bronze or 2205 (duplex) SS or Nitronic 60 casing wear rings are certified to both NSF/ANSI/CAN 61 and 372 standards. Standard construction pumps are certified for use with either MR3 (C/SiC/EPDM or SiC/SiC/EPDM) metal pusher and MR4 (C/SiC/EPDM) rubber bellow mechanical seals.

8. Although not required, an optional epoxy coating (Epoxline 22) is available.

N. Pump Station Functional Electrical Equipment-

1. One (1) VFD per pump. VFDs shall be NEMA 12 wall mounted type to minimize the amount of air turn over required in the station. VFDs shall be capable of managing variable speed multi-pump systems in a constant pressure application without the need for external PLCs. VFDs shall be equipped with quick start programing and integrated pump control logic for ease of use in the field.

2. One (1) Distribution Control Panel (DCP). Station will be equipped with a NEMA-4X fiberglass panel with fused disconnect for each drive with a complete set of extra fuses, properly sized main breaker(s), branch circuit breaker(s), low suction pressure relay, green pump run light, red fault alarm light, H-O-A switches, lightning arrestor, incoming power feed distribution block. The DCP shall be UL508 labeled and the VFDs shall be wired to the DCP in the field.

3. If required pump station shall be supplied with a UL-listed 3R enclosed ACME step down transformer for control power. Feed power is noted above in section 1.2

O. Functional Requirements-

1. Control of the pumps and their speed (via the associated VFDs) shall be based on the level of the associated storage tank. The Booster Station RTU (provided by others) shall monitor and relay the storage tank level, as well as the desired tank level, to each of the VFDs. When the level drops to an operator adjustable setpoint (in the plant SCADA system) the Booster Station RTU shall provide a run command (via a digital output) to the lead pump VFD (as selected by the Booster Station RTU). When commanded to run, the lead pump's VFD should observe the current tank level (as an analog input) in conjunction with the operator adjustable desired level (also as an analog input) and modulate the output speed of the VFD accordingly to maintain the desired level (via an internal PID loop). If the level continues to fall, the lag pump shall be called to run. The speed for each VFD shall be computed by an internal PID loop but the VFDs shall be programmed with the same gains and settings so that the pumps operate at similar speeds when running simultaneously.

2. Pump VFDs will adjust speed of pump to match demand of the system.

3. Pump(s) will run until operator adjustable levels are reached in the storage tank as monitored by the Booster Station RTU, and adjustable via the plant SCADA system.

4. System will alternate between lead-lag-backup pump at each start. This functionality will be provided by the Booster Station RTU (provided by others).

5. If one pump should fail second pump shall override control. If two pumps shall fail the backup pump shall override control. This functionality shall be provided by the Booster Station RTU (provided by others).

6. The storage tank shall be provided with a low level float (provided by others) to prevent operation of the pumps in the event that the tank level is too low.

   a. Booster Pump Station shall be provided with variable frequency drives (VFDs) for level control of the storage tank and operation of pumping equipment. VFDs shall be properly sized for incoming power feed and pump station requirements. VFDs, control panels, transformers and all associated electrical equipment must be provided by the package system manufacture in order to assure system integration and sole source responsibility. The pump controller shall be variable speed and wall mounted. The pump controller shall provide an adjustable carrier frequency. The controller shall provide noiseless operation of the driving motor, short circuit and ground protection, and work with controlled sinusoidal current synthesis and dynamic over current limitations. The pump controller shall incorporate Torque Based Pump Protection, TPP. The pump controller shall be one complete integrated unit including the variable frequency drive, programmable pump specific control logic, and include a NEMA 1 or NEMA 12 enclosure. Standard variable frequency drives that do not incorporate pump control logic as the primary control software; programming and features directly applicable to centrifugal pump applications shall not be considered equal. VFDs shall be ABB ACQ550 pump specific drives no substitutions.

   b. The Pump Controller shall provide an LCD display that offers the following modes and displays: Output Mode provides three line display a minimum of 16 characters per line Operating modes, Fault mode and alarm mode with up to five lines of display information display and, along with a keypad, programming interface. Unit(s) shall utilize user-friendly front panel programming in four languages that displays pump and motor language in clear text. Status LED shall signal green for normal operation and flashing or red for Troubleshooting. Program settings shall be changeable and stored in non-volatile memory. Program settings shall be retained in non-volatile memory in the event of loss of power to the controller, without the use of a backup battery. The display shall provide an ability to back up pump controller parameters for safekeeping or for the purpose of transferring parameters to like pump controllers. System operating level shall be clearly displayed in feet for ease of use and to provide an operator friendly interface. Additional parameters, where applicable, shall be displayed in units consistent with pumping systems. Generic control systems adapted from other applications shall not be considered equal.

   c. Faults shall be displayed in plain English terms and not depend on interpretation of error codes. All faults must include a real-time date and time stamp.

d. The Pump Controller shall use Assistants to enable quick and clear setup. For basic PID or speed control parameterization should be accomplished in less than 12 steps. In the event additional features are required for control or pump protection user access to advance parameters is needed. The settings and program in whole or part may be locked out with the use of an operator selectable password.

e. Pump-protect features, when the protection limit is enabled, provide: dry run protection in pressure and flow control, run out flow protection in pressure control mode and minimum flow protection when in flow control. With additional system condition inputs, secondary protection shall be available to provide protection from dry-running and operating against a closed discharge valve

f. The pump controller shall incorporate a normal or inverse regulation mode and dual set-points for speed control & process PID

g. Interface The control board unit shall contain form C dry contact relay outputs which can be connected to external devices for operation of:

    1) Two selectable analog inputs
    2) Potentiometer reference value
    3) Two analog 4-20 mA outputs
    4) Auxiliary Voltage
    5) Six digital inputs
    6) Three digital outputs
    7) Serial Communication/Fieldbuses:
        a) Profibus DP
        b) Profinet
        c) DeviceNet
        d) Controlnet
        e) Modbus RTU (integrated)
        f) Modbus TCP
        g) Ethernet
        h) BACnet IP to MS/TP router (integrated)
        a) System Protection pump controller shall provide a programmable automatic error reset of the pump system that will provide up to five restarts, with a programmable time delay between each start. The pump controller shall provide a fault history with at least ten previous fault codes. The pump controller shall incorporate motor thermal protection and drive temperature protection as standard equipment. The pump controller shall be capable of monitoring and displaying total

operating hours, and total motor run hours. The ABB ACQ unit shall protect the variable frequency drive and motor from: overvoltage, under-voltage, phase loss, phase imbalance, motor overcurrent, ground fault and short circuit. The variable speed pump controller shall be UL, cUL, CE listed.

b) The pump controller must function in an ambient temperature range between -15° and 40°C (5° to 104°F) without de-rating, but may operate above 40°C when the maximum output current is de-rated 1% for every additional 1°C (up to 50°C (122°F) maximum limit. The pump controller shall operate in a relative humidity range of 5 to 95%, no condensing. The pump controller shall operate at site altitudes up to 1000 meters above sea level (MASL) without any de-rate, and up to a maximum altitude of 2000 MASL when output power is de-rated 1% for every 100 meters above 1000 meters.

P. ELECTRICAL COMPONENTS

1. All electrical components and materials supplied shall function as a complete unit to automatically control the booster pump station. All devices and material shall be new and of standard product design. All components used in the panel shall be Underwriters' Laboratory approved for the application. Electrical work shall be in accordance with the latest edition of the National Electrical Code (NEC-70).

2. Wire- shall be stranded copper and sized as required for load and application according to NEC. All wiring on the rear of the inner door shall be neatly bundled using tie wraps or other means. All internal wiring on the backplate shall be neatly routed in wire duct with removable covers.

All wiring shall be continuous point to point (no splices) and be totally accessible.

a. All conductors shall be 98% conductive annealed copper unless otherwise note, UL listed and labeled

b. Conductors No. 10 and smaller shall be solid

c. Conductors No. 8 or larger shall be stranded

d. Branch circuits shall not be less than No. 12 copper wire type THW, THHN or THWN insulation

e. All control and signal wire shall be a minimum of No. 14 AWG, 90-degree C insulated and color-coded, colors shall be as follows:

1) Red for all AC control

2) Blue for all DC control

3) Yellow for external source control

4) White for AC neutral

5) Green for equipment ground wiring

6) Main Ground- Conductors for main ground form neutral bus or equipment grounding bus shall be bare copper

3. Mounting- All other components shall be securely mounted to the backplate with stainless steel hardware through machine thread tapped holes in the backplate. The screws shall be of adequate size for the device being secured. Permanent marking to identify each component as shown on the drawing shall be provided on the back plate and schematic laminated on inside of enclosure door.

4. Variable Frequency Drives (VFD)- as indicated in section 1.6 above shall be UL, cUL & CE listed and provide adjustable carrier frequency with IGBT power switching and utilize PWM technology. VFDs shall be completely integrated unit including VFD and programmable pump specific control. PLCs or external control devices shall not be acceptable or approved equal. VFD shall function in an ambient temperature range between -15-degrees C and 40-degrees C and may operate up to 50-degrees C with a 1% derate for every 1-degree C. VFD shall operate in relative humidity range of 5% to 95%, no condensing. VFD shall operate at altitudes up to 1000M above sea level. VFD shall tolerate voltage variances of +/- 10% on input power and shall provide three phase output power from 0V to (Rated)V and frequency's from 0Hz to 60Hz.

5. Pressure Transducer- a pressure transducer shall be furnished and installed in the piping of the pump station and shall be prewired. Transducer shall be two wire type with a 4-20mA signal calibrated for 0 - 300psig. Shall be of the NEMA -4X design and equipped with a ½" NPT male process connection (fluid) and a ½" NPT male electrical connection. Accuracy shall be +/- 1.5%. Diaphragm shall be 17-4PH stainless steel and

case shall be 304 stainless steel. Transducer shall be NSF-61 compliant. Manufactured by Goulds, HO Trerice, Ashcroft or equal.

6. Low Suction Switch- Shall be factory set and of the diaphragm type. Manufactured by Ashcroft or equal.

7. Enclosures- DCP enclosure shall be NEMA-4X fiberglass shall be manufactured by Allied Molded, Hoffman or equal. VFDs shall be NEMA-1 as provided by the drive manufacturer

8. H-O-A Switches each pump shall be equipped with HAND-OFF-AUTOMATIC (H-O-A) switches. Switches shall be Square-D model ZB5 Series or equal.

9. Pump Disconnects- provide one (1) properly sized fused disconnect per pump shall be ABB OT or equal. Provide one set of spare fuses per pump.

10. Main Circuit Breaker- shall be properly sized for pump station load and shall be Square-D QOU or equal.

11. Branch Circuit Breakers- Shall be properly sized for load and shall be Square-D QOU or equal. At a minimum the DCP shall be equipped with:

    a. One (1) Duplex GFI outlet

    b. One (1) Enclosure heater circuit

    c. One (1) Enclosure blower/vent fan circuit

    d. One (1) Enclosure convenience light circuit

    e. One (1) Spare

12. Time Delay Relay- shall be properly sized to prevent both pumps from starting at once. Shall be Macromatic or equal.

13. Repeat Timer- Shall be properly sized to prevent pumps from short starting after stop. Shall be Macromatic or equal.

14. Control Relays- Shall be Omron or equal.

15. Alternator- DCP shall be equipped with a manual override alternator. Shall be Infitec or equal

16. Lightning Arrestor- Pump station shall be equipped with one (1) properly sized lightning arrestor on the feed power. Shall be Square D SDS or equal.

17. Switches- Convenience switches shall be Square-D model ZB5 series or equal

18. Pump Run Lights- DCP shall be equipped with one (1) green run light per pump. Shall be Square D ZB5 series or equal.

19. Pump Fault Lights- DCP shall be equipped with one (1) red pump fault light per pump. Shall be Square D ZB5 series or equal.

20. Common Alarm Light- DCP shall be equipped with one (1) red common fault light. Shall be Square D ZB5 series or equal

21. Thermostat- DCP shall be equipped with a thermostat to control pump station vent fan. Shall be Columbus Electric or equal

22. Convenience Light- shall be Acuity-Lithonia or equal

23. Main Power Distribution Block- DCP shall be equipped with a properly sized incoming power distribution block. Shall be Bussmann, Square D or equal.

24. Space Heater- Fiberglass building/enclosure shall be equipped with a 1500W forced air space heater 120V/60Hz/1pH. Shall be Dayton 3VU or equal.

25. Exhaust Fan- Fiberglass building/enclosure shall be equipped with a 120CFM exhaust fan on simplex enclosures and a 300CFM exhaust fan on duplex and larger enclosure. Motors shall be 120V/60Hz/1pH and will be controlled by thermostat in 1.7.T. Manufactured by Dayton or equal

26. Control Transformer- On applications needing step-down transformer it shall be supplied and mounted on the control panel hoop. Transformer shall be properly sized for load and shall be UL-listed UL-3R enclosure with 180-degree C insulation system with 115-degree C rise. Shall be of the encapsulated design. Manufactured by Hubbell-Acme Electric or equal

27. Grounding lugs- Booster pump system shall be provided with two grounding lugs. One shall be located in the DCP with a secondary lug located on the baseplate. Lugs shall be manufacturer standard

28. Conduit- All conduit shall be of the flexible liquid-tight type or PVC NEC approved as manufactured by Grainger, Hubbell or equal

29. All electrical wiring shall be per NEC-70

END OF SECTION

SECTION 13215
GRANULATED ACTIVATED CARBON VESSELS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Adsorption System Description

2. Adsorption System Specifications

3. Installation and Start-up Services

1.2 REFERENCES

A. ASME Section VIII, Division 1 – American Society of Mechanical Engineers Boiler and Pressure Vessel Code

B. ASME/ANSI B16.5 – American Society of Mechanical Engineers/American National Standard Institute

C. Steel Structures Painting Council Surface Preparation Specifications and National Association of Corrosion Engineers

D. ASME Section II, American Society of Mechanical Engineers – Materials, Parts A, B & C

E. American Society of Testing Materials (ASTM)

F. American Water Works Association (AWWA) – B604, Standard for Granular Activated Carbon

G. ANSI/NSF Standard Drinking Water System Components – Health Effects.

H. NSF/ANSI Standard 372: Drinking Water System Components – Lead Content

1.3 System Description

A. Two Calgon Carbon Corporation Model 14 Carbon Adsorption Systems (4 vessels total) described herein are the basis of design for this application. This does not exclude other manufacturers from submitting their products as an alternative providing that all specifications meet or exceed those written here.

B. The complete adsorption system includes the following:

1. Carbon adsorbers with internals for carbon retention

2. Activated carbon

3. Influent, effluent, and backwash piping with valves

4. Carbon fill and discharge piping with valves

5. Vent and pressure relief piping

6. Water piping and utility connections

7. Accessories as shown below

8. Manufacturer's services

C. The vessels, piping, valves, and carbon function as a system and are the end products of Calgon Carbon Corporation to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

1.4 QUALIFICATIONS

A. Supplier of the adsorption system shall have the following minimum qualifications:

1. Must have applied for and received certification that the system and all components are approved per the requirements of NSF/ANSI Standards 61 and 372.

2. At least 20 years of experience successfully supplying both adsorption systems and GAC to treat water with flow rates greater than 500 gpm average daily flow.

3. Must own and operate an equipment fabrication facility with capabilities to both fabricate the equipment per applicable ASME code and finish lining and paint in a single facility. In addition, this facility must be certified per the requirements of NSF/ANSI Standard 61.

4. Must own and operate at least two (2) GAC production facilities in the United States to guarantee the source of supply of activated carbon.

5. Must have conducted a full-scale test to verify GAC side discharge locations which enables removal of spent GAC in 20,000 lbs. increments. Must submit a report with their proposal documenting full scale test work. Failure to provide the required information in its entirety will result in the rejection of the proposal.

1.5 SUBMITTALS

A. One submittal package with the following information will be provided for approval by the Owner. Fabrication will begin upon receipt of Owner's approval.

1. Adsorber vessel specifications and drawing including design pressure, dimensions, and capacity.

2. System flow diagram showing all valves, components, instrumentation and utilities.

3. System general arrangement showing dimensions, weights, and elevations including influent, effluent, backwash, and carbon exchange pipe connection locations.

4. Pressure drop information across the system.

5. Specifications of the granular activated carbon to utilized in the system.

6. Material specifications for pipe, fittings and instrumentation.

7. Specifications for vessel lining.

8. Specifications for vessel painting.

B. The system Operating & Maintenance Manual will be provided upon completion of the project/shipment of the system.

PART 2 PRODUCTS

2.1 GENERAL

A. The Contract Documents indicate specific required features of the equipment, but do not purport to cover all details of design and construction.

2.2 CARBON ADSORBER VESSELS

A. The carbon adsorbers are **Model 14 Carbon Adsorption Vessels**, as designed by Calgon Carbon Corporation to meet the following specifications.

B. The carbon adsorber vessels are fabricated of carbon steel, conforming to ASTM A516 grade 70, 14'-0" diameter by 17'-0" straight side height with 2:1 elliptical top and bottom heads. Each vessel will be sized to contain 60,000 pounds of GAC and to accommodate approximately 30% bed expansion within the straight side of the vessel using Filtrasorb 400 GAC. The vessels are designed, constructed, and stamped in accordance with ASME Section VIII, Division 1 and registered with the National Board for a design pressure rating of 125 psig at 140□F. Each vessel will be provided with one (1) 20" diameter round manway located on the lower straight side portion of the vessel and one 14" x 18" elliptical manway located on the bottom head. The vessels will be free standing utilizing four (4) structural steel support legs. The vessel will be provided with four (4) lift lugs located on the top head and one tailing lug on the bottom head.

C. The structural aspects of the vessel will be sufficient to meet the International Building Code, latest addition. Calgon Corbon Corporation shall submit detailed calculations illustrating the seismic characteristics of the proposed vessels.

D. Each vessel will be designed with an internal 30° cone bottom underdrain system that provides uniform distribution of the treated water using a minimum of one (1) septa for every nominal square foot of vessel cross section, facilitates GAC removal without the need to open the manway to manually hose out the remaining spent GAC, and allows replacement of the septa without the need to remove external piping. The septa will be designed to contain the GAC within the adsorber and be constructed of polypropylene (ppl)

E. The vessel will be provided with the following nozzles:

1. One (1) 6″ nozzle on the upper sidewall of the vessel for GAC fill.

2. Three (3) nozzles for GAC discharge. Two (2) 6″ GAC discharge nozzles are located on the vessel side wall and one (1) 4″ centered on the bottom head.

3. One (1) 10″ influent nozzle located on the top head constructed of stainless steel and provided with an internal flange to support the inlet distributor.

4. One (1) 10″ effluent nozzle located on the bottom head.

5. Three (3) 2″ sample nozzles located on the side wall.

6. One (1) 2″ cone vent nozzle located on the lower side wall

F. All surfaces will be degreased prior to sandblasting. The adsorber internal surface that will be lines will be blasted to a white metal finish (SSPC-SP5) to provide a 3 to 4 mil anchor pattern. The exterior surfaces of the adsorber will be prepared by blasting per SSPS-SP6.

G. The interior surfaces of the vessel will be lined as follows: he surfaces above the internal cone with a nominal lining thickness of 35 to 45 mil dry film thickness (dft) and the surfaces under the internal cone bottom a nominal lining thickness of 20 to 25 mil dft. The lining material meets the requirements of ANSI 61 when applied and cured per the manufacturer's requirements. The lining material will be one of the following:

1. Carboline's Plasite 4110, vinyl ester lining

2. Blome International's TL-220S AR, vinyl ester lining

3. Carboline's Reactamine 760, aromatic polyurethane hybrid

H. The exterior surface of the adsorbers will be painted to a dry film thickness of 10 to 14 mil with a high solids epoxy (gray color) paint and finished with a polyurethane topcoat of 2 to 3 mil dft.

2.3 PROCESS AND UTILITY PIPING

A. The process and utility piping on the adsorption system will include influent water to the system, treated water (effluent), backwash water supply and discharge, adsorber vent lines and granular activated carbon fill and discharge piping.

B. The influent and effluent pipe network allows series (lead/lag) and parallel only operating modes. Lead/lag operation allows either; a) flow from the influent flange to Adsorber A, to the pipe module, to Adsorber B, to the pipe module then to the effluent flange, or b) flow from the influent flange to Adsorber B, to the pipe module, to Adsorber A, to the pipe module then to the effluent flange. The change in flow pattern is accomplished with a change of valve positions. The purpose of lead/lag operation allows an adsorber to act as an on-line backup and/or provides for sufficient contact time to allow adsorption of the contaminants of concern.

C. Process piping (influent, effluent and backwash) will be 10" diameter, constructed of schedule 40 carbon steel, ASTM A53 Grade B materials with 125# ASTM A126 Class B cast iron flanged fittings.

D. Vent piping will be 4" diameter, constructed of schedule 40 carbon steel, ASTM A53 Grade B materials.

E. Carbon fill piping will be 4" diameter, constructed of schedule 40 carbon steel, ASTM A53 Grade B materials. The connection at the vessel side wall will be a 4"x 6" reducing elbow. The GAC fill connection will be supplied with an adjustable stainless-steel insert. There is a total of one (1) GAC fill line per vessel.

F. Carbon discharge piping will be 4" diameter, constructed of schedule 40 polypropylene lined carbon steel, ASTM 53 Grade B materials with ppl lined flanged fittings. There are a total of three (3) GAC discharge lines per vessel. The connections at the vessel side wall will include a 4"x 6" reducing elbow. The GAC side wall discharge connection will be supplied with an adjustable stainless-steel insert.

G. The vessel must be designed with an adjustable GAC removal system to allow for removal of the spent in 20,000 lbs. increments.

H. Utility piping will be constructed of threaded schedule 80 carbon steel, ASTM 53 Grade B materials.

I. All piping surfaces will be prepared by blasting per SSPC-SP7.

J. The exterior surface of the piping will be painted to a dry film thickness of 10 to 14 mil with high solids epoxy paint prior to assembly to minimize oxidation at flanged connections, then finished with a polyurethane topcoat of 2 to 3 mil dft after assembly.

K. The piping network will be provided with a structural steel support frame for support of the piping module.

2.4 PROCESS AND UTILITY VALVES

A. The process and utility piping; excluding GAC fill and discharge piping will be equipped with butterfly valves to direct flow. A total of ten (10) 10" diameter butterfly valves will be supplied to accommodate the process and backwash functions. Two (2) valves are needed for backwash supply, two (2) valves are needed for influent isolation, two (2) valves for effluent isolation, two (2) valves for staging of the vessels and two (2) valves for the vent function.

B. The influent, effluent, and backwash valves will be a cast iron wafer type body butterfly valve with aluminum-bronze disc, BUNA-N seats, and stainless-steel shaft to mate to 150-pound ANSI flanges. The valves are rated for 200 psig in closed position at 180□F and meet or exceed section 5.0 of AWWA specification C-504-87.

C. The carbon fill and discharge valves are 4" diameter full port ball valves, 316 stainless steel construction with TFE seats and seals. A total of eight (8) valves are supplied, two (2) for carbon fill and six (6) for carbon discharge.

D. Utility valves for the compressed air supply will be bronze or brass or barstock brass body regular port ball valves.

2.5 INSTRUMENTATION

A. Instrumentation will be accessible from grade.

B. Pressure relief will be provided by a 4" rupture disk constructed of impervious graphite and designed to relieve pressure at the design pressure of the vessel and at the maximum flow to the system. The rupture disks will be mounted off the vessel vent line and vent to atmosphere. A total of two (2) will be provided for the system.

C. Each vessel will be provided with an indicating differential pressure switch, 4" diameter dial, scaled for 20-0-20psi. The switch is rated at 1.0 amp @ 115 volts AC for remote indication. A total of two (2) will be provided for the system .

D. The process piping will be equipped with pressure gauges to indicate the pressure entering and exiting each adsorber and to provide information on pressure drop across each adsorber and the system. The pressure gauges will

have 4 ½" face diameter with a stainless-steel bourdon tube in a phenolic case housing (1 to 160 psig range). A total of three (3) will be provided for the system.

E. The process piping will be equipped with sample taps to enable sampling of the water entering and exiting each adsorber. A total of three (3) will be provided for the system.

2.6 MISCELLANEOUS

A. The carbon fill and discharge will be fitted with female hose connections, such that carbon transfer to and from the adsorbers can be facilitated using carbon transfer hoses. These connectors will be 4" Quick Disconnect Adaptors constructed of aluminum as manufactured by Dover Corp. as Kamlock connectors or equal.

B. Two (2) flush connections will be provided on each GAC fill line, one upstream and one downstream of the valve. One (1) flush connection will be provided on each GAC discharge line, downstream of the valve. The connections will be welded into the steel or stainless-steel pipe or screwed into solid propylene "spacers" for the lined pipe. Flush connections will consist of a short section of ¾" pipe, a ¾" full port ball valve and a ¾" quick disconnect adaptor to match with water hose fittings.

C. Each vessel will be provided with one (1) 10" stainless steel effluent strainer basket mounted in the effluent line from the vessel. The basket strainer shall be constructed of 316 stainless 14 gage plate with 1/8" diameter holes drilled on 3/16" centers, covered with 40 mesh 316 stainless steel screen and topped by a 4 mesh 316 stainless steel support screen (0.063" wire diameter). A total of two (2) will be provided for the system.

D. The influent and effluent pipe for each vessel will be provided with a molded neoprene reinforced rubber expansion joint which allows 4-way movement and 19° angular misalignment. A total of four (4) will be provided for the system.

E. Each vessel will be provided with an inlet distributor constructed of 316 stainless steel. The distributor will connect to the inlet nozzle and be fitted with multiple arms. Each arm is drilled along its length to facilitate even distribution of water during normal operation and collection of backwash water. A total of two (2) distributors will be provided for the system.

F. In-Bed Sample Taps: Each adsorber will be provided with three (3) 2" side sample nozzles for use with in-bed water sample probes. Sample probes consist of a 12" stainless steel pipe with a stainless-steel slotted septum to collect a water sample from within the carbon bed. The sample probe will be inserted through a 2" flanged nozzle and will be provided with stainless steel tubing drop line and stainless-steel shutoff valve external to the adsorber. A total of six (6) in-bed sample taps will be provided for the system.

G. Air/Vacuum Release Valve – Option Adder: Each adsorber can be provided with one (1) 1" combination air/vacuum release valve mounted at the top of the influent pipe. Two (2) 1" ball valves will be provided to isolate the air release valve, one ball valve positioned between the influent pipe and the air release valve and the second mounted at the bottom of the air release piping (at ground level). A total of two (2) will be provided for the system.

H. Each system will be provided with one Carbon Acceptance Canister. This will allow for testing of the carbon to determine its suitability for reactivation or disposal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01300 – Submittals.

B. Verify site conditions are ready for installation.

C. Field verify that the foundation has been constructed and ready for installation.

3.2 PREPARATION

A. Protect structures near construction site from damage.

3.3 INSTALLATION

A. Calgon Carbon Services

1. Calgon Carbon will assign a Project Manager (PM) to facilitate the execution of the project. The PM will interface with the customer for both the technical and commercial aspects of the project.

2. Calgon Carbon will provide an Engineering Submittal Package as outlined in paragraph 1.05A.

3. Calgon Carbon will supply Operation and Maintenance Instructions upon completion of the project/shipment of the system.

4. A manufacturer's trained specialists, experienced in the installation of the Calgon Carbon's Adsorption Systems, and with at least five (5) years of field experience will be present at the job site and/or classroom designated by the Owner/Contractor to provide the following services:

a. Inspection of the installed equipment

b. Supervision of carbon loading

c. Start-up assistance

d. Troubleshooting

e. Operator training

5. Calgon Carbon will retain design and fabrication documentation for a minimum period of seven (7) years following completion of the project.

B. Contractor Responsibilities

1. The contractor will be responsible for installation and site services, including:

a. Site preparation

b. Receipt, off-loading (and storage) of adsorption system equipment

c. Installation of adsorption system equipment

d. Connection of the dP switch to an alarm system

e. Provision of a means to keep the vessel flooded in all operating modes

f. Any hydrostatic test of the installed (assembled) system at the site

g. System connection to existing infrastructure

h. System disinfection prior to initial fill of carbon

i. Utilities for bulk loading of GAC (compressed air, clean water source, backwash water disposal)

j. Operation of the system during carbon fill operation

k. Mechanical startup of the system

3.4 FIELD QUALITY CONTROL

A. Certified factory start-up shall be provided for by a factory authorized service representative. A certified start-up form shall be filled out with a copy provided to the owner and a copy kept on file at the manufacturer.

B. The factory will extend the normal warranty for the system with a certified factory start-up.

C. With a certified start-up, warranty shall be 24 months from the date of start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time, and expenses.

D. Notify Engineer five days prior to start-up.

END OF SECTION

SECTION 13215
INSTALLATION OF GRANULATED ACTIVATED CARBON VESSELS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes

1. Adsorption System Description

2. Adsorption System Specifications

3. Installation and Start-up Services

1.2 REFERENCES

A. ASME Section VIII, Division 1 – American Society of Mechanical Engineers Boiler and Pressure Vessel Code

B. ASME/ANSI B16.5 – American Society of Mechanical Engineers/American National Standard Institute

C. Steel Structures Painting Council Surface Preparation Specifications and National Association of Corrosion Engineers

D. ASME Section II, American Society of Mechanical Engineers – Materials, Parts A, B & C

E. American Society of Testing Materials (ASTM)

F. American Water Works Association (AWWA) – B604, Standard for Granular Activated Carbon

G. ANSI/NSF Standard Drinking Water System Components – Health Effects.

H. NSF/ANSI Standard 372: Drinking Water System Components – Lead Content

1.3 System Description

A. Installation of two Calgon Carbon Corporation Model 14 Carbon Adsorption Systems (4 vessels total) described herein are the basis of design for this application. This does not exclude other manufacturers from submitting their products as an alternative providing that all specifications meet or exceed those written here.

B. The complete adsorption system includes the following:

1. Carbon adsorbers with internals for carbon retention

2. Activated carbon

3. Influent, effluent, and backwash piping with valves

4. Carbon fill and discharge piping with valves

5. Vent and pressure relief piping

6. Water piping and utility connections

7. Accessories as shown below

8. Manufacturer's services

C. The vessels, piping, valves, and carbon function as a system and are the end products of Calgon Carbon Corporation to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.

1.4 QUALIFICATIONS

A. Supplier of the adsorption system shall have the following minimum qualifications:

1. Must have applied for and received certification that the system and all components are approved per the requirements of NSF/ANSI Standards 61 and 372.

2. At least 20 years of experience successfully supplying both adsorption systems and GAC to treat water with flow rates greater than 500 gpm average daily flow.

3. Must own and operate an equipment fabrication facility with capabilities to both fabricate the equipment per applicable ASME code and finish lining and paint in a single facility. In addition, this facility must be certified per the requirements of NSF/ANSI Standard 61.

4. Must own and operate at least two (2) GAC production facilities in the United States to guarantee the source of supply of activated carbon.

5. Must have conducted a full-scale test to verify GAC side discharge locations which enables removal of spent GAC in 20,000 lbs. increments. Must submit a report with their proposal documenting full scale test work. Failure to provide the required information in its entirety will result in the rejection of the proposal.

1.5 SUBMITTALS

A. One submittal package with the following information will be provided for approval by the Owner. Fabrication will begin upon receipt of Owner's approval.

1. Adsorber vessel specifications and drawing including design pressure, dimensions, and capacity.

2. System flow diagram showing all valves, components, instrumentation and utilities.

3. System general arrangement showing dimensions, weights, and elevations including influent, effluent, backwash, and carbon exchange pipe connection locations.

4. Pressure drop information across the system.

5. Specifications of the granular activated carbon to utilized in the system.

6. Material specifications for pipe, fittings and instrumentation.

7. Specifications for vessel lining.

8. Specifications for vessel painting.

B. The system Operating & Maintenance Manual will be provided upon completion of the project/shipment of the system.

PART 2 PRODUCTS

2.1 GENERAL

A. The Contract Documents indicate specific required features of the equipment, but do not purport to cover all details of design and construction.

2.2 CARBON ADSORBER VESSELS

A. The carbon adsorbers are **Model 14 Carbon Adsorption Vessels**, as designed by Calgon Carbon Corporation to meet the following specifications.

B. The carbon adsorber vessels are fabricated of carbon steel, conforming to ASTM A516 grade 70, 14'-0" diameter by 17'-0" straight side height with 2:1 elliptical top and bottom heads. Each vessel will be sized to contain 60,000 pounds of GAC and to accommodate approximately 30% bed expansion within the straight side of the vessel using Filtrasorb 400 GAC. The vessels are designed, constructed, and stamped in accordance with ASME Section VIII, Division 1 and registered with the National Board for a design pressure rating of 125 psig at 140□F. Each vessel will be provided with one (1) 20" diameter round manway located on the lower straight side portion of the vessel and one 14" x 18" elliptical manway located on the bottom head. The vessels will be free standing utilizing four (4) structural steel support legs. The vessel will be provided with four (4) lift lugs located on the top head and one tailing lug on the bottom head.

C. The structural aspects of the vessel will be sufficient to meet the International Building Code, latest addition. Calgon Corbon Corporation shall submit detailed calculations illustrating the seismic characteristics of the proposed vessels.

D. Each vessel will be designed with an internal 30° cone bottom underdrain system that provides uniform distribution of the treated water using a minimum of one (1) septa for every nominal square foot of vessel cross section, facilitates GAC removal without the need to open the manway to manually hose out the remaining spent GAC, and allows replacement of the septa without the need to remove external piping. The septa will be designed to contain the GAC within the adsorber and be constructed of polypropylene (ppl)

E. The vessel will be provided with the following nozzles:

1. One (1) 6″ nozzle on the upper sidewall of the vessel for GAC fill.

2. Three (3) nozzles for GAC discharge. Two (2) 6″ GAC discharge nozzles are located on the vessel side wall and one (1) 4″ centered on the bottom head.

3. One (1) 10″ influent nozzle located on the top head constructed of stainless steel and provided with an internal flange to support the inlet distributor.

4. One (1) 10″ effluent nozzle located on the bottom head.

5. Three (3) 2″ sample nozzles located on the side wall.

6. One (1) 2″ cone vent nozzle located on the lower side wall

F. All surfaces will be degreased prior to sandblasting. The adsorber internal surface that will be lines will be blasted to a white metal finish (SSPC-SP5) to provide a 3 to 4 mil anchor pattern. The exterior surfaces of the adsorber will be prepared by blasting per SSPS-SP6.

G. The interior surfaces of the vessel will be lined as follows: he surfaces above the internal cone with a nominal lining thickness of 35 to 45 mil dry film thickness (dft) and the surfaces under the internal cone bottom a nominal lining thickness of 20 to 25 mil dft. The lining material meets the requirements of ANSI 61 when applied and cured per the manufacturer's requirements. The lining material will be one of the following:

1. Carboline's Plasite 4110, vinyl ester lining

2. Blome International's TL-220S AR, vinyl ester lining

3. Carboline's Reactamine 760, aromatic polyurethane hybrid

H. The exterior surface of the adsorbers will be painted to a dry film thickness of 10 to 14 mil with a high solids epoxy (gray color) paint and finished with a polyurethane topcoat of 2 to 3 mil dft.

2.3 PROCESS AND UTILITY PIPING

A. The process and utility piping on the adsorption system will include influent water to the system, treated water (effluent), backwash water supply and discharge, adsorber vent lines and granular activated carbon fill and discharge piping.

B. The influent and effluent pipe network allows series (lead/lag) and parallel only operating modes. Lead/lag operation allows either; a) flow from the influent flange to Adsorber A, to the pipe module, to Adsorber B, to the pipe module then to the effluent flange, or b) flow from the influent flange to Adsorber B, to the pipe module, to Adsorber A, to the pipe module then to the effluent flange. The change in flow pattern is accomplished with a change of valve positions. The purpose of lead/lag operation allows an adsorber to act as an on-line backup and/or provides for sufficient contact time to allow adsorption of the contaminants of concern.

C. Process piping (influent, effluent and backwash) will be 10" diameter, constructed of schedule 40 carbon steel, ASTM A53 Grade B materials with 125# ASTM A126 Class B cast iron flanged fittings.

D. Vent piping will be 4" diameter, constructed of schedule 40 carbon steel, ASTM A53 Grade B materials.

E. Carbon fill piping will be 4" diameter, constructed of schedule 40 carbon steel, ASTM A53 Grade B materials. The connection at the vessel side wall will be a 4"x 6" reducing elbow. The GAC fill connection will be supplied with an adjustable stainless-steel insert. There is a total of one (1) GAC fill line per vessel.

F. Carbon discharge piping will be 4" diameter, constructed of schedule 40 polypropylene lined carbon steel, ASTM 53 Grade B materials with ppl lined flanged fittings. There are a total of three (3) GAC discharge lines per vessel. The connections at the vessel side wall will include a 4"x 6" reducing elbow. The GAC side wall discharge connection will be supplied with an adjustable stainless-steel insert.

G. The vessel must be designed with an adjustable GAC removal system to allow for removal of the spent in 20,000 lbs. increments.

H. Utility piping will be constructed of threaded schedule 80 carbon steel, ASTM 53 Grade B materials.

I. All piping surfaces will be prepared by blasting per SSPC-SP7.

J. The exterior surface of the piping will be painted to a dry film thickness of 10 to 14 mil with high solids epoxy paint prior to assembly to minimize oxidation at flanged connections, then finished with a polyurethane topcoat of 2 to 3 mil dft after assembly.

K. The piping network will be provided with a structural steel support frame for support of the piping module.

2.4 PROCESS AND UTILITY VALVES

A. The process and utility piping; excluding GAC fill and discharge piping will be equipped with butterfly valves to direct flow. A total of ten (10) 10" diameter butterfly valves will be supplied to accommodate the process and backwash functions. Two (2) valves are needed for backwash supply, two (2) valves are needed for influent isolation, two (2) valves for effluent isolation, two (2) valves for staging of the vessels and two (2) valves for the vent function.

B. The influent, effluent, and backwash valves will be a cast iron wafer type body butterfly valve with aluminum-bronze disc, BUNA-N seats, and stainless-steel shaft to mate to 150-pound ANSI flanges. The valves are rated for 200 psig in closed position at 180□F and meet or exceed section 5.0 of AWWA specification C-504-87.

C. The carbon fill and discharge valves are 4" diameter full port ball valves, 316 stainless steel construction with TFE seats and seals. A total of eight (8) valves are supplied, two (2) for carbon fill and six (6) for carbon discharge.

D. Utility valves for the compressed air supply will be bronze or brass or barstock brass body regular port ball valves.

2.5 INSTRUMENTATION

A. Instrumentation will be accessible from grade.

B. Pressure relief will be provided by a 4" rupture disk constructed of impervious graphite and designed to relieve pressure at the design pressure of the vessel and at the maximum flow to the system. The rupture disks will be mounted off the vessel vent line and vent to atmosphere. A total of two (2) will be provided for the system.

C. Each vessel will be provided with an indicating differential pressure switch, 4" diameter dial, scaled for 20-0-20psi. The switch is rated at 1.0 amp @ 115 volts AC for remote indication. A total of two (2) will be provided for the system .

D. The process piping will be equipped with pressure gauges to indicate the pressure entering and exiting each adsorber and to provide information on pressure drop across each adsorber and the system. The pressure gauges will

have 4 ½" face diameter with a stainless-steel bourdon tube in a phenolic case housing (1 to 160 psig range). A total of three (3) will be provided for the system.

E. The process piping will be equipped with sample taps to enable sampling of the water entering and exiting each adsorber. A total of three (3) will be provided for the system.

2.6 MISCELLANEOUS

A. The carbon fill and discharge will be fitted with female hose connections, such that carbon transfer to and from the adsorbers can be facilitated using carbon transfer hoses. These connectors will be 4" Quick Disconnect Adaptors constructed of aluminum as manufactured by Dover Corp. as Kamlock connectors or equal.

B. Two (2) flush connections will be provided on each GAC fill line, one upstream and one downstream of the valve. One (1) flush connection will be provided on each GAC discharge line, downstream of the valve. The connections will be welded into the steel or stainless-steel pipe or screwed into solid propylene "spacers" for the lined pipe. Flush connections will consist of a short section of ¾" pipe, a ¾" full port ball valve and a ¾" quick disconnect adaptor to match with water hose fittings.

C. Each vessel will be provided with one (1) 10" stainless steel effluent strainer basket mounted in the effluent line from the vessel. The basket strainer shall be constructed of 316 stainless 14 gage plate with 1/8" diameter holes drilled on 3/16" centers, covered with 40 mesh 316 stainless steel screen and topped by a 4 mesh 316 stainless steel support screen (0.063" wire diameter). A total of two (2) will be provided for the system.

D. The influent and effluent pipe for each vessel will be provided with a molded neoprene reinforced rubber expansion joint which allows 4-way movement and 19° angular misalignment. A total of four (4) will be provided for the system.

E. Each vessel will be provided with an inlet distributor constructed of 316 stainless steel. The distributor will connect to the inlet nozzle and be fitted with multiple arms. Each arm is drilled along its length to facilitate even distribution of water during normal operation and collection of backwash water. A total of two (2) distributors will be provided for the system.

F. In-Bed Sample Taps: Each adsorber will be provided with three (3) 2" side sample nozzles for use with in-bed water sample probes. Sample probes consist of a 12" stainless steel pipe with a stainless-steel slotted septum to collect a water sample from within the carbon bed. The sample probe will be inserted through a 2" flanged nozzle and will be provided with stainless steel tubing drop line and stainless-steel shutoff valve external to the adsorber. A total of six (6) in-bed sample taps will be provided for the system.

G. Air/Vacuum Release Valve – Option Adder: Each adsorber can be provided with one (1) 1″ combination air/vacuum release valve mounted at the top of the influent pipe. Two (2) 1″ ball valves will be provided to isolate the air release valve, one ball valve positioned between the influent pipe and the air release valve and the second mounted at the bottom of the air release piping (at ground level). A total of two (2) will be provided for the system.

H. Each system will be provided with one Carbon Acceptance Canister. This will allow for testing of the carbon to determine its suitability for reactivation or disposal.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01300 – Submittals.

B. Verify site conditions are ready for installation.

C. Field verify that the foundation has been constructed and ready for installation.

3.2 PREPARATION

A. Protect structures near construction site from damage.

3.3 INSTALLATION

A. Carbon vessels and associated piping as outlined in this spec are owner-pre-purchased and will be on-site for installation. Contractor will be responsible for the installation of the system as described herein.

B. Calgon Carbon Services

1. Calgon Carbon will assign a Project Manager (PM) to facilitate the execution of the project. The PM will interface with the customer for both the technical and commercial aspects of the project.

2. Calgon Carbon will provide an Engineering Submittal Package as outlined in paragraph 1.05A.

3. Calgon Carbon will supply Operation and Maintenance Instructions upon completion of the project/shipment of the system.

4. A manufacturer's trained specialists, experienced in the installation of the Calgon Carbon's Adsorption Systems, and with at least five (5) years of

field experience will be present at the job site and/or classroom designated by the Owner/Contractor to provide the following services:

a. Inspection of the installed equipment

b. Supervision of carbon loading

c. Start-up assistance

d. Troubleshooting

e. Operator training

5. Calgon Carbon will retain design and fabrication documentation for a minimum period of seven (7) years following completion of the project.

C. Contractor Responsibilities

1. The contractor will be responsible for installation and site services, including:

a. Site preparation

b. Receipt, off-loading (and storage) of adsorption system equipment

c. Installation of owner-pre-purchased adsorption system equipment

d. Connection of the dP switch to an alarm system

e. Provision of a means to keep the vessel flooded in all operating modes

f. Any hydrostatic test of the installed (assembled) system at the site

g. System connection to existing infrastructure

h. System disinfection prior to initial fill of carbon

i. Utilities for bulk loading of GAC (compressed air, clean water source, backwash water disposal)

j. Operation of the system during carbon fill operation

k. Mechanical startup of the system

3.4 FIELD QUALITY CONTROL

A. Certified factory start-up shall be provided for by a factory authorized service representative. A certified start-up form shall be filled out with a copy provided to the owner and a copy kept on file at the manufacturer.

B. The factory will extend the normal warranty for the system with a certified factory start-up.

C. With a certified start-up, warranty shall be 24 months from the date of start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time, and expenses.

D. Notify Engineer five days prior to start-up.

END OF SECTION

SECTION 13216
GRANULATED ACTIVATED CARBON

PART 1 GENERAL

1.1 SUMMARY

A. This specification section is for the initial fill of Granular Activated Carbon (GAC) as follows:

1. Furnish all materials, equipment, and supervision for the transport, supply, and installation of virgin GAC into the filters.

B. Each bidder shall visit the site and shall inform themselves of all existing conditions.

1.2 SUBMITTALS

A. Pre-shipment samples:

1. Prior to GAC delivery to site, pre-shipment samples shall be submitted to an independent laboratory mutually agreed upon between the Engineer/City and the manufacturer.

2. The samples shall be accompanied with a Certificate of Analysis and shall also include the following parameters:

a. Iodine number, mg/g (ASTM D4607)

b. Moisture (as packed), wt% (ASTM D2867)

c. Effective size, mm (ASTM D2862)

d. Uniformity coefficient (ASTM D2862)

e. Abrasion number (AWWA B604 – latest edition)

f. Trace capacity number (TCN), mg/cc

g. Particle size distribution (US mesh size), wt% (ASTM D2862)

3. The number of samples to be submitted shall be in accordance with AWWA B604, latest edition. Based on the project size, the manufacturer shall determine the lot size and in turn shall provide the appropriate number of samples to be considered representative.

4. Failure of the pre-shipment samples to meet specifications shall be cause for rejection. Manufacturer shall then resubmit new pre-shipment samples

for testing. Manufacturer shall not be given approval to ship GAC until pre-shipment samples meet specification.

5. The Certificate of Analysis shall certify that the GAC sample shipped to the site is 100% virgin activated carbon and in full compliance with the specifications stated herein.

6. Costs for pre-shipment sample testing shall be borne by the manufacturer.

1.3 QUALIFICATIONS

A. Manufacturer shall have a minimum of 15 years' experience manufacturing virgin granular activated carbon and shall submit proof via a Manufacturer's Certificate and/or an Affidavit of Compliance.

B. Manufacturer shall furnish evidence of comprehensive general liability insurance in the minimum amount of $2,000,000 to provide protection from any and all claims that may arise from the supplier's supply, shipping, and installation supervision of the activated carbon.

C. Manufacturer's virgin and reactivation manufacturing processes shall produce NSF/ANSI 61 certified products.

D. Manufacturer shall certify that it is the owner and operator of a potable reactivation facility or has long-term agreement with the owner/operator of a potable reactivation facility.

PART 2 PRODUCTS

2.1 PRODUCT SPECIFICATION

A. The manufacturer shall supply 100% virgin GAC for the initial fill of the filters. The virgin GAC shall meet the following specifications:

1. Virgin GAC shall be Filtrasorb 400M or pre-approved equal.

2. The coal shall be mined and the corresponding GAC manufactures in the United States of America.

3. The GAC product designated by the Bidder as the material to be supplied for this bid shall have five (5) years of history of use in municipal drinking water facilities in North America. Bidder shall submit referenced per Section 7.

4. The GAC shall be manufactured in a facility certified to conform to the Management System Standard: ISO 9001:2000 or later quality standards and at the specific plant or site holding such certification.

5. The GAC shall comply with AWWA B604, latest edition.

6. The GAC shall conform to the requirements of the NSF/ANSI 61 Drinking Water System Components – Health Effect standard.

7. The GAC shall comply with the requirements for activated carbon as defined by the Food Chemical Codex (FCC) latest edition published by the U.S. Pharmacopeia.

8. The GAC must be a 100% reagglomerated, bituminous coal-based product, sized to a granular form prior to thermal activation. The following materials shall not be accepted if submitted in lieu of the required product, nor may any amount of these materials be blended into a mix with the required reagglomerated, bituminous coal-based product:

    a. Broken pellets, regardless of base material

    b. Direct activated GAC, regardless of base material

    c. Lignite-based GAC

    d. Peat-based GAC

    e. Wood-based GAC

    f. Coconut-based GAC

    g. Sub-bituminous based GAC

    h. Anthracite based GAC

9. The GAC shall be capable of removing color, tastes, odors and other organic contamination from previously pretreated water by conventional treatment processes.

10. The manufacturer shall indicate the source of coal, carbon manufacturing location, a description of the reagglomeration/thermal process and capacity of the manufacturing facility. The Engineer reserves the right to inspect the GAC manufacturing and thermal processing facility.

11. Product as packaged (confirmed by pre-shipment sample testing) shall meet the following specifications:

Product Specification: FILTRASORB 400M	**Value**	**Test Method**
Iodine Number (mg/g), min.	1000	ASTM D4607
Moisture, weight %, max.	2	ASTM D2867
Effective size, mm	0.55 – 0.75	ASTM D2862
Uniformity Coefficient, max.	1.9	ASTM D2862
Abrasion No., min.	75	AWWA B604
Trace Capacity Number, (mg/cc), min.	10	TM-79, TM-85 (converted to TCN)
Screen Size (US Sieve), weight %		
*Larger than No. 12, max.	5	ASTM D2862
*Smaller than No. 40, max.	4	ASTM D2862
Typical Property	**Value**	
Apparent Density, g/cc, min.	0.54	ASTM D2854
Ash	8%	ASTM D2866
Water Extractables	<1%	AWWA B604
Non-Wettable	<1%	AWWA B604

12. The Certificate of Analysis shall certify that the GAC sample shipped to the site is 100% virgin carbon and in full compliance with the specifications stated herein. Failure to comply shall be considered non-responsive and the GAC shall be rejected.

2.2 POST-DELIVERY SAMPLES

A. After delivery to the site, but before GAC installation occurs, the Engineer may take random samples of each media prior to loading of the GAC into the filters.

1. Sieve analysis may be performed on each sample by a laboratory selected by the Engineer.

2. Additional tests may be performed on the GAC including, but not limited to, iodine, ash, and apparent density.

3. This testing shall be for informational and record purposes only.

4. Costs for sample testing shall be borne by the Engineer.

5. Number of samples taken shall be determined by the Engineer.

B. "In-situ" samples after installation of GAC into filters/vessels may be taken as directed by the Engineer.

1. Such in-situ samples are not to be considered representative of the GAC installed due to inherent inaccuracies involved in sampling from filters and vessels.

2. Any test results obtained from testing of in-situ samples shall be for informational and record purposes only.

3. Costs for sample testing shall be borne by the Engineer.

4. Number of samples taken shall be determined by the Engineer.

PART 3 EXECUTION

3.1 CARBON INSTALLATION PROCEDURES

A. GAC installation shall be performed by the General Contractor under the supervision of the GAC manufacturer.

B. The GAC installation shall be under the direct supervision of the GAC manufacturer's employee, having a minimum of 5 years' experience in performing carbon exchanges. Supervision by a third party or agent shall not be allowed.

C. Manufacturer shall submit resumes of supervisors capable of performing carbon installations, indicating qualifications, years of experience and location.

D. GAC shall be transported, delivered and placed in a careful manner to exclude all dust, dirt or deleterious material and to prevent physical damage to the particles.

E. Bidder shall submit a detailed carbon installation procedure for use by the General Contractor.

END OF SECTION

SECTION 13216
INSTALLATION OF GRANULATED ACTIVATED CARBON

PART 1 GENERAL

1.1 SUMMARY

A. This specification section is for the initial fill of Granular Activated Carbon (GAC) as follows:

1. Installation of virgin GAC into the filters.

B. Each bidder shall visit the site and shall inform themselves of all existing conditions.

1.2 SUBMITTALS – NOT APPLICABLE

A. Pre-shipment samples:

1. Prior to GAC delivery to site, pre-shipment samples shall be submitted to an independent laboratory mutually agreed upon between the Engineer/City and the manufacturer.

2. The samples shall be accompanied with a Certificate of Analysis and shall also include the following parameters:

a. Iodine number, mg/g (ASTM D4607)

b. Moisture (as packed), wt% (ASTM D2867)

c. Effective size, mm (ASTM D2862)

d. Uniformity coefficient (ASTM D2862)

e. Abrasion number (AWWA B604 – latest edition)

f. Trace capacity number (TCN), mg/cc

g. Particle size distribution (US mesh size), wt% (ASTM D2862)

3. The number of samples to be submitted shall be in accordance with AWWA B604, latest edition. Based on the project size, the manufacturer shall determine the lot size and in turn shall provide the appropriate number of samples to be considered representative.

4. Failure of the pre-shipment samples to meet specifications shall be cause for rejection. Manufacturer shall then resubmit new pre-shipment samples for testing. Manufacturer shall not be given approval to ship GAC until pre-shipment samples meet specification.

5. The Certificate of Analysis shall certify that the GAC sample shipped to the site is 100% virgin activated carbon and in full compliance with the specifications stated herein.

6. Costs for pre-shipment sample testing shall be borne by the manufacturer.

1.3 QUALIFICATIONS – NOT APPLICABLE

A. Manufacturer shall have a minimum of 15 years' experience manufacturing virgin granular activated carbon and shall submit proof via a Manufacturer's Certificate and/or an Affidavit of Compliance.

B. Manufacturer shall furnish evidence of comprehensive general liability insurance in the minimum amount of $2,000,000 to provide protection from any and all claims that may arise from the supplier's supply, shipping, and installation supervision of the activated carbon.

C. Manufacturer's virgin and reactivation manufacturing processes shall produce NSF/ANSI 61 certified products.

D. Manufacturer shall certify that it is the owner and operator of a potable reactivation facility or has long-term agreement with the owner/operator of a potable reactivation facility.

PART 2 PRODUCTS

2.1 PRODUCT SPECIFICATION – NOT APPLICABLE

A. The manufacturer shall supply 100% virgin GAC for the initial fill of the filters. The virgin GAC shall meet the following specifications:

1. Virgin GAC shall be Filtrasorb 400M or pre-approved equal.

2. The coal shall be mined and the corresponding GAC manufactures in the United States of America.

3. The GAC product designated by the Bidder as the material to be supplied for this bid shall have five (5) years of history of use in municipal drinking water facilities in North America. Bidder shall submit referenced per Section 7.

4. The GAC shall be manufactured in a facility certified to conform to the Management System Standard: ISO 9001:2000 or later quality standards and at the specific plant or site holding such certification.

5. The GAC shall comply with AWWA B604, latest edition.

6. The GAC shall conform to the requirements of the NSF/ANSI 61 Drinking Water System Components – Health Effect standard.

7. The GAC shall comply with the requirements for activated carbon as defined by the Food Chemical Codex (FCC) latest edition published by the U.S. Pharmacopeia.

8. The GAC must be a 100% reagglomerated, bituminous coal-based product, sized to a granular form prior to thermal activation. The following materials shall not be accepted if submitted in lieu of the required product, nor may any amount of these materials be blended into a mix with the required reagglomerated, bituminous coal-based product:

    a. Broken pellets, regardless of base material

    b. Direct activated GAC, regardless of base material

    c. Lignite-based GAC

    d. Peat-based GAC

    e. Wood-based GAC

    f. Coconut-based GAC

    g. Sub-bituminous based GAC

    h. Anthracite based GAC

9. The GAC shall be capable of removing color, tastes, odors and other organic contamination from previously pretreated water by conventional treatment processes.

10. The manufacturer shall indicate the source of coal, carbon manufacturing location, a description of the reagglomeration/thermal process and capacity of the manufacturing facility. The Engineer reserves the right to inspect the GAC manufacturing and thermal processing facility.

11. Product as packaged (confirmed by pre-shipment sample testing) shall meet the following specifications:

Product Specification: FILTRASORB 400M	**Value**	**Test Method**
Iodine Number (mg/g), min.	1000	ASTM D4607
Moisture, weight %, max.	2	ASTM D2867
Effective size, mm	0.55 – 0.75	ASTM D2862
Uniformity Coefficient, max.	1.9	ASTM D2862
Abrasion No., min.	75	AWWA B604
Trace Capacity Number, (mg/cc), min.	10	TM-79, TM-85 (converted to TCN)
Screen Size (US Sieve), weight %		
*Larger than No. 12, max.	5	ASTM D2862
*Smaller than No. 40, max.	4	ASTM D2862
Typical Property	**Value**	
Apparent Density, g/cc, min.	0.54	ASTM D2854
Ash	8%	ASTM D2866
Water Extractables	<1%	AWWA B604
Non-Wettable	<1%	AWWA B604

12. The Certificate of Analysis shall certify that the GAC sample shipped to the site is 100% virgin carbon and in full compliance with the specifications stated herein. Failure to comply shall be considered non-responsive and the GAC shall be rejected.

2.2 POST-DELIVERY SAMPLES

A. After delivery to the site, but before GAC installation occurs, the Engineer may take random samples of each media prior to loading of the GAC into the filters.

1. Sieve analysis may be performed on each sample by a laboratory selected by the Engineer.

2. Additional tests may be performed on the GAC including, but not limited to, iodine, ash, and apparent density.

3. This testing shall be for informational and record purposes only.

4. Costs for sample testing shall be borne by the Engineer.

5. Number of samples taken shall be determined by the Engineer.

B. "In-situ" samples after installation of GAC into filters/vessels may be taken as directed by the Engineer.

1. Such in-situ samples are not to be considered representative of the GAC installed due to inherent inaccuracies involved in sampling from filters and vessels.

2. Any test results obtained from testing of in-situ samples shall be for informational and record purposes only.

3. Costs for sample testing shall be borne by the Engineer.

4. Number of samples taken shall be determined by the Engineer.

PART 3 EXECUTION

3.1 CARBON INSTALLATION PROCEDURES

A. GAC installation shall be performed by the General Contractor under the supervision of the GAC manufacturer.

B. The GAC installation shall be under the direct supervision of the GAC manufacturer's employee, having a minimum of 5 years' experience in performing carbon exchanges. Supervision by a third party or agent shall not be allowed.

C. Manufacturer shall submit resumes of supervisors capable of performing carbon installations, indicating qualifications, years of experience and location.

D. GAC shall be transported, delivered and placed in a careful manner to exclude all dust, dirt or deleterious material and to prevent physical damage to the particles.

E. Bidder shall submit a detailed carbon installation procedure for use by the General Contractor.

END OF SECTION

SECTION 13221
FILTER MEDIA

PART 1 GENERAL

1.1 SUMMARY

A. This specification section is for the replacement of sand and anthracite for the constant rate gravity filters.

B. CONTRACTOR shall provide all labor, materials, equipment, and start-up services for the installation and satisfactory operation of the complete filter media system of sand and anthracite materials.

C. CONTRACTOR shall be completely responsible for the proper start-up, operation and functions of the filtering material herein specified. CONTRACTOR shall be responsible for coordination of all interfaces with other sub-contractors to achieve the required filtering materials operation.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:

1. American Society for Testing and Materials, (ASTM).

   a. ASTM C127, Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.

   b. ASTM C128, Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate.

   c. ASTM C136, Test Method for Sieve Analysis of Fine and Coarse Aggregates.

   d. ASTM E11, Specification for Woven Wire Test Sieve Cloth and Test Sieves.

   e. ASTM D75, Practice for Sampling Aggregates.

2. American Water Works Association, (AWWA).

   a. AWWA B100, Granular Filter Material.

   b. AWWA C653-13, Disinfection of Water Treatment Plants

3. National Sanitation Foundation, (NSF).

   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.

4. Occupational Safety and Health Administration (OSHA)

5. Recommended Standards for Water Works, Great Lakes and Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.

1.3 SUBMITTALS

A. Samples: Submit the following:

1. General: Representative samples from each production lot shall be taken at manufacturer's facility prior to shipping and sent to a 3rd party test facility. The production lot shall be held at the manufacture's facility until testing has been completed and release for shipment. No filter media shall be placed until certified copies of the testing laboratory report have been submitted to and approved by the ENGINEER.

2. Representative Samples of Proposed Filter Media: CONTRACTOR shall furnish to the ENGINEER and testing laboratory representative samples of the sand and anthracite filter materials proposed to be used in the filters. Care shall be taken to ensure that samples are obtained from locations within each stockpile to ensure characteristics representative of the material proposed. A full depth core sample shall be taken of the stockpile. Samples shall be placed in tight glass or clear plastic jars holding not less than two quarts and shall be properly labeled.

3. Representative samples of the filter media shipped to the plant:

a. Representative samples from each production lot shall be taken at manufacturer's facility prior to shipping and sent to a 3rd party test facility. The production lot shall be held at the manufacture's facility until testing has been completed and release for shipment.

b. No filter media shall be placed until certified copies of the testing laboratory report on the media have been submitted to and approved by the ENGINEER.

B. Test reports: Certified test reports on the representative samples of proposed filter media, and on samples of filter media shipped to the Site, shall be submitted in duplicate by the testing laboratory directly to the ENGINEER. Test reports shall contain, as a minimum, the following information for each media:

1. Average specific gravity (apparent).

2. Total percentage of material passing each sieve.

3. Total percentage of material retained on each sieve.

4. A plot on probability paper, showing the percent of the material passing the sieve versus the sieve size opening.

5. Effective Size: The size of grain (in millimeters) such that ten percent by weight of the media grains are smaller in diameter.

6. Uniformity Coefficient: The ratio of the size of the grain which has 60 percent by weight of the media grains smaller in diameter to the effective size.

7. Acid solubility.

8. Hardness (anthracite).

C. Qualification Statements:

1. Media Supplier's qualifications

2. Installer's qualifications

3. Testing laboratory's qualifications

1.4 QUALITY ASSURANCE

A. Media Supplier's Qualifications:

1. CONTRACTOR shall furnish the filter media under this Section to be the product of a supplier who maintains a complete engineering, continuous quality control, and service capabilities in the application and production of the materials specified herein.

2. CONTRACTOR shall be prepared to document the filter media supplier's technical competence and experience in providing the filter media specified herein.

3. The CONTRACTOR shall have the supplier submit a letter or certificate describing quality control program.

4. Supplier shall have a minimum of ten (10) years experience in producing materials similar to that specified herein and shall provide evidence of at least ten (10) installations in satisfactory operation.

B. Installer's Qualifications:

1. Provide a single installer experienced in and regularly engaged in the installation of all types of filter media. Submit name and qualifications to ENGINEER.

C. Filter Media Sampling and Testing:

1. Perform sampling of filter media materials in accordance with ASTM D75 as modified and supplemented in Section 5 of AWWA B100.

2. The minimum size of composite field samples shall be as specified in Section 5 of AWWA B100.

3. Tests shall be performed on representative samples taken from the proposed filter media and the filter media prior to shipping to the plant. Tests to be performed and the test standards to be followed by the testing laboratory shall include the following:

    a. Specific Gravity (apparent): ASTM C127 for filter sand; ASTM C128 for filter anthracite.

    b. Sieve Analysis: ASTM C136 and AWWA B100.

    c. Acid Solubility: AWWA B100.

    d. Hardness (anthracite only).

4. Testing Prior to Shipment

    a. All filter media materials shall be tested to demonstrate compliance with requirements of these Specifications. The various tests required are specified below. Tests shall be performed by an approved commercial testing laboratory, except as indicated herein.

    b. Perform tests on samples obtained directly from the supply source of the filter media materials. Obtain samples not sooner than 30 days prior to the date scheduled for the shipment of filter media to the job site.

    c. Initial Acceptance Tests are required for the following:

        1) Silica Sand

        2) Anthracite

    d. Initial Acceptance Tests shall include the following parameters:

        1) Grain size analysis.

        2) Effective size.

        3) Uniformity coefficient.

        4) Specific gravity.

        5) Acid solubility.

6) Mohs Hardness (anthracite only).

5. Receipt Sampling and Tests

a. Collect representative samples from bags or semibulk containers of filter media shipped to the job site using a core sampler. Combine the representative samples from each bag or semibulk container to produce the required field sample. Sample the number of bags or semibulk containers as specified in Section 5 of AWWA B100.

6. All costs in connection with sampling and testing of the filter media materials shall be at the expense of the CONTRACTOR.

D. Rejection of Filter Media:

1. Failure of the filter media to meet the requirements as demonstrated by the certified test reports of the testing laboratory shall constitute cause for rejection.

2. Filter media that has been tested after delivery to the Site and is rejected shall be removed from the Site and replaced with acceptable material. As an alternative, the rejected material may be reprocessed and retested.

3. All costs related to the testing, reprocessing, and replacement of rejected material shall be at the expense of the CONTRACTOR.

E. Testing Laboratory:

1. CONTRACTOR shall retain the services of an independent testing laboratory, acceptable to the ENGINEER, to perform the tests specified herein, and to attest to the fact that the filter media will comply with the requirements set forth herein, and that all testing work has been in accordance with the methods stipulated.

2. All costs incidental to the testing laboratory shall be borne entirely by CONTRACTOR.

1.5 PRODUCT, DELIVERY, STORAGE AND HANDLING

A. Deliver filter media to the Site to ensure uninterrupted progress of the Work.

B. Deliver filter media in bags or semi bulk containers only. Bulk shipment by rail car or truck will not be permitted.

C. Conform to AWWA B100 and the requirements and recommendations of the filter media supplier.

D. Store filter media on pallets. Cover media stored outdoors with black polyethylene sheets to prevent UV deterioration and moisture contamination.

E. Do not order materials for shipment until ENGINEER has approved the results of the Certified Test Results.

1.6 JOB CONDITIONS

A. Protection:

1. Dust Control:

a. Provide adequate protection for surrounding areas at all times during the installation of filter media, particularly during the placement of anthracite coal.

2. Personnel Protection:

a. Provide OSHA approved-type dust protection for personnel placing filter media, in particular, during placing of silica materials.

PART 2 PRODUCTS

2.1 DESIGN CONDITIONS

A. Description:

1. Filter media shall consist of silica sand and anthracite coal placed to the thicknesses shown and specified.

B. Filter Operating Conditions:

1. Type of Filter: Constant Rate.

2. Maximum Filtration Rate: 5 gpm/sf.

3. Maximum Backwash Rate: 22 gpm/sf.

2.2 FILTER MEDIA

A. Silica Sand:

1. Silica sand shall consist of hard, durable and dense grains of predominantly siliceous material that will resist degradation during handling and use and shall be visually free of clay, dust, and micaceous and organic matter. Place silica sand in a single layer directly on the filter underdrain.

2. Silica sand characteristics shall be as follows:

    a. Layer 1: Provide 7.75 inches of high density sand to cover existing Triton underdrain gaps.

    b. Layer 2:9 inches (measured from the top of Layer 1 to the top of the sand layer).

    c. Effective Size Range: 0.45 to 0.55 mm.

    d. Uniformity Coefficient: Not greater than 1.4.

    e. Apparent Specific Gravity: >2.50

    f. Acid Solubility: Less than five percent.

B. Anthracite Coal:

1. Anthracite coal shall consist of hard, durable anthracite particles of various sizes, visually free of clay, shale and extraneous dirt. Place anthracite coal in a single layer directly on the silica sand.

2. Anthracite coal characteristics shall be as follows:

    a. Depth of Layer: 18 inches.

    b. Effective Size Range: 0.90 to 1.0 mm.

    c. Uniformity Coefficient: Not greater than 1.4.

    d. Hardness: >2.7 on Mohs scale.

    e. Apparent Specific Gravity: >1.4.

    f. Acid Solubility: Less than five percent.

C. Supplier

1. Provide product from one of the following:

    a. Unifilt Corporation

    b. F.B. Leopold

    c. CEI

PART 3 EXECUTION

3.1 GENERAL

A. CONTRACTOR shall provide the services of a qualified technical representative of the media supplier throughout the entirety of filter bed preparation, media inspection and installation to ensure proper compliance with the procedures described herein. This provision, however, shall not be construed as relieving CONTRACTOR of his overall responsibility for this portion of the Work.

3.2 INSPECTION

A. Sand and anthracite shall be inspected on Site for organic matter. All sand and anthracite which have been found to be contaminated by organic matter will be rejected.

3.3 PREPARATION

A. CONTRACTOR shall thoroughly clean each filter before any filter materials are placed and shall keep each filter clean throughout placement operations. CONTRACTOR shall thoroughly clean and sweep the filter walls and underdrains and shall determine that all holes in the filter underdrains are open and free of any obstructions.

B. Before any materials are placed, CONTRACTOR shall mark the top elevation of each layer by a continuous level line on the inside of each filter.

3.4 INSTALLATION

A. General:

1. No filter media shall be placed until certified copies of the laboratory reports on tests performed on representative samples of filter media shipped to the Site have been forwarded to and accepted by the ENGINEER.

2. No filter media shall be placed until after the underdrain installation has been accepted by the ENGINEER.

3. Special care shall be taken in transporting and placing the filter media to prevent it from being contaminated. Filter media that has become dirty, before, during or after being placed in the filter, shall either be removed and washed or replaced with clean media in a manner satisfactory to the ENGINEER. Pneumatic methods of transporting or placing filter media shall not be utilized.

4. Each layer of filter media shall be deposited in a uniform thickness corresponding to that specified and shown with each surface screened and

brought to a true level plane. Care shall be exercised in placing each layer to avoid disturbing the surface of the layer beneath. Workmen shall not stand or walk directly on media. They shall walk on boards or plywood that will sustain their weight without displacing the material.

5. The elevation of the top surface of each layer shall be checked by filling the filter with water to the level line previously marked on the inside of the filter. Filter material shall be within +/- 0.5 inches of the water surface, with the area of the material above and below the water surface within 10 percent of each other.

6. Placing of filter materials shall conform to AWWA Section 5, AWWA B100, and the recommendations of the filter media supplier.

7. **All water used by CONTRACTOR for media installation will be supplied by OWNER at no charge**.

B. Filter Sand:

1. Prior to placement of filter sand, the underdrain and air backwash systems shall be tested by CONTRACTOR in the presence of the ENGINEER.

2. Place the material in reasonably level layers and exercise care in depositing each layer so as not to cause any damage to the underdrains and not disturb the level surface of the layer below.

3. Upon completion of placement of the filter sand layer, wash, scrape and skim the material in accordance with AWWA B100.

4. After skimming of the sand is completed, install additional material, if required, to bring the final thickness of the layer to that specified.

C. Anthracite Coal:

1. Before placing the anthracite, the filters shall be filled with water to the depth corresponding to the top elevation of the anthracite layer. Anthracite shall then be poured carefully into the water. The anthracite after placement shall be soaked in water for at least 24 hours before conducting the first backwash.

2. After the anthracite has been placed and soaked, CONTRACTOR shall backwash each filter at least three times, each for at least ten minutes, in the presence of the ENGINEER. Backwash shall start at a rate not to exceed five gpm per square foot and shall be gradually increased to the maximum backwash design rate to produce a minimum bed expansion of 30 percent. At the end of ten minutes, the backwash valve shall be slowly closed to allow the anthracite to gradually settle and compact. Closure

rate of the backwash valve shall be directed by the media supplier, but shall be not less than 30 seconds between the valve position corresponding to ten percent bed expansion and the final position. After allowing the water to drain at the end of the backwash period, CONTRACTOR shall skim off the fine-grained materials, which have accumulated at the surface of the bed to the satisfaction of the ENGINEER. After initial backwashing, CONTRACTOR shall place additional filter anthracite as required to bring the anthracite layer to the specified level. This backwash sequence shall be conducted two additional times until the anthracite is clean and no further water discoloration appears. Initial backwashing shall be conducted on one filter box at a time and shall use filtered water.

D. Backwash Water:

1. Potable water required for backwashing shall be supplied by OWNER.

2. CONTRACTOR shall coordinate with ENGINEER prior to backwashing filters.

E. Filter Media Supplier's Representative:

1. A qualified representative of the filter media supplier shall be in attendance at all times when filter media is being installed. The media supplier's representative shall instruct CONTRACTOR'S personnel in the correct procedures for each aspect of the media installation, check each filter installation before it is placed in service and instruct the OWNER'S personnel in operation and care of the media.

3.5 DISINFECTION

A. After the filter sand and anthracite coal layers have been placed and brought to the specified gradation and thickness, disinfect each in accordance with AWWA C653 and as follows:

1. Inject sufficient chlorine into the wash water to produce a solution having a chlorine concentration of at least 25 mg/l throughout the filter. Introduce sufficient wash water so that all surfaces up to the maximum operating level of the filter will be in contact with the chlorinated water. Hold chlorinated water in the filter for a minimum of 12 hours.

2. As an alternative to the disinfection procedure above, spray all surfaces of the filter box up to the maximum operating level with a 200 mg/l chlorine solution. The solution shall remain in contact with the surfaces for a minimum of 30 minutes. Disinfect the remaining portion of the filter with a 25 mg/l chlorine solution for a minimum of 12 hours.

3. Remove chlorine prior to placing the filter in service by thorough washing.

4. Bacteriological sampling shall be performed according to AWWA C653 before the filters are placed into service.

B. Potable water for disinfecting the filters shall be supplied by the OWNER. CONTRACTOR shall supply all chlorine required for chlorination.

END OF SECTION

SECTION 13400
STATIC MIXER

PART 1 GENERAL

1.01 SCOPE OF WORK

Work under this section includes but is not limited to furnishing and installing static mixers system as indicated on the project drawings, herein specified, as necessary for proper and complete performance.

1.02 QUALITY ASSURANCE

A. The manufacturer of the mixer system must have at least 45 years of experience in the design and manufacture of municipal mixer systems in USA. The manufacturer must provide a list of similar projects upon request.

B. Mixers furnished for Work: New

C. Manufacturer shall demonstrate expertise in design and manufacture of static mixers of similar size and scope.

1.03 SUBMITTALS

Prior to fabrication, the mixer manufacturer must provide the following information for review and approval

Shop drawings with dimensions for general review.

A. Product Data sheets for make and model being supplied.

B. Complete catalog information, descriptive literature, specifications and identification of materials of construction.

C. Calculations are to be shown for flow characteristics, flow velocity and pressure drop

D. Material of construction with ASTM reference and grade. Submit Manufacturer's compliance with referenced standards.

E. Operations and Maintenance Manual.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. KOMAX SYSTEMS INC

2.02 MIXER DESIGN

A. STATIC MIXER AS-83634

1. Mixer shall provide uniform mixing of chemicals into the main water stream at through its 36 inch NPS diameter housing.
2. Each mixer shall be furnished with 316SS components included flanged end body, internal elements and all other necessary appurtenances.
3. Mixer housing ends shall be AWWA C207 Class D Flanges.
4. Mixer shall contain a minimum of 3 sets of HDP triple action mixing elements.
5. Mixing element should be a triple-action mixing design producing two-by-two division, cross current mixing and counter rotating vortices shall be provided which produce a high degree of back mixing at the designed flow rates with minimum pressure drop. Mixing elements should be welded in mixer spool.
6. Trapezoidal tab type mixing elements shall not be accepted. Mixing elements configured as corrugated metal plates shall not be accepted. Helical, double action mixing elements shall not be accepted.
7. Mixer shall include four 1" FNPT additive ports with retractable injector specifically designed to disperse chemicals at the centerline of the mixer.
8. Mixer overall length shall not exceed 70 inches.
9. The static mixer to achieve a CoV of 0.05 or better within 3 pipe diameter downstream of the mixer.

PART 3 EXECUTION

3.01 INSTALLATION

A. The mixing equipment shall be installed in accordance with manufacturer's installation drawings and instructions

END OF SECTION

SECTION 13500
WATER STORAGE TANK

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and erect a glass-coated, bolted-steel water storage tank, including foundation, tank structure and tank appurtenances as shown on the contract drawings and described herein.

B. All required labor, materials and equipment shall be included.

1.02 QUALIFICATIONS OF TANK SUPPLIER

A. The Engineer's selection of factory applied glass-fused-to-steel bolted tank construction for this facility has been predicated upon specific criteria, construction methods, and an optimum coating for resistance to internal and external tank corrosion. Deviations from the specified design, construction or coating details, will not be permitted.

1. The company constructing the tank shall be a firm with at least 20 years' experience in the construction of glass lined bolted steel tanks; and shall give satisfactory evidence that it has the skill, reliability and financial ability to build and guarantee the tank in accordance with the quality required by these specifications. The company constructing the tank shall have built completely in its own name in the past 10 years and be presently responsible for a minimum of ten (10) steel tanks of equal size or larger, which meet these specifications and which are now giving satisfactory service

B. The bidder shall offer a new tank structure as supplied from a manufacturer specializing in the design, fabrication and erection of factory applied glass-fused-to-steel, bolted tanks. The bidder shall provide a new tank structure as supplied from a manufacturer using only steel smelted in the United States of America with mill certification. Tank shall be compliant with the Consolidated & Further Continuing Appropriations Act of 2015 (EPA AIS guidelines) and the conditions set forth in the United States Environmental Protection Agency De Minimis Waiver of Section 436 of P.L. 113-76. The manufacturer shall employ a staff of full-time design engineers, shall own and operate its steel fabrication facilities and glass coating facilities and fully design the tank and foundation.

C. The tank shown on the contract drawings and specified herein is a model of 25-ft diameter and 19-ft height.

D. Glass-fused-to-steel tank contractors and manufacturers lacking the stated performance and experience requirements will not be considered.

E. Strict adherence to the standards of design; fabrication; erection; product quality; and long-term performance, established in this Specification will be required by the Owner and Engineer.

F. Tank suppliers must pre-qualify and submit the following to the Engineer/Owner for consideration and be a licensed general contractor in the State of Alabama.

1. Typical AWWA structure, foundation drawing(s), and structural calculations including aluminum dome (if applicable).

2. List of tank materials, gauges, thicknesses, appurtenances and tank coating specifications including aluminum dome (if applicable).

3. List of ten (10) tanks presently in potable water service designed to AWWA D103 Standard, of equal or greater size and character specified herein, built by the submitting contractor (list of tanks provided by a manufacturer will not be considered as the equivalent) operating satisfactorily for a minimum of five (5) years, including the name and telephone number of Owner and Engineer.

G. Only bids from U.S.A. manufactured tank suppliers who have successfully pre-qualified will be considered.

H. The Engineer reserves the right to evaluate all bids based on long term, 50 year minimum operation, coating and maintenance costs. Values to be used in this evaluation will be at the discretion of the Engineer, as detailed in this specification and bid tabulation form. The Engineer will add such costs, dependent upon the type of tank offered, to the bidder's price to determine the effective low bid for purposes of making the award.

1.03 SUBMITTAL DRAWINGS AND SPECIFICATIONS

A. Construction shall be governed by the Owner's drawings and specifications showing general dimensions and construction details, after written approval by the Engineer of detailed erection drawings prepared by the tank bidder. There shall be no deviation from the drawings and specifications, except upon written order from the Engineer.

B. The bidder is required to furnish, for the approval of the Engineer and at no increase in contract price, two sets of complete specifications and construction drawings for all work not shown in complete detail on the bidding drawings. A complete set of structural calculations shall be provided for the tank structure and foundation. All such submissions shall be stamped by a Licensed Professional Engineer licensed in the state of project location, as well as, by a Licensed Professional Engineer or Structural Engineer employed on the tank manufacturer's engineering staff. Where the tank manufacturer's P.E. is licensed in the state of the project location, only one stamp is required.

C. When approved, two sets of such prints and submittal information will be returned to the bidder marked **"APPROVED FOR CONSTRUCTION"** and these drawings will then govern the work detailed thereon. The approval by the Engineer of the tank supplier's drawings shall be an approval relating only to their general conformity with the bidding drawings and specifications and shall not guarantee detail dimensions and quantities, which remains the bidder's responsibility.

D. The tank manufacturer's and installing contractor's standard published warranty shall be included with submittal information.

E. The tank manufacturer shall include a standard Operation and Maintenance Manual upon receipt of approved drawings.

1.04 QUALITY ASSURANCE

A. The Tank manufacturer's Quality Assurance program shall be certified to comply with ISO 9001.

B. The tank manufacturer must certify that a satisfactory annual FACTORY MUTUAL inspection of its manufacturing facilities was conducted to establish and review quality control procedures.

C. All materials furnished by the tank manufacturer including vitreous glass coated steel panels, joint sealant, encapsulated bolt heads, etc. shall be certified and listed by the National Standard Foundation (NSF) to ANSI/NSF additive standard No. 61. Certification of the coating type alone will not be sufficient to meet this requirement.

PART 2 DESIGN CRITERIA

2.01 TANK SIZE

A. The factory coated glass-fused-to-steel, bolt together tank shall have a nominal diameter of 25 feet, with a nominal sidewall height (to roof eave) of 19 feet.

2.02 TANK CAPACITY

A. Tank capacity shall be 60,000 gallons (nominal, U.S. gallons).

2.03 FLOOR ELEVATION

A. Finished floor elevation shall be set as shown on the drawings.

2.04 TANK DESIGN STANDARDS

A. The materials, design, fabrication and erection of the bolt together tank shall conform to the AWWA Standard for "Factory Coated Bolted Steel Tanks For Water Storage" - ANSI/AWWA D103, latest revision. Stating intent to meet AWWA D103 or use of the EN 15282 design standard will not be accepted.

B. The tank coating system shall conform solely to Section 10.4 of ANSI/AWWA D103, latest revision. **NOTE:** Baked-on epoxy painted, galvanized, or stainless steel bolt-together tanks are not considered equal.

2.05 DESIGN LOADS

A. Structural Design Code: AWWA D-103
B. Seismic Design Code: IBC 2012/2015
C. Wind Design: ASCE 7-16
D. Wind Speed: 120 mph Roof Snow Load: 25 psf

PART 3 MATERIALS SPECIFICATIONS

3.01 PLATES AND SHEETS

A. All steel shall be smelted and produced in the United States of America.

B. All plates and sheets used in the construction of the tank shell, tank floor (when supplied) and tank roof, shall comply with the minimum standards of AWWA D103, latest edition.

C. Design requirements for mild strength steel shall be ASTM A570 Grade 30 with a maximum allowable tensile stress of 14,566 psi.

D. Design requirements for high strength steel shall be ASTM A607 Grade 50 with a maximum allowable tensile stress of 26,000 psi.

E. 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 psi be utilized for calculations detailed in AWWA D103, Sections 3.4 and 3.5.

F. Multiple vertical bolt line sheets and plates of ASTM A607 Grade 50 only shall be manufactured such that 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.

3.02 ROLLED STRUCTURAL SHAPES

A. Material shall conform to minimum standards of ASTM A36 or AISI 1010.

3.03 HORIZONTAL WIND STIFFENERS

A. Design requirements for intermediate horizontal wind stiffeners shall be of the "web truss" design with extended tail to create multiple layers of stiffener, permitting wind loads to distribute around tank. Minimum single length of 5’.

B. Web truss stiffeners shall be of steel with epoxy base/urethane top coat the same color of tank.

C. Rolled steel angle stiffeners are not permitted for intermediate stiffeners.

3.04 BOLT FASTENERS

A. Bolts used in tank lap joints shall be ½" - 13 UNC- 2A rolled thread, and shall meet the minimum requirements of AWWA D103, Section 2.2.

B. Bolt Material

1. ASTM F3125, Type A325 (1" bolt length)
   a. Tensile Strength - 120,000 psi Min.
   b. Proof Load - 85,000 psi Min.
   c. Allowable shear stress with threads excluded from the shear plane – 29,454 psi (AWWA D-103).
2. ASTM F3125, Type A490 (>1 1/4" bolt length)
   a. Tensile Strength - 150,000 psi Min.
   b. Proof Load - 120,000 psi Min.
   c. Allowable shear stress with threads excluded from the shear plane – 36,818 psi (AWWA D-103).
3. Bolt Finish - Zinc, mechanically deposited.
   a. 2.0 Mils Min - under bolt head, on shank and threads.
   b. Nut & Washer Finish – Mechanical galvanized with polyethylene caps.
4. Bolt Head Encapsulation
   a. High impact polypropylene copolymer encapsulation of entire bolt head up to the splines on the shank.
   b. Resin shall be stabilized with an ultraviolet light resistant material such that the color shall appear black. The bolt head encapsulation shall be certified to meet the ANSI/NSF Standard 61 for indirect additives.
5. All bolts on the vertical tank wall shall be installed such that the head portion is located inside the tank, and the washer and nut are on the exterior.
6. All lap joint bolts shall be properly selected such that threaded portions will not be exposed in the "shear plane" between tank sheets.
7. Bolt lengths shall be sized to achieve a neat and uniform appearance. Excessive threads extending beyond the nut after torquing will not be permitted.
8. All lap joint bolts shall include a minimum of four (4) splines on the underside of the bolt head at the shank in order to resist rotation during torquing.

3.05 SEALANTS

A. The lap joint sealant shall be a one component, moisture cured, polyurethane compound. The sealant shall be suitable for contact with potable water and shall be certified to meet ANSI/NSF Additives Standard 61 for indirect additives.

B. The sealant shall be used to seal lap joints and bolt connections and edge fillets for sheet notches and starter sheets. The sealant shall cure to a rubber-like consistency, have excellent adhesion to the glass coating, low shrinkage, and be suitable for interior and exterior use.

C. Sealant curing rate at 73°F and 50% RH

1. Tack-free time: 6 to 8 hours.

2. Final cure time: 10 to 12 days.

D. The sealant shall be Sika TS+ Urethane sealer.

E. Manus, Sika 1A, neoprene gaskets and tape type sealer shall not be used.

PART 4 GLASS COATING SPECIFICATION

4.01 SURFACE PREPARATION

A. Following the shearing process, sheets shall be steel grit blasted on both sides to the equivalent of SSPC-10 (Near – White Blast Cleaning). Sand blasting and chemical pickling of steel sheets is not acceptable.

B. The surface anchor pattern shall be not less than 1.0 mil (0.001 inch).

C. These sheets shall be evenly oiled on both sides to protect them from corrosion during fabrication.

4.02 PREPARATION OF SHEET EDGES

A. After initial sheet preparation, all full height vertical wall sheets and all rectangular shaped floor sheets shall be machined to create a beveled edge. Sheet edges shall be rounded in profile per Technical Manual PEI-101 to enable the same glass coating to be applied to all four sides of the sheet and ensure full encapsulation of the sheet edges with a minimum thickness of 5 mils (127 microns). Mastic, zinc primer or sealer shall not be acceptable as the only means to protect sheet edges from corrosion.

4.03 CLEANING

A. After fabrication and prior to application of the coating system, all sheets shall be thoroughly cleaned by a caustic wash and hot rinse process followed immediately by hot air drying.

B. Inspection of the sheets shall be made for traces of foreign matter, soil particles, grease or rust. Any such sheets shall be re-cleaned or grit blasted to an acceptable level of quality.

4.04 COATING

A. A base coat of catalytic nickel oxide to be electrostatically applied to both sides of the sheet.

B. A second coat to both sides of the sheets, of milled cobalt blue glass, shall be applied.

C. A third coat of glass shall be applied all interior wetted surfaces which must be titanium dioxide reinforced mixture.

D. The sheets shall then be fired at a minimum temperature of 1500°F in strict accordance with the manufacturer's ISO 9001 quality process control procedures, including firing time, furnace humidity, temperature control, etc.

E. The interior coating process must be a 3 coat and 1 fire process. The interior color shall be white. The exterior color shall be cobalt blue.

F. The dry film interior coating thickness shall be 11.0 – 18.0 mils (0.010 to 0.018 inches) minimum.

G. Verification of the dry film interior coating thickness shall be performed on each interior sidewall and (steel) floor sheet by a third party ASTM or NACE certified entity in accordance with SSPC-PA 2, latest version.

H. The dry film exterior coating thickness shall be 7.0 – 15.0 mils (0.007 to 0.015 inches) minimum.

I. The same glass coating as applied to the exterior sheet surfaces shall be applied to the exposed edges.

4.05 FACTORY INSPECTION

A. The manufacture’s quality system shall be ISO 9001 certified.

B. Chemical Resistance of Glass Coating

1. Every batch of component frits shall be individually tested in accordance with PEI Test T-21 (Citric Acid at Room Temperature)

C. Holiday Testing

1. A wet sponge test is required.

2. Frequency of the test shall be every sheet. Any sheet registering a discontinuity shall be rejected.

3. All inside sheet surfaces shall be holiday free.

D. Measurement of Glass Thickness

1. Glass thickness shall be measured using an electronic dry film thickness gauge (magnetic induction type). The thickness gauge shall a valid calibration record.

2. Frequency of the test shall be every tenth sheet. The thickness of the glass shall be between 10 and 18 mils.

E. Measurement of Color

1. The exterior color of the sheets shall be measured using a colorimeter. The colorimeter shall have a valid calibration record.

2. Frequency of the test shall be every tenth sheet.

F. Impact Adherence Test

1. The adherence of the glass coating to the steel shall be tested in accordance with ASTM B916-01. Any sheet that has poor adherence shall be rejected.

2. Frequency of this test shall be one sheet per gauge lot run minimum.

G. Fishscale Test

1. The glass coating shall be tested for fishscale by placing the sheet in an oven at 400 degrees F for one hour. The sheet will then be examined for signs of fishscale. Any sheet exhibiting fishscale shall be rejected and all sheets from that gauge lot will be similarly tested.

2. Frequency of this test shall be one sheet per gauge lot run minimum.

4.06 PACKAGING

A. All sheets that pass Factory Inspection and Quality Control checks shall be protected from damage prior to packing for shipment.

B. Heavy paper or plastic foam sheets shall be placed between each panel to eliminate sheet-to-sheet abrasion during shipment.

C. Individual stacks of panels will be wrapped in heavy mil black plastic and steel banded to special wood pallets built to the roll radius of the tank panels. This procedure eliminates contact or movement of finished panels during shipment.

D. Shipment from the factory will be by truck, hauling the tank components exclusively.

PART 5 ERECTION

5.01 FOUNDATION

A. The tank foundation is a part of this contract and shall be installed by the tank bidder. Tank foundation is to be designed in accordance with AWWA D103, latest revision and/or IBC-2006 without exception. **Stating intent to meet AWWA D103 or use of the EN 15282 design standard will not be accepted.**

B. The tank foundation shall be designed by the manufacturer without exception to safely sustain the structure and its live loads.

C. Tank footing design shall be based on the soil bearing capacity given in the Geotechnical Report (Appendix A) as determined by geotechnical analysis performed by a licensed soils engineer. Copies of the soil report are included with these documents in Appendix A.

D. Footing designs for soil bearing strengths less than that specified, and those designs deviating from tank manufacturer's standard shall be the responsibility of the Owner and his Engineer based on tank live and dead loading data provided by the tank manufacturer.

E. Embedded starter shall be 19 inches or 25 inches at a minimum as determined by manufacturer.

F. Slot mount concrete footing or flange mount designs are not acceptable.

5.02 CONCRETE

A. Cement shall be standard Portland Cement, conforming to ASTM C 150, Type I.

B. Fine aggregrate will be natural siliceous river sand, consisting of hard, clean, sharp, strong, durable, and uncoated particles, conforming to the requirements of ASTM C 33.

C. A maximum of 25% of cementitious material may be fly ash.

D. Coarse aggregrate shall consist of clean, natural, washed gravel or crushed stone suitably processed and conforming to the requirements of ASTM C 33.

E. Water used in mixing concrete shall be fresh, clean, potable water free from injurious amount of oil, acid, alkaki, vegetable, sewage, and/or organic matter.

F. Admixtures- All concrete shall contain an air entraining admixture conforming to ASTM 260 in order to provide and entrained air content of five percent (5%) plus one percent (1%) by volume.

G. All concrete shall contain a chloride-free, water reducing admixture or plasticizer conforming to ASTM C 494, Type A.

H. Accelerators and retarders may be used under adverse placement conditions when required by Tank Supplier. Accelerators shall be Calcium Chloride conforming to ASTM D 98M dispensed as a solution. Calcium Chloride shall not exceed one percent (1%) of the cement content by weight. Retarders shall be Chloride-free water reducing and retarding admixtures conforming to ASTM C 494, Type D.

I. The admixture content, batching method, and time of introduction into the mix shall be in strict accordance with the manufacturer's recommendations.

J. Standard Per Yard Specifications:

- 4000 PSI
- 0.40 Water Cement Ratio
- 516 lbs Portland Cement
- 129 lb Fly Ash-Type F
- 4.5 to 7.5% Air (Footer and Slab)
- Slump 3-5"
- Tank Supplier at their option will use mid-range for workability and

pumping of concrete. These admixtures will change the slump of the concrete.

- NOTE: Specific concrete mixes requiring higher strength PSI concrete or straight cement (no flyash), xypex, fiber, etc. are excluded. Tank Supplier must be notified of special concrete requirements PRIOR to time of bidding the project or a change order will be submitted due to the cost difference in concrete.

K. Strength:

1. Concrete ingredients shall be selected, proportioned, and mixed in such manner as will produce a watertight durable concrete that will develop the following minimum compressive strengths at an age of twenty-eight (28) days when sampled, cured and tested in accordance with the procedures specified in ASTM C 31 and C 39:

   a. Concrete Class: Class A

   b. Age: 28 days

   c. Average of 3 samples: 4,000 psi

   d. Any one specimen: 3,500 psi

L. Placement:

1. Tank Supplier will place concrete to comply with ACI 318, placing concrete in a continuous operation within planned joints or sections. No concrete placement will begin until work of other trades affecting concrete is completed.

2. Cold Weather Placement: Tank Supplier will comply with ACI 306 for placement.

3. Hot Weather Placement: Tank Supplier will comply with ACI 305 for placement.

M. Testing:

1. Tank Supplier will hire a testing laboratory to make, store, cure and test compression strength made during placing of concrete. Compression test specimens shall be tested in accordance with ASTM C-39. Test results will be provided to the engineer and owner by Tank Supplier.

2. Tank Supplier will have test cylinders cast for every 50 yards of concrete poured. If the project has multiple tanks a set of test cylinders will be cast for each tank. Test cylinders will be cast for each footer and slab pour.

3. Each strength test requires five (5) standard test cylinders. From each set of five (5) test cylinders, two cylinders will be broken at seven (7) days and will be used as an aid in determining the early strength of the concrete and two (2) cylinders broken at 28 days and one (1) cylinder retained in reserve for later testing if required.

4. In the circumstance the owner is bearing the cost of casting the cylinders

Tank Supplier requires documentation of each test for their permanent records.

5.03 CONCRETE FLOOR

A. The floor design is of reinforced concrete with an embedded glass coated steel starter sheet per the manufacturer's design and in accordance with AWWA D103, Sec 11.4. Slot mount style foundation is not acceptable.

B. Leveling of the starter ring shall be required and the maximum differential elevation within the ring shall not exceed one eighth (1/8) inch, nor exceed one sixteenth (1/16) inch within any ten (10) feet of length.

C. A leveling plate assembly, consisting of two 18" anchor rods (3/4" dia.) and a slotted plate (3 ½" X 11" X 3/8" thick) shall be used to secure the starter ring, prior to encasement in concrete. Installation of the starter ring on concrete blocks or bricks, using shims for adjustment, is not permitted.

D. Place one butyl rubber elastomer waterstop seal on the inside surface of the starter ring below concrete floor line. Place one bentonite impregnated water seal below the butyl rubber seal. Install materials in accordance with tank manufacturer's instructions.

5.04 SIDEWALL STRUCTURE

A. Field erection of the glass-coated, bolted-steel tank shall be in strict accordance with the procedures outlined in the manufacturer's erection manual, and performed by an authorized dealer of the tank manufacturer, regularly engaged in erection of these tanks, using factory trained erectors.

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. The placement of sealant on each panel may be inspected prior to placement of adjacent panels. However, the Engineer's inspection shall not relieve the bidder from his responsibility for liquid tightness.

E. 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.

5.05 ROOF

A. Tank and roof shall be supplied from the same manufacturer. Tanks with diameters of 14 to 20 ft. 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/airtight 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. 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 twenty-four (24") inches in one direction and fifteen (15") inches in the other direction. The opening shall have a curb at least four (4") inches in height, and the cover shall have a downward overlap of at least two (2") inches, or a gasketed weather-tight cover in lieu of the four (4") inch curb and two (2") inch overlap.

B. Roofs for tanks greater than 20 ft. diameter shall be constructed of non-corrugated triangular aluminum panels which are sealed and firmly clamped in an interlocking manner to a fully triangulated aluminum space truss system of wide flange extrusions, thus forming a dome structure.

1. The dome shall be clear span and designed to be self - supporting from the periphery structure with primary horizontal thrust contained by an integral tension ring. The dome dead weight shall not exceed 3 pounds per square foot of surface area.

2. The dome and tank shall be designed to act as an integral unit. The tank shall be designed to support an aluminum dome roof including all specified live loads.

3. Materials

   a. Triangulated dome frame struts: AA6005A-T6 aluminum. Perimeter tension/compression ring: AA6005A-T6 aluminum.

   b. Structural frame node plates: 0.375" nominal thickness, AA6061-T6 aluminum.

   c. Triangular dome panels: 0.050" nominal thickness, AA3003-H16 aluminum sheet. Triangular skylight panels, (if specified): nominal thickness of ¼" thick clear acrylic or polycarbonate.

   d. Fasteners: AA2024-T4 aluminum or austenitic series 300 stainless steel as required by the manufacturers design.

   e. Sealant: Silicone, conforming to Federal Specification TT-S-00230.

   f. Gaskets: Silicone, conforming to Federal Specification ZZ-R-765, Class 2, Grade 50 or equal or Neoprene conforming to ASTM C509-00.

   g. Dormers, doors, vents and hatches: AA6061-T6, AA6005A-T6, AA5086-H34 or AA5052-H36 aluminum, 0.090" nominal thickness.

4. Supplier shall be the same as tank manufacturer, a USA based company.

C. 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 0.5" 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) 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.

5.06 APPURTENANCES (PER AWWA D103, SECTION 5)

A. Pipe Connections

1. 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 and the 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.

2. Overflow piping shall be 8-inches diameter schedule 80 PVC.

B. Outside Tank Ladder

1. An outside tank ladder shall be furnished and installed as shown on the contract drawings.

2. Ladders shall be fabricated of aluminum and utilize grooved, skid resistant rungs.

3. Safety cage and step off platforms shall be fabricated of galvanized steel. Ladders shall be equipped with a hinged lockable entry device.

C. Access Doors

1. One bottom access door shall be provided as shown on the contract drawings in accordance with AWWA D103.

2. The manhole opening shall be a minimum of 24 inches in diameter. The access door (shell manhole) and the tank shell reinforcing shall comply with AWWA D103 latest edition, Sec. 5.1.

D. Identification Plate: 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 five (5) feet from grade elevation in a position of unobstructed view.

E. Cathodic Protection

1. A passive cathodic protection system shall be designed and supplied by the tank manufacturer based upon information supplied by the Engineer or Owner.
2. Attachment of anodes and wiring to tank structure shall be approved by tank manufacturer.
3. When cathodic protection is specified, electrical continuity between sidewall panels shall be the responsibility of the tank manufacturer.

PART 6 FIELD TESTING

6.01 HYDROSTATIC

A. Following completion of erection and cleaning of the tank, the structure shall be tested for liquid tightness by filling tank to its overflow elevation.

B. Any leaks disclosed by this test shall be corrected by the erector in accordance with the manufacturer's recommendations.

C. Water required for testing shall be furnished by the owner at the time of tank erection completion, and at no charge to the tank erector. Disposal of test water shall be the responsibility of the owner.

D. Labor and equipment necessary for tank testing is to be included in the price of the tank.

PART 7 DISINFECTION

7.01 STANDARDS

A. The tank structure shall be disinfected at the time of testing by chlorination in accordance with AWWA Standard C652 "Disinfection of Water Storage Facilities" as modified by the tank manufacturer.

B. Disinfection shall not take place until tank sealant is fully cured (see Sect. 3.5.3).

C. Acceptable forms of chlorine for disinfection shall be:

1. Liquid chlorine as specified in AWWA C652.
2. Sodium hypochlorite as specified in AWWA C652.
3. Calcium hypochlorite (HTH) is not acceptable.

D. Acceptable methods of chlorination per AWWA C652:

1. Chlorination method 1 as outlined in AWWA C652-02.
2. Chlorination method 2 as outlined in AWWA C652-02.
3. Chlorination method 3 as outlined in AWWA C652-02.

E. Acceptable application methods shall be:

1. Chemical feed pump.
2. Spraying, brushing, or painting of all water-contact surfaces.

PART 8 TANK MANUFACTURER'S WARRANTY

8.01 The tank manufacturer shall include a warranty for the tank materials and coating. As a minimum, this warranty shall provide assurance against defects in material or workmanship for the period of one (1) year and corrosion of the glass-coated surface for the period of five (5) years in potable water service. The tank contractor shall warrant the liquid storage tank shall be free from any defect in workmanship, under normal and proper use, maintenance and operation, during the period expiring on the earlier of (i) one year after liquid is first introduced into the tank or (ii) 14 months after a substantial portion of the tank sheets is delivered to the site where the tank is erected.

PART 9 REFERENCES

9.01 SSPC SP-10- Surface Preparation Standard – Near-White Blast Cleaning

9.02 ASTM C633-79 – Standard Test Method for Adhesion or Cohesive Strength of Flame Sprayed Coatings

9.03 PEI Test T-21 – Test for Acid Resistance for Porcelain Enamels (Citric Acid Spot Test)

9.04 ASTM D5162-91 – Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates

9.05 ASTM B916-01 – Standard Test Method for Adherence of Porcelain Enamel Coatings for Sheet Metal

END OF SECTION

SECTION 13600
ON-SITE SODIUM HYPOCHLORITE GENERATION SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope

1. This Section covers the work necessary by the Contractor, On-site Sodium Hypochlorite Generation System (OSHGS) Supplier, Owner, and Engineer, to furnish, install, test, and make ready for operation an On-site Sodium Hypochlorite Generation System.

2. The Generation System includes but is not limited to the Sodium Hypochlorite Generator Skid with integral piping, valves, system control cabinet with PLC, Water Softener, bulk salt/brine tank, hypochlorite solution storage tank, commercial strength hypochlorite dilution panel, piping, valves, ancillary equipment as specified herein, related testing, start-up and training services.

3. The OSHGS Supplier shall furnish an entire OSHGS consisting of the following major components:

a. Sodium Hypochlorite Generation cells

b. Control cabinet, PLC, VFD's, networking communication components, and associated equipment

c. Hydrogen Dilution System

d. Water Softeners & Cartridge Filters

e. Brine Tank and accessories

f. Sodium hypochlorite storage tank and accessories

g. Acid cleaning Cart/System

h. Booster Pump (if incoming water to generator below 50PSI)

i. Spare parts

B. System Description

1. Each On-site Sodium Hypochlorite Generation System (OSHG) shall consist of rack-mounted sodium hypochlorite generation cells, solenoid control valves, an electrical control panel, a transformer rectifier, a water softener, brine tank, sodium hypochlorite storage tank, feed pump, and hydrogen dilution system. The OSHGS shall generate an aqueous solution of a minimum concentration of 0.8 percent (±0.05%) by weight sodium hypochlorite expressed as chlorine. The minimum capacity shall be demonstrated to be equal to the capacity specified for each installation while not exceeding the maximum aggregate raw material quantities specified below.

2. The system shall be designed for the following operating conditions:

GENERATION CAPACITY*	STORAGE CAPACITY^
300	24

*Expressed as pounds per day (PPD) free available chlorine (FAC)
^Expressed as hours storage capacity

3. The electrolytic cell shall consume 2.5-3.5 pounds of salt per pound of chlorine equivalent output, using solar salt containing no additives (organic binders, flow control agents, resin cleaning material, etc.), and meeting the following specifications:

COMPONENT	Weight
Sodium Chloride (dry basis)	99.7% minimum
Insolubles	0.15% maximum
Surface Moisture	0.20% maximum

4. The electrolytic cell shall consume 1.8-2.4 AC kilowatt-hours of electricity per pound of chlorine equivalent output.

5. Expected water consumption will be in the range of 14.0-17.0 gallons per pound of chlorine equivalent output. Water temperature must measure between 55 °F and 78 °F. Higher temperature water will result in lower system efficiency and higher total consumable units. A minimum of 50 psi water pressure is required at the inlet to the water softener. The raw water supply to the softener must be potable.

6. Generator performance is to be measured as a function of total consumption for salt and power. Expected ranges of consumption for salt will be 2.5-3.5 pounds of salt and 1.8-2.4 KWH per pound of equivalent chlorine (PE). Product concentrations will be in the range of 0.80% ± 0.05%.

   a. Performance will be measured as the sum of the unit measurements for salt (PPE) and power (KWHPPE) and will not exceed 6.0 consumable units. Example: salt consumption at 3.0 PPE and 2.0 KWHPPE will measure 5.0 consumable units and will be considered proper performance.

b. Note that electrolytic cells require an initial acclimation period of approximately 300 operational hours. Performance measured before the cells have completed this exercise may not satisfy specification requirements. Water softener salt consumption and or chiller or heater power consumption shall be excluded from performance calculations.

7. The only liquid waste product allowed from the OSHGS will be the periodic backwash discharge from the water softener.

1.02 RELATED SECTIONS

A. All electrical, mechanical, metal, painting and instrumentation work included herein shall conform to the applicable Sections or Divisions of this project except as otherwise shown or specified.

1.03 QUALITY ASSURANCE

A. OSHG System Supplier Requirements

1. All equipment provided under this section shall be obtained from a single manufacturer, who shall:

a. Assume full responsibility for the completeness and proper operation of the OSHG.

b. Have experience, be reputable, and be qualified in designing and manufacturing on-site hypochlorite generation equipment.

c. Have current NSF Standard 61 Certification for the generation skid being offered.

d. Have at least 15 years' experience with on-site sodium hypochlorite generation equipment ranging in capacity from 20 to 2400 pounds per day of 100% chlorine equivalent.

e. Supply units containing all necessary appurtenances and components for a complete and operating system conforming to this specification. The OSHG System shall be pre-assembled, piped, and factory-tested to assure compliance with all operational requirements. The OSHG System shall be shipped as a single unit. Loose hypochlorite generation components shall not be acceptable. No field assembly or wiring will be permitted with the exception of external conduits. Equipment footprint as shown on the drawings shall not be exceeded.

f. Have at least ten similar OSHG Systems in operation for at least five years.

2. To ensure quality and complete unit responsibility, the OSHG must be assembled and inspected by the OSHGS Supplier at its facility. The complete OSHG must be a standard and regularly-marketed product of that manufacturer. The OSHG Supplier must have a physical plant, technical and design staff, and fabricating personnel to complete the work specified.

3. The Owner reserves the right to be present at the fabricator's facility for visual inspection of equipment to be supplied.

B. Specified Manufacturer

1. On-site Sodium Hypochlorite Generation System shall be Microclor® as manufactured and supplied by PSI Water Technologies, Inc., Campbell, California, (408) 370-6540.

C. Warranty

1. Prior to acceptance of the Sodium hypochlorite generator system, provide written warranty from the OSHGS Supplier that includes the following statements:

   a. OSHGS Supplier has inspected the installation during and after completion and the sodium hypochlorite generator system is free from faults and defects and is in conformance with the Contract Documents.

   b. The warranty period shall start from the date of commissioning of the system or 6 months after shipment, whichever comes sooner.

   c. Principal components of the sodium hypochlorite generator system will remain free of defects for a period of three (3) years from the date of final acceptance and all other equipment supplied for one (1) year.

   d. The electrolytic cells including cell body shall have a three (3) year full replacement warranty and a prorated straight-line replacement warranty for years 4-7 from the date of final acceptance.

D. Pre-Approval Submittals

1. Each supplier submitting an alternate to the equipment defined herein shall provide the following submittals 20 days prior to the established bid date. Failure to provide a complete and thorough submittal package shall render their preapproval request non-responsive and will not be considered. Approval of manufacturers will be at the sole interpretation of the Engineer. A blanket statement that equipment proposed will meet all requirements will not be sufficient to establish equivalence to the specified manufacturer(s). If requested by the Engineer, the supplier must be prepared to demonstrate a unit similar to the one proposed. The following information is required:

   a. A complete set of drawings as described in Section 1.03.E. Provide a minimum of one drawing per system clearly showing how the proposed system will fit on the site.

   b. A reference list of no less than then ten installations of the type and size of system proposed. The installations must have been in service for a minimum of five years. The list shall include the following information: Owner name and accurate contact information, placed in service date, and design conditions including generation capacity. Provide graphical performance data from a minimum of ten systems showing that the raw materials consumption levels satisfy the requirements of Section 1.01.B.

Failure to submit references for similar systems may deem the pre-approval request "non-responsive" and will be rejected without further review.

c. If the alternate OSHGS Supplier's hydrogen handling and safety equipment design differs in any way from Section 2.02, they must submit a statement signed by a corporate officer stating they have never had a hydrogen related cell rupture incident. Failure to submit this statement may deem the request for pre-approval "non-responsive" and will be rejected without further review.

d. It shall be the supplier's responsibility to carefully examine each item of the specifications. Failure to offer a complete submittal or failure to respond to each section of the technical specifications will cause the pre-approval to be rejected without further review as "non-responsive." All exceptions and/or deviations shall be fully described in the appropriate section. Deceit in responding to the specifications will be cause for automatic rejection. The supplier must include a separate sheet listing any and all deviations to the specifications. The Engineer understands that manufacturers design systems with different features. This listing is therefore integral to the Engineer's determination of an equivalent product. Each deviation must reference the listed specification, by number if necessary, and explain in full detail how the proposed system is different.

E. Product Submittals

1. The following product data shall be electronically submitted by the OSHGS Supplier for review and approval by the Engineer that the product provided conforms to the site-specific requirements prior to the fabrication of the systems:

   a. Process and instrumentation diagram for the systems.

   b. Shop drawings and catalog literature showing dimensional information and details of piping, fabrication, and erection of all materials and equipment furnished under this section, including:

      1) Detailed drawings of tank nozzle orientations provided.

      2) Detailed drawings of equipment installations provided.

   c. Scaled drawing of general layout, general arrangements, and major system components, including:

      1) Dimensions, including those for system connections

   d. Drawings showing fabrication, assembly, installation, and wiring diagram. Wiring diagrams for the electrical control panel and rectifier transformer shall consist of, at a minimum, control schematics, including coordination with other electrical devices operating in conjunction with the OSHGS.

e. Manufacturer's literature, illustrations including weight and dimensions, specifications, materials of construction, and bill of materials for each component of the system. Data shall include a complete description in sufficient detail to permit comparison with the technical Specifications. Major system components include:

   1) Water softener

   2) Brine pump

   3) Hydrogen dilution blower

   4) Miscellaneous instrumentation, valves, and accessories

f. Performance data: for each pump and blower furnish a performance certification indicating:

   1) Pressure

   2) Capacity

   3) Efficiency

   4) Horsepower

g. Motor data: for each motor furnish a certified motor data sheet for the actual motor or for a previously manufactured electrically duplicate motor which was tested.

h. Control philosophy including I/O list and loop descriptions.

i. The acceptable range of water pressure for proper system operation. If a pressure or flow regulator is required, it shall be provided.

j. A list of all parameters, ratings or other characteristics where the proposed Sodium hypochlorite generator system deviates from the requirements set forth in these Specifications.

k. Installation instructions.

l. Performance testing protocol including a recommended test plan, measurement methods, and sample data sheet showing all pertinent process data to be recorded and the frequency and data readings.

m. Current NSF Standard 61 Certification for the generation skid being offered.

n. References for at least ten similar units that have been installed and have been operational for at least five years of continuous service.

o. Affidavits of compliance with referenced standards and codes.

F. Operation and Maintenance Manuals

1. Detailed operation and maintenance (O&M) manuals shall be provided by the Supplier to the Engineer for review and approval. At a minimum, the following shall be included:

a. Required Operation Data.

1) Complete, detailed operating instructions for each piece of equipment.

2) Explanations for all safety considerations relating to operations.

3) Recommended spare parts lists.

b. Required Maintenance Data.

1) All information and instructions required by plant personnel to keep equipment properly cleaned, lubricated, and adjusted so that it functions economically throughout its full design life.

2) Maintenance summary forms.

3) Explanation with illustrations as necessary for each maintenance task

4) Recommended schedule of maintenance tasks.

5) Lubrication charts and table of alternate lubricants.

6) Troubleshooting instructions.

7) List of maintenance tools and equipment.

8) Name, address, and phone number of manufacturer and manufacturer's local service representative for major system components.

G. Manufacturer Services

1. Prior to scheduling services by the OSHGS Supplier, the Contractor shall verify the equipment installation and provide the completed installation checklist with photo documentation. Upon receipt of the completed installation checklist with photo documentation, the OSHGS Supplier shall schedule start-up and training to take place no sooner than two (2) weeks. The Contractor shall coordinate testing requirements and scheduling with the Engineer.

2. The OSHGS Supplier shall be present at each jobsite for the following time period after the system is installed, travel time excluded:

a. Certification of proper installation, system startup, and functional testing.

1) Installation inspection shall include supervising the correction of any defective or faulty work before acceptance by Owner.

2) System startup shall include testing, calibrating, and adjustment of all components for optimum performance.

3) Functional testing shall include inspection of integration of the provided equipment’s controls to the Owner’s SCADA system, etc.

b. Training Owner’s personnel and providing detailed instructions in the operation, maintenance, and troubleshooting for the system.

1) Upon request, a training manual will be provided with an outline of the training procedures.

3. Services shall be provided by a technician that is factory-trained by the OSHGS Supplier and has demonstrated ability and experience in the installation and operation of the equipment.

PART 2 PRODUCTS

2.01 ON-SITE SODIUM HYPOCHLORITE GENERATION SYSTEM

A. A transformer rectifier, electrolytic cells, water solenoid valve, brine solenoid valve, brine pump, rectifier cabinet, hydrogen dilution blower, chemical storage tanks, chemical metering pumps, and a PLC-based control panel containing system controls, water softener with flow meter, and all necessary interconnecting wiring and hardware shall form a complete on-site sodium hypochlorite generation system. Components of the OSHGS shall comply with this specification. All components of the electrolytic cell skid shall be pre-assembled, piped, wired to input and output, flanged, threaded, etc. connections located at easily accessible points on the skid. The installation contractor shall provide all interconnecting piping and conduit, which shall be Sch 80 PVC. The OSHGS shall be factory-tested prior to shipping as one self-contained unit.

2.02 HYDROGEN SAFETY MANAGEMENT

A. The generators shall have no waste products associated with its use other than hydrogen gas, which is to be vented to the atmosphere. Hydrogen Dilution blowers will be used to purge all residual hydrogen out of the system and storage tanks and dilute the hydrogen concentration 100 to 1 or below 25% of the LEL.

B. Any proposed system must meet every operational and material aspect of this specification. Hydrogen management shall be accomplished by the passive venting of each electrolytic cell without potential restrictions. This flow path should not have baffle plates, orifice plates or backpressure valves between the last point of product generation and atmospheric evacuation.

C. The presence of over-pressure rupture disks is not acceptable as the initiation of disk rupture would render the system inoperable. No hydrogen shall be vented directly to the hypochlorite storage tank where an accumulation could occur.

D. Under no circumstance will waste hydrogen be allowed to flow from one cell or cell compartment to the next. All hydrogen must immediately be released from each cell pack.

E. Minimum passive venting capability from each electrolytic cell pack shall be 4.0 square inches for every 100 pounds of chlorine production.

F. The hydrogen dilution system shall dilute the hydrogen concentration to below 25% of the LEL or 1% by volume.

G. Generator skid hydrogen dilution shall include passive vents connected to each cell and blower connected to the vent header. Sodium hypochlorite storage tanks shall be evacuated by blower.

H. Under no circumstance will the Hydrogen Safety Management requirements (Part 2.02) be relaxed or modified as they are critical operator safety features and core to the generator design. NOTE: THIS HYDROGEN SAFETY DESIGN MUST BE MET, REGARDLESS OF ONSITE GENERATOR MANUFACTURER SELECTED, AND WILL BE REQUIRED FOR SUBMITTAL APPROVAL.

2.03 ELECTROLYTIC CELL SKID ASSEMBLY

A. An electrolytic cell skid assembly shall be provided with the following overall dimensions:

SYSTEM I.D.	WIDTH	DEPTH	HEIGHT
MC-300	74″	20″	76″

B. Each electrolytic cell skid assembly shall have the following components and features:

1. 316 Stainless steel brine gear pump, with:
   a. Magnetic drive.
   b. Cavity-style design.
   c. PEEK gear construction.
   d. Integral speed control.
   e. Mfg Tuthill.
2. Water solenoid valve.
3. Polycarbonate water and brine rotameters.
4. Electrolytic cells
5. Transformer rectifier.
6. Magnetic flow meter.
7. Optical level switches.
8. Temperature switches.
9. Temperature sensor.
10. Teflon and Kynar interconnecting tubing.
11. 304 stainless steel frame, electrolytically polished for passivation, corrosion resistance, and chemical compatibility.

a. Horizontal and vertical tube sections shall be minimum .090-inch wall thickness.

b. All vertical and horizontal frame connections shall be welded.

c. The completed frame with all mounted components shall comply with the UBC structural requirements for seismic zone four.

C. The generator shall be factory wired, plumbed, and mounted on a self-contained skid assembly.

D. The generator will be designed and built to allow one of the five electrolytic cells to be removed (replaced with a pipe spool) and still run at 80% production capacity.

E. Each electrolytic cell shall be arranged so that it can be completely drained in place.

F. The rack mounted flow control panel will consist of a water rotameter, water sensor, brine rotameter and a positive displacement gear pump with variable speed drive.

The variable speed drive will respond to a 0-5 VDC signal generated by the PLC algorithm in order to maintain constant current relative to variable water temperature or flow rate.

G. The process shall operate in a batch environment allowing for consistent hypochlorite concentrations and greatest efficiencies.

H. The generator skid will be supplied with a 4-20 mA electrolyte temperature sensor that will function to return a linear signal proportional to 0-100°C, which will allow continuous operation up to 130°F without interruption. Under no circumstance will bimetallic "snap" switches be permitted as the primary over-temperature sensor.

I. The generator package shall have the following redundant interlocked safety features:

1. Cell high temperature switch.
2. Low level switch for each cell.
3. Water flow sensor.
4. Transformer high temperature switch.
5. Automatic current regulation.

J. All electrical equipment and enclosures will be built and certified to UL 508 standards and will possess the appropriate label.

K. The generation system shall be pre-piped and skid-mounted.

1. The OSHGS skid frame shall be constructed of 304 stainless steel tube for structural strength. Horizontal and vertical tube sections shall be of .125-inch wall thickness and have a depth no greater than twenty four inches by a length not exceeding six feet two inches. The entire skid shall undergo

electrolytic polishing for ultimate passivation, chemical compatibility, and corrosion resistance. The completed frame with all mounted components shall comply with the UBC structural requirements for seismic zone four.

2. The skid frame shall be configured to allow easy access to all components, including the electrolytic cells. All vertical and horizontal frame connections shall be welded. Under no circumstances can water/liquids handling and/or cells be located immediately above the power supplies. The skid frame shall support, as a minimum, the following mounted equipment:

   a. Generator electrolytic cells

   b. Power supply/rectifier

   c. Water and brine rotameters

   d. Control panel

   e. Interconnect pipes valves and fittings

   f. Interconnect conduit and wiring

   g. Water flow sensor

   h. Variable-speed, positive-displacement brine pump

2.04 ELECTROLYTIC CELLS

A. Multiple electrolytic cells shall be provided as follows:

CELL QUANTITY	CELL CAPACITY	ACTIVE SURFACE
5	60	6″ x 12″

Any system using fewer electrolytic cells than that specified above must demonstrate its ability to achieve 80% production capacity with one of the cells removed from service.

B. The electrolytic cell bodies shall be constructed of and clear acrylic materials, allowing for front and rear visual inspection of the electrodes from all angles.

C. Each electrolytic cell will be constructed utilizing DSA coated titanium anodes and titanium cathodes. The cells must be configured in a vertical format with a recirculating loop provided for each cell. This recirculating loop will also allow the passive removal of hydrogen from each cell via the upper hydrogen vent. Under no circumstance will hydrogen be allowed to be driven from one cell or cell loop to the next.

D. Each cell loop will also incorporate an optical level sensor so as to preclude any possibility of exposing an active electrode surface

E. The wetted cell components will consist only of the electrodes and acrylic cell body. No internal baffles, spacers, or connecting hardware will be allowed.

F. Cells shall utilize titanium bolting hardware.

2.05 TRANSFORMER RECTIFIER

A. The 6-pulse D.C. Rectifier will consist of a fully isolated three phase step down transformer and bridge rectifier. D.C. voltage output will be fixed with multiple primary taps for + 5-10% voltage correction. Under no circumstance will switching rectifiers or phase angle fired SCR voltage correction be permitted. D.C. ripple will be less than 4% with a power factor of 99% or better.

B. The transformer rectifier will be a fixed voltage unit where the current will be allowed to float as a function of electrolyte conductivity.

1. Constant current will be achieved via an active feedback loop where rectifier amperage is measured and reported to the PLC. The control algorithm calculates the appropriate amount of brine to mix with the incoming water so as to maintain constant current.

2. SCR-controlled rectifiers will not be allowed.

C. Rectifier efficiency will be 97% or greater.

D. The transformer/rectifier will house a 4-20 mA D.C. current transducer and NEMA 4X digital display of amperage.

E. The rectifier cabinet and base frame will be constructed of 304 Stainless Steel and will be of a modular design. All internal wiring connections and components will be easily accessible by removing the front access panel.

F. The transformer enclosure will be removable from the skid assembly as one piece, allowing for unobstructed access to the transformer.

G. The transformer rectifiers shall be designed for the following operating conditions:

TRANSFORMER I.D.	CAPACITY (kVA)	PRIMARY VOLTAGE	SECONDARY VOLTAGE
	36	480VAC/3PH/60A	240-300 VDC

H. The stepdown transformer rectifier shall be provided with the following accessories:

1. DC bridge rectifier utilizing three diode assemblies and an aluminum heat sink with 120 VAC cooling fan.

2. Panel-mounted electrical disconnect switch.

2.06 ELECTRICAL CONTROL PANEL

A. The OSHGS Supplier shall provide a NEMA 4X, 304 stainless steel, electrical control panel, which shall include controls for the entire sodium hypochlorite generation and feed system. The panel shall be mounted onto the generator skid and pre-wired at the factory to system components. The control panel shall house the operator interface terminal (OIT), PLC, hydrogen blower controls, and terminal strips to fully support the functions of generator operation, tank level, and metering pump proportional control.

B. All controls and operations logic specified herein and as shown on the instrumentation loop diagrams required for the system shall be programmed in a Programmable Logic Controller (PLC). The control cabinet logic will function at the PLC level where operating parameters will be measured, corrected, scaled, reported, and controlled. Contractor shall coordinate with OSHGS Supplier and instrumentation supplier for proper integration of the system.

C. The control panel shall display all relevant operating parameters and/or alarm conditions. The OIT will serve as the operator interface, data input screen, and alarm log.

D. At a minimum, the panel shall have the following features, components, and functionality:

1. The generator shall automatically start and stop based on the high and low levels in the sodium hypochlorite storage tank.
2. The generator shall shut down and alarm for the following conditions:
    a. Low electrolyte level in cell.
    b. Hypochlorite temperature exceeds 130°F (55°C).
    c. Inlet flow falls below a preset value.
    d. Rectifier high or low amperage.
    e. Rectifier high temperature.
    f. Hydrogen dilution blower failure.
3. Low-low level alarm for hypochlorite storage tank.
4. High-high level alarm for hypochlorite storage tank.
5. Enclosure cabinet, 24" x 24" x 8", with ample interior volume so as to be easily wired and serviced.
6. 5.7" color touchscreen human-machine interface (HMI) with dedicated screens, including help dialogs covering all basic operations and detailed alarm explanations, for each portion of the process and Ethernet communications for PLC connection.
7. Allen Bradley MicroLogix 1400 programmable logic controller (PLC) with Ethernet communication protocol.
8. Rectifier controls.

9. Blower controls.

10. Analog inputs from the flow meter and residual analyzer to drive each VFD based on the appropriate flow, residual, or compound loop algorithm.

    a. Under no circumstances will external controllers be allowed to control the VFD output.

11. Logging and storing alarm history.

12. Security protection.

13. Dedicated 24 VDC power supply for PLC and HMI.

14. Emergency stop pushbutton.

15. Cabinet-mounted electrical disconnect switch.

16. Start-up shall be accomplished without the need for a laptop computer or proprietary software.

E. The OSHGS Supplier shall be responsible for programming the Generation System package control software. The OSHGS Supplier shall deliver to the Owner all PLC and HMI code for future reference prior to final acceptance.

2.07 HYDROGEN DILUTION BLOWER

A. A hydrogen dilution blower shall be designed for the following operating conditions:

BLOWER I.D.	Capacity (ACFM)	STATIC PRESSURE (IN WC)	MOTOR HP	ELECTRICAL SERVICE
	406	3.4″	1	240V/1Ph/60Hz

B. The blower shall be AMCA type B spark resistant of cast aluminum construction. The blower shall be cast with commercial grade 319 cast aluminum, having a 3/16″ minimum wall thickness. Housing halves should be attached with tapered lugs having a minimum 45-degree taper from centerline for additional strength. Inlets and outlets shall be round.

C. The blower wheel hub shall be an integral part of the wheel casting. The wheel shall be a radial-type wheel. The blower shall be statically balanced by removal of material only – no additional weights are to be used in the balancing process.

D. The blower shall be arrangement 4 with a base of 12 gauge steel (minimum).

E. Hydrogen dilution blower shall be PB Series by Cincinnati Fan or equal.

F. The hydrogen dilution blower shall be provided with the following accessories:

1. Inlet guard.
2. Teflon shaft seal.
3. Current sensor.
4. Differential pressure switch positioned in the dilution ductwork vent stack.
5. Software controlled safety interlocks to detect control system sequence failure.

2.08 WATER FILTER

A. A wall-mounted large-capacity cartridge type filter housing holding a 10" cartridge for dirt, rust, and particulate matter from softener's feed water shall be provided. The filter housing shall be feature NPT inlet and outlet connections and a mounting bracket. A polypropylene cap with Buna-N O-ring shall be supplied.

B. The filter cartridge shall be a 4-1/2" diameter, 50-micron, disposable cartridge. Cartridge shall be manufactured from a pleated non-woven and reusable polyester fabric with polypropylene core.

C. Two (2) pressure gauges shall be provided to measure the pressure drop across the filter.

2.09 WATER SOFTENER

A. A dual-tank automatic water softening system shall be provided to remove hardness in the feed stream to the OSHGS, plus provides brine water makeup. The softener shall be designed for the following operating conditions:

SOFTENER I.D.	DUAL TANK DIMENSIONS	EFFICIENCY*	KINETICO MODEL No.
	21" ø x 60" H	4,108	CP-210S

*Expressed as grains exchanged per pound of salt

B. Softener shall remove hardness to less than ½ gpg. One tank will be on-line during service. A water meter shall automatically initiate system regeneration. The water meter shall measure the processed volume and be adjustable. Water softeners that regenerate on a fixed time will not be acceptable. When the ion exchange capacity of one resin tank is nearly exhausted, the hydraulically-driven, flow-controlled switchover valve will automatically divert flow to the alternate tank while initiating brine backwashing of the first tank for regeneration of the ion exchange resin. During regeneration cycles, one tank shall provide water to service and to the regenerating tank. Regeneration shall use salt solution from the brine tank.

C. The regeneration control valve shall be top mounted (top of media tank), and manufactured from non-corrosive materials. Control valve shall not weigh more than four pounds. Control valve shall provide service and regeneration control for two media tanks. Inlet and outlet ports shall accept a quick connect, double O-

ring sealed adapter. Interconnection between tanks shall be made through the regeneration valve with a quick connect adapter. Control valve shall operate using a minimum inlet pressure of 25 psi. Pressure shall be used to drive all valve functions. No electric hook-up, electric timers, or gear motors shall be required. Control valve shall incorporate four operational cycles including service, brine draw, slow rinse, and a combined fast rinse and brine refill. The brine cycle shall flow shall be opposite the service flow, providing a countercurrent regeneration. Control valve shall contain a fixed orifice eductor nozzle and self-adjusting backwash flow control. The control valve will prevent the bypass of hard water to service during the regeneration cycle.

D. The tanks shall be designed for a maximum working pressure of 125 psi and hydrostatically tested at 300 psi. Tanks shall be made of polyethylene and reinforced with fiberglass wrapping. Each tank shall include a 2.5 in. threaded top opening. Upper and lower distribution system shall be of a slot design. Distributors will provide even flow of regeneration water and the collection of processed water.

E. Each softener shall include a non-solvent, high capacity cation resin having a minimum exchange capacity of 30,000 grains/ft^3 when regenerated with 15.0 lbs/ft^3. The media shall be solid, of a proper particle size and shall contain no plates, shells, agglomerates or other shapes, which might interfere with the normal function of the water softener.

F. The water softener shall be provided with the following accessories:

1. 1-1/2-inch inlet and outlet pipe connections.
2. 1/2-inch HDPE tube with in-line check valve for feeding brine for regeneration.
3. 1/4-inch wastewater discharge to sewer for backwash waste.

2.10 BRINE FILTERS

A. A wall-mounted cartridge type filter housings holding a 10" cartridge for dirt, rust, and particulate matter from the brine stream shall be provided. The filter housing shall be feature NPT inlet and outlet connections and mounting bracket. A polypropylene cap with Buna-N O-ring shall be supplied.

B. The filter cartridge shall be a 50-micron, disposable cartridge.

2.11 CHILLER

A. If the incoming feed water to the water softener is greater than 78 °F, a chiller shall be provided.

2.12 HYDROGEN DETECTOR

A. A hydrogen gas monitoring system shall be provided to continuously measure and display gas concentration and provide alarms when preset limits are exceeded. A transmitter will send the signal to the control panel.

B. The gas monitoring system shall have a NEMA 4X enclosure and two-line, eight-alphanumeric character LCD display with linear 4-20 mA output signal.

C. The gas detector shall be model CN06 by Conspec Controls.

2.13 ACID CLEANING SYSTEM (50 GALLON CAPACITY - CART)

A. The cart shall be pre-piped and pre-wired prior to shipment. All piping, fittings and valves shall be SCH 80 PVC and the Cart is to be wheeled for ease of movement and storage.

B. Pump shall be of chemical resistant materials constructed of polypropylene body with PTFE, FKM, and Hastelloy wetted parts. Pump shall be a mag drive. A 120VAC single phase plug shall be included for connection to a standard electrical receptacle.

C. Valving shall be such that flow can be reversed allowing the OSHGS System to be filled and drained.

D. Acid cleaning tank shall have a capacity of 50 gallons and be chemical resistant and constructed of polyethylene.

E. A one-inch camlock fitting, discharge hose, and appurtenance shall be included to transfer acid to and from the electrolytic cells.

F. A carbon filter is to be fitted so that off gas of the muriatic acid during operation will be contained within the Acid Cleaning System.

2.14 TOOLS, SPARE PARTS, AND MAINTENANCE MATERIALS

A. The OSHGS Supplier shall furnish one set of the following spare parts for each onsite sodium hypochlorite generator system:

1. One (1) electrolytic cell level sensor
2. One (1) electrolytic cell temperature sensor
3. One (1) brine pump spare parts kit
4. One (1) spare parts kit for each backpressure and pressure relief valve
5. One (1) complete electrolytic cell including cell housing (loose electrodes are not acceptable)

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the completion of the contract.

C. The OSHGS Supplier shall furnish an initial supply of all greases and lubricants required to start operations. Supply an amount of these materials necessary for one year of continuous operation.

PART 3 EXECUTION

3.01 FACTORY ASSEMBLY AND TESTING

A. The OSHGS shall be pre-assembled at the manufacturing location.

B. System shall be tested for a minimum of eight hours at the location of assembly to assure it is in full compliance with the requirements of the specific design for the project and this specification.

C. Factory testing shall include visual inspection of all equipment, complete assembly, and functional testing of equipment including leak testing, piping and instrumentation check, verification of control panel wiring and operation, and confirmation of proper operating parameters.

D. Engineer and/or Owner reserve the right to be present at the OSHGS Supplier's manufacturing facility to witness factory testing. Engineer and/or Owner shall provide intent to witness factory testing at the time of the design submittal review and approval, and OSHGS Supplier shall provide notice to Engineer and/or Owner regarding the scheduled time of the factory testing at least five business days in advance of the proposed factory test.

E. The OSHGS Supplier shall maintain Quality Control documentation that includes system test settings and measured performance.

3.02 DELIVERY, STORAGE, AND HANDLING

A. The OSHGS shall be packaged and shipped so as not to incur damage to any portion of the equipment through handling and installation of the system itself.

B. The Contractor shall be responsible for the delivery, storage, and handling of products in accordance with the OSHGS Supplier's recommendations.

C. The Owner shall inspect all equipment and materials against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to the OSHGS Supplier for replacement or repair.

D. Equipment and materials shall be stored in a dry, chemical-free location and protected from the elements according to the OSHGS Supplier's instructions.

E. Equipment and materials shall be handled in an approved manner according to the OSHGS Supplier's instructions.

3.03 INSTALLATION

A. Installation of the generator, tanks, metering pumps, and appurtenances shall be performed by the Contractor and shall be in accordance with the Drawings and with the OSHGS Supplier's instructions and recommendations. Conflicts of information shall be called to the attention of the Engineer. It is the Contractor's (or Owner's) responsibility to provide:

1. Water piping and valves from source to water softener, if applicable, and from softener to brine tank and electrolytic cell skid.
2. Brine piping and valve from brine tank to electrolytic cell skid.
3. Sodium hypochlorite piping and valves from electrolytic cell skid to sodium hypochlorite storage tank(s), from sodium hypochlorite storage tank(s) to metering pump(s), and from metering pump(s) to point of application.
4. Vent piping, valves, and stack from hydrogen dilution blower to electrolytic cell skid vent connection and onwards.
5. Vent piping, valves, and stack from hydrogen dilution blower to sodium hypochlorite storage tank(s) and onwards.
6. All overflow and drain piping and valves.
7. Electrical connections, wiring, and conduits to/from system control panel for power, control, and alarm interfaces with remote located instruments (tank level and pressure transmitters, etc.), plant SCADA, etc.
    a. All wiring to be TTHN stranded wiring and will conform to the most current version of the National Electric Code.
    b. All 4-20 mA instrumentation wiring will be 2- or 4-conductor shielded cable.
    c. Instrumentation and signal/control wiring will be run in conduits separated from all other AC wiring systems.
8. Gaskets, seals, and O-rings for hypochlorite service shall be constructed of Hypalon, PTFE, or FKM. Santoprene or neoprene shall be used for brine service. EPDM shall be used for water and ammonia.
9. Any necessary unistrut, hangers, supports, etc. for Contractor-supplied piping and conduits.
10. Anchor bolts, suitable concrete mounting pads and other incidentals as necessary to complete the installation.
11. Pressure testing of all interconnecting piping as is practical or directed by the Owner.
12. Flushing of all piping with potable water prior to system start-up and commissioning to remove materials that may have entered as a result of the installation process.

B. All equipment units or assemblies shall be installed on concrete bases and secured with anchor bolts in accordance with the OSHGS Supplier's recommendations and as shown. Contractor shall be responsible for the design of the equipment pads. The contractor shall coordinate with OSHGS supplier for skid placement and anchoring.

C. Contractor shall inspect all concrete pads for proper elevation, dimensions, cutouts, evenness and anchor bolt locations and correct if necessary.

D. The Contractor shall inspect all equipment before installation, if damaged; notify the Engineer and OSHGS Supplier promptly. Do not install damaged equipment until the OSHGS Supplier makes repairs in accordance with OSHGS Supplier's written instruction and approval.

E. The Contractor shall, after installation of storage tanks is complete but before piping connections are made, block all outlets and fill each tank with potable water and tested for leakage for a minimum of 24 hours prior to system start-up and commissioning. Any leaks that are observed will be repaired and the tank re-tested.

F. Contractor shall provide a drain for each piece of equipment, according to the OSHGS Supplier's instructions.

G. Power shall be provided by the Contractor to the system control panels as shown on the OSHGS skid drawings. The Contractor shall be responsible for providing all necessary conduit and wiring necessary for a complete electrical service to this location. All wiring shall comply with the National Electrical Code.

H. Installation shall include furnishing and applying an initial supply of lubricants, as provided by the OSHGS Supplier.

I. Contractor shall support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping.

J. All equipment including motors, belts, and drives shall be aligned to the best industrial standards. Field check and adjust all equipment alignments in the presence of the Engineer.

K. The Contractor shall inspect all equipment before installation, if damaged; notify the Engineer and OSHGS Supplier promptly. Do not install damaged equipment until the OSHGS Supplier makes repairs in accordance with OSHGS Supplier's written instruction and approval.

L. Tie-down lugs for tanks shall be grouted or shimmed to prevent excessive loads being transferred to the tank shell.

M. Make all electrical connections in conformance with the requirements of the electrical specifications.

3.04 START-UP SERVICES AND FUNCTIONAL TESTING

A. A factory technician from the OSHGS Supplier shall be present at the jobsite for initial system start-up/commission of equipment as specified in section 1.03 G.

B. Factory technician will ensure that the systems are properly installed, start-up the systems, and train the Owner's personnel.

C. Contractor and OSHGS Supplier shall make equipment adjustments required to place system in proper operating condition.

3.05 IDENTIFICATION AND MARKING

A. The OSHGS, along with all applicable components, shall be marked and identified for all health, flammability, and reactivity of hazardous materials as required by all applicable jurisdictional building codes, statues, standards, regulations, and laws.

END OF SECTION

SECTION 15001
WATER MAIN PIPING, VALVES AND ACCESSORIES

PART 1 GENERAL

1.01 WORK INCLUDED

A. This Section covers the Work necessary to furnish and install, complete, the piping, valves, meters and accessories specified herein in order to complete the water main extension and services, including connections to existing mains and facilities.

1.02 GENERAL

A. Like items of material provided hereunder shall be the end products of one (1) manufacturer. All materials shall be manufactured in the United States of America unless otherwise noted by the Engineer.

B. See Section GENERAL REQUIREMENTS, which contain information and requirements that apply to the Work specified herein and are mandatory for this project.

1.03 HIGHWAY PERMITS

A. Highway permits for State and Federal highway right-of-way construction will be obtained by the owner following the award of Contract. The Contractor shall assist the Engineer in preparing the permit applications, including locating existing utilities, selecting the desired pipe locations, and staking the desired pipe locations, and staking the permit stations. The permit shall be submitted by the Owner and the Contractor shall pay the permit bond required by the Highway Department.

B. The actual location of pipes along State and Federal highway rights-of-way shall be as required by the Highway Department and the final permit.

PART 2 PRODUCTS

2.01 DUCTILE IRON PIPE

A. Ductile iron pipe shall be centrifugally cast, Grade 60-42-10 iron, ANSI A21.51, AWWA C151, cement-mortar lined and seal coated in accordance with ANSI A21.4.

B. Ductile iron pipe pressure class shall be as follows unless shown or required otherwise.

12″ or less – Pressure Class 350

14″-20″ - Pressure Class 250

24″ – Pressure Class 200

30″ and up – Pressure Class 150

B. Joints shall be as follows unless shown or required otherwise:

1. Typical buried pipe: push-on joint.

2. Creek crossings: TR-Flex by U.S. Pipe, Flex-Ring by American, or equal.

3. Bridge crossings: TR-Flex by U.S. Pipe, Flex-Ring by American, or equal.

2.02 PVC PIPE

A. Polyvinyl chloride (PVC) pipe shall comply with ASTM D1784 for PVC materials and ASTM D2241 for PVC pipe and shall meet the requirements of NSF 14 and 61 standards for potable water supply. PVC pipe shall be supplied in lengths not less than twenty (20) feet.

B. Joints shall be push-on type spigot and bell with integral bell homogeneous with the pipe. Gaskets shall be rubber meeting the requirements of ASTM F477 and D3139 and shall be locked into the bell groove.

C. The pipe classes shown below shall be defined according to the Standard Pipe Diameter Ration (SDR) as defined by ASTM D2241. Pipe Class will be shown on the plans:

1. Class 160 Pipe: SDR 26.

2. Class 200 pipe: SDR 21.

3. Class 250 Pipe: SDR 17.

D. PVC pipe shall be as manufactured by North American Pipe Corporation, or equal.

E. Locator wire or metallic detector tape shall be included with all PVC mains and all plastic service tubing as per Owners request. Locator wire shall be No. 14 solid insulated copper wire buried approximately six (6) inches above the top of the pipe.

2.03 FITTINGS

A. Fittings for piping shall be cement-lined cast iron or ductile iron with mechanical joint ends and conforming to AWWA C110 and C111 or C153. Fittings less than twelve (12) inches shall be rated two hundred-fifty (250) psi minimum working pressure and fittings twelve (12) inches and larger shall be rated for one hundred-fifty (150) psi minimum working pressure.

B. Provide PVC adapters as required to connect fittings to PVC pipe.

2.04 THRUST RESTRAINT

A. Thrust restraint shall be provided by mechanical thrust restraints as shown in the details on the Drawings except where concrete thrust blocks are indicated.

B. Restrained joint systems shall be used where indicated. Concrete thrust blocks may be used in lieu of mechanical restraints if approved by the Engineer. Restrained joints shall be equal to TR-Flex by U.S. Pipe or Flex-Ring by American Cast Iron Pipe. Field Lok gaskets by U.S. Pipe or Fast-Grip gaskets by American Cast Iron Pipe may also be used for pipe sizes up to twenty-four (24) inches in diameter.

C. Restraining system consisting of mechanical joints with retainer glands and screws applicable for ductile iron pipe shall be equal to Megalug as manufactured by EBAA Iron may be used.

2.05 CASING PIPE

A. Casing pipe shall be steel, ASTM A139, Grade B with welded field joints. Casing wall thickness shall be min. 0.250 inches for all sizes thirty-six (36) inches and smaller and shall conform to State of Alabama Highway Department Section 862 for larger diameters. Casing pipe shall be shop coated with primer internally and externally, and final coated with bituminous paint on the exterior.

B. Casing Spacers: Carrier pipe shall be supported inside the casing with approved casing spacers, sized as required for the casing diameter. Casing spacers shall be CCI Model CSC (or approved equal) heavy-duty carbon steel with glass filled polymer runners.

C. Casing End Seals: shall be seamless neoprene with stainless steel banding. End seals shall be CCI model ESC or approved equal.

D. The approximate locations and lengths of encasements are shown on the Drawings for bidding information, but the exact location and length of encasement will be determined by the appropriate highway department.

2.06 VALVES

A. General:

1. Valves shall be suitable for the intended service. Renewable parts including disc, packing, and seats shall be of types recommended by valve manufacturer for intended service, but not of a lower quality than specified herein. Valves shall be suitable for the exposure they are subject to, buried, interior or exterior, as applicable.

2. Unless otherwise shown, valves shall be the same size as the adjoining pipe. For the purpose of designating the type and grade of valve desired, a manufacturer's name and list or figure number is given in the following Specifications. Valves of equal quality by other manufacturers will be considered in accordance with the GENERAL CONDITIONS.

3. Valve ends shall be as specified, as shown on the Drawings, and to suit the adjacent piping.

4. Buried service operators shall have a two (2) inch AWWA operating nut. All moving parts of the valve and operators shall be enclosed in the housing to prevent contact with the soil. Exposed operators shall have manual handwheel or lever operator as specified for the valve type.

B. Valve Types:

1. Gate Valves:

a. Gate valves for buried water service shall be resilient wedge type. The valve body, bonnet and wedge shall be constructed of ductile iron, with all internal and external ferrous surfaces having a fusion bonded epoxy coating, complying with ANSI/AWWA C550. The exterior of the ductile iron wedge shall be encapsulated with nitrite rubber. Ductile iron wrench nuts, O-rings and thrust washers shall be used to achieve watertight seals and ease of operation. Valves shall be Series 2500 American Flow Control, or equal.

b. Tapping valves shall comply with the Specifications for gate valves specified hereinbefore. Tapping valves shall be American-Darling 565, M&H Style 751, or equal. Tapping valve shall include cast iron tapping sleeve equal to M&H Style 974.

2. Check Valves:

   a. CV-1: Swing check valves two (2) inches through thirty-six (36) inches shall be in accordance with AWWA C508 and shall be flanged end, cast iron body, bronze mounted valves, with solid bronze hinges and stainless steel hinge shaft. Valves two (2) inches through twelve (12) inches shall be rated one hundred seventy-five (175) pounds and fourteen (14) inches through thirty-six (36) inches rated one hundred-fifty (150) pound cold water, non-shock. Valves shall be fitted with adjustable outside lever and spring. Valves shall be M&H Valve Style 60-SL; American Darling No. 50 Line; or equal.

C. Valve Boxes: Valve boxes shall be cast iron two (2) piece adjustable heavy roadway type with 5-¼-inch diameter and appropriate length for the installation. Include cast iron lid with the word "WATER" cast into the top of the lid. Extension pieces, if required, shall be the manufacturer's standard type. All units shall be complete with all necessary bases and accessories. Units shall be Mueller H-10364, Clow F-2452, or equal.

2.07 HYDRANTS

A. Fire Hydrant Specification (5-1/4" Main Valve)

Fire hydrants purchased or installed shall meet or exceed all applicable requirements and tests of ANSI and the latest revisions of AWWA Standard C502. Fire hydrants shall meet all test requirements and be listed by Underwriters Laboratories Inc. Fire hydrants shall meet all test requirements and have full approval of Factory Mutual. Fire hydrants shall meet the following requirements

1. Fire hydrants shall be rated for a working pressure of 250 Psig. (1725 kPa).

2. Fire hydrants shall be of the compression type, opening against the pressure and closing with the pressure.

3. Fire hydrants shall have a minimum 5-1/4" main valve opening and a minimum inside lower/upper barrel diameter (I.D.) of 7" to assure maximum flow performance. Pressure loss at 1,000 GPM shall not exceed the following values:

   4.5" Pumper Nozzle: 2.50psi

4. Fire hydrants shall be three-way in design, having one pumper nozzle (size as specified) and two 2-1/2" hose nozzle(s). Nozzle thread type shall be as specified by the end-user. Nozzles shall thread

counterclockwise into hydrant barrel utilizing "o" ring seals. A suitable nozzle lock shall be in place to prevent inadvertent nozzle removal.

5. The bonnet assembly shall provide an oil reservoir and lubrication system that automatically circulates lubricant to all stem threads and bearing surfaces each time the hydrant is operated. This lubrication system shall be sealed from the waterway and any external contaminants by use of "o "ring seals. An anti-friction washer shall be in place above the thrust collar to further minimize operating torque. The oil reservoir shall be factory filled with a low viscosity; FDA approved non-toxic oil lubricant which will remain fluid through a temperature range of -60^0 F. to $+150^0$ F.

6. The operating nut shall be a one piece design, manufactured of ASTM B-584 bronze. It shall be pentagon/square in shape and the nut dimensions shall be as specified by the end-user. The operating nut shall be affixed to the bonnet by means of an ASTM B-584 bronze hold down nut. The hold down nut shall be threaded into the bonnet in such a manner as to prevent accidental disengagement during the opening cycle of the hydrant. The use of Allen head set screws as a means of retention is unacceptable. A resilient weather seal shall be incorporated into the hold down nut, for the purpose of protecting the operating mechanism from the elements.

7. The direction of the opening shall be **Open Left**. An arrow shall be cast on the bonnet flange to indicate the specified opening direction.

8. The hydrant bonnet shall be attached to the upper barrel by not less than eight **316 Stainless Steel** bolts and nuts and sealed by an "o" ring.

9. Hydrants shall be a "traffic-model" having upper and lower barrels joined at the ground line by a separate and breakable "swivel" flange providing 360^0 rotation of upper barrel for proper nozzle facing. This flange shall employ not less than eight **316 Stainless Steel bolts**. The safety flange segments shall be located under the upper barrel flange to prevent the segments from falling into the lower barrel when the hydrant is struck. The pressure seal between the barrels shall be an "o" ring. The proper ground line shall be cast clearly on the lower barrel and shall provide not less than 18" of clearance from the centerline of the lowest nozzle to the ground. Hydrants shall be painted **Mueller Yellow (Mueller paint code 14).**

10. The operating stem shall consist of two pieces, not less than 1 1/4" diameter (excluding threaded or machined areas) and shall be connected by a stainless steel safety coupling. The Upper and Lower operating stem shall made from **17-4 Stainless Steel**. The safety coupling shall have an integral internal stop to prevent the coupling from sliding down into the lower barrel when the hydrant is struck. Screws, pins, bolts, or fasteners used in conjunction with the stem couplings shall also be stainless steel.

The top of the lower stem shall be recessed 2" below the face of the safety flange to prevent water hammer in the event of a "drive over" where a vehicle tire might accidentally depress the main valve.

11. The lower barrel shall be an integrally cast unit. The use of threaded on or mechanically attached flanges is deemed unacceptable. The hydrant bury depth shall be clearly marked on the hydrant lower barrel.

12. Composition of the main valve shall be a molded rubber having a durometer hardness of 95 +/- 5 and shall be reversible in design to provide a spare in place. Plastic (polyurethane) main valves are unacceptable. The main valve shall have a cross section not less than 1".

13. Hydrants shall be equipped with (2) two drain valves which drain the barrel when the hydrant is closed and seal shut when the hydrant is opened. These drain valves shall be an integral part of the one piece bronze upper valve plate. They shall operate without the use of springs, toggles, tubes, levers or other intricate synchronizing mechanisms.

14. The upper valve plate, seat ring and drain ring (shoe bushing) must be ASTM B-584 bronze and work in conjunction to form an all bronze drain way. A minimum of two (2) internal and two (2) external drain openings are required. Drains ported through an iron shoe must be bronze lined.

15. The bronze seat ring shall thread into a bronze drain ring (or shoe bushing) providing a bronze to bronze connection. Seat rings shall be "o" ring pressure sealed.

16. The shoe inlet size and connection type shall be as specified (flanged, MJ, etc.), having ample blocking pads for sturdy setting and the MJ connection must have two strapping lugs to secure the hydrant to piping. A minimum of six **316 Stainless Steel** bolts and nuts is required to fasten the shoe to the lower barrel.

17. The interior of the shoe including the lower valve plate and stem cap nut shall have a protective coating that meets the requirements of AWWA C-550. If a stem cap nut is utilized, it must be locked in place by a stainless steel lock washer or similar non-corrosive device that will prevent the cap nut from backing-off during normal use.

19. Hydrants shall be warranted by the manufacturer against defects in materials or workmanship for a period of ten years (10) from the date of manufacture. The manufacturing facility for the hydrant must have current ISO certification.

20. Hydrants shall be Mueller Super Centurion 250 or approved equal.

21. Hydrants shall be cast, manufactured, machined and assembled in the USA.

23. The (isolation) Gate Valve shall be of the same manufacture as the hydrant and must have Mueller cast into the bonnet.

Failure to comply with any of these above requirements is sufficient cause for rejection of proposed hydrants.

The city reserves the right to accept only those materials which are in full compliance with these specifications and deemed most advantageous to its interests.

2.08 SERVICE ASSEMBLIES

1. Meters shall conform to AWWA C700, split case type, 5/8 inch by ¾ inch size or two (2) inch size, positive displacement type, straight reading in gallons, with hermetically sealed and magnetically driven register and leak detector indicator separate from the sweep hand. All meters shall be first line, manufactured and assembled in the United States.

2. Meters shall include meter connections and shall have hinged bronze cover with manufacturer's serial stamp, white glazed enamel dial with large black register figures. The register shall be completely separated from the measuring chamber and shall be driven by permanent magnets. The main case shall be connected with bolts only, screws shall not be permitted.

3. Whether the project involves a new system or extension to an existing system, the Owner reserves the right to require a specific meter manufacturer in order to establish or maintain standardization. The meters shall be equal to Sensus with all bronze cases.

A. Brass Cocks, Stops, and Clamps

1. Corporation cocks shall be ¾ inch unless shown otherwise on the Drawings. Cocks shall be brass, complying with AWWA C800 and equal to Mueller H-15000 for copper tubing and Mueller H-15008 for plastic tubing.

2. Curb stops shall be ¾ inch with full opening unless shown otherwise on the Drawings. Stops shall be brass, complying with AWWA C800 and equal to Ford B-43-232W with lock out wing.

3. Service clamps shall be used for PVC main connections and shall be equal to Mueller bronze service clamp with corporation cock thread.

B. Backflow Preventer: Backflow preventers shall be ¾ inch, complying with ADEM cross connection regulators, rated for one hundred-fifty (150) psi, and equal to A. Y. McDonald Series II or Watts No. 7 dual check valve.

C. Meter Boxes: Meter boxes shall be plastic, approximately twelve (12) inches by seventeen (17) inches by (12) inches deep, rectangular shape with plastic top, hinged reading lid and cast-in magnet.

D. Service Pipe:

1. Copper tubing shall conform to Federal Specifications WW-T-799 Type K. Size shall be ¾ inch unless shown otherwise on the Drawings.

2.09 RECONNECTION OF EXISTING SERVICE ASSEMBLIES

A. Brass Cocks, Stops, and Clamps.

1. Corporation cocks shall be 3/4-inch unless shown otherwise on the Drawings. Cocks shall be brass, complying with AWWA C800 and equal to Mueller H-15000 for copper tubing and Mueller H-15008 for plastic tubing.

2. Curb stops shall be 3/4-inch with full opening unless shown otherwise on the Drawings. Stops shall be brass, complying with AWWA C800 and equal to Ford B-43-232W with lock out wing.

3. Service clamps shall be used for PVC main connections and shall be equal to Mueller bronze service clamp with corporation cock thread.

B. Copper tubing shall conform to Federal Specifications WW-T-799, Type K. Size shall be 3/4 inch unless shown otherwise on the Drawings.

2.10 PRECAST CONCRETE VALVE/METER VAULT

A. Precast valve or meter vaults shall be of the size shown on the Drawings or as required to contain the necessary equipment and provide minimum clearances as shown on the Drawings. Vault shall include concrete footings and walls with hinged aluminum access doors. Vaults with depths greater than four (4) feet shall be provided with aluminum ladder attached to one (1) wall. Vaults shall be as manufactured by Hughes Supply, Eagle Wholesale Supply, or equal.

2.11 UTILITY MARKERS

A. Continuous glass fiber and resin reinforced composite utility markers shall be installed at each valve location and locations shown on the drawings. Utility markers shall be 3.75 inches wide and a minimum of 66 inches in length. Markers shall be installed with an embedment depth of 18-inches. Markers shall be blue and imprinted with white lettering: '*Caution Water Pipeline'.* Utility

markers shall be Utility Marker brand as manufactured by Carsonite Composites or equal.

PART 3 EXECUTION

3.01 TRENCH EXCAVATION AND BACKFILL

A. General:

1. Trenches for mains shall be excavated in the locations shown on the Plans or as directed by the Engineer.

2. All trees, telephone and power poles along the line of Work shall be protected. Where clearing or partial clearing of the right-of-way is necessary, complete before the start of trenching. Cut trees and brush as near to the ground surface as practical, remove all stumps, and remove for disposal. Do not remove trees over two (2) inches in diameter unless they are within four (4) feet of the pipe centerline, without permission from the Engineer. Protect from damage all privately owned shrubs or plants unless approved by the Engineer. If necessary for protection, remove and replace trees, shrubs, or plants by balling the root system and placing in stockpiled topsoil, watering as required. Should any tree, shrub, or plant that has been disturbed as a result of its removal, or otherwise damaged by the Contractor, die within six (6) months from the time it was disturbed or damaged, it shall be replaced in kind and size by the Contractor.

3. Unless boring and jacking is required as shown on the Drawings, cut all bituminous and concrete pavements, curbs and sidewalks before excavation of the trenches with an approved pavement saw, hydrohammer, or approved pavement cutter. Pavement and concrete materials removed shall be hauled from the site and not used for trench backfill. No driveway or road shall be inaccessible at the end of the day's Work and all street crossings shall be backfilled and opened to traffic each day.

B. Trench Excavation:

1. Trench widths shall be as required to properly install the mains, but not less than twelve (12) inches wide. The trench depths shall be as required to provide a minimum pipe cover of three (3) feet, unless otherwise approved by the Engineer.

2. At all times provide and maintain ample means and devices to promptly remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipe laying, during the laying of the pipe, and until the backfill at the pipe zone has been completed.

C. Trench Backfill:

1. The Contractor may backfill the trenches before hydrostatic testing, but is responsible for locating and repairing all leaks until a satisfactory hydrostatic test is completed.

2. When backfill is placed mechanically, push the backfill material onto the slope of the backfill previously placed and allow to slide down into the trench. Do not push backfill into the trench in such a way as to permit free fall of the material until at least two (2) feet of cover is provided over the top of the pipe. Under no circumstances allow sharp, heavy pieces of material to drop directly onto the pipe or the tamped material around the pipe. Do not use backfill material of consolidated masses larger than ½ cubic foot.

3. Backfill trenches beneath roads, paving and sidewalks by placing material in six (6) inch lifts and compacting each lift with mechanical tampers or vibratory compactors to at least ninety-five (95%) percent of the relative maximum compaction as determined by AASHTO T99.

4. Backfill trenches in other areas by placing materials in loose lifts as described hereinbefore and leave the backfill material neatly mounded so that after normal settlement the finished surface will meet with existing grade.

5. Any excess or deficiency of backfill material which becomes apparent after settlement and within the warranty period shall be corrected by disposing of excess material, or adding additional material where required.

6. Any settlement noted in backfill, fill, or in structures built over the backfill or fill within one (1) year warranty period in accordance with the General Conditions will be considered to be caused by improper compaction methods and shall be corrected at no cost to the Owner. Structures damaged by settlement shall be restored to their original condition by the Contractor at no cost to the Owner.

3.02 PIPE INSTALLATION

A. Handling Material: Provide and use proper implements, tools, and facilities for the safe and proper prosecution of the Work. Lower all pipe, fittings, and appurtenances into the trench, piece by piece, by means of a crane, slings, or other suitable means and in such a manner as to prevent damage to the pipeline materials and protective coatings and linings. Do not drop or dump pipeline materials into the trench.

B. Cleaning Pipe and Fittings: Remove all dirt, blisters, lumps, and excess coating from the bell and spigot ends of each pipe. Wipe the outside of the spigot and the inside of the bell until joints are clean, dry, and free from oil and grease before the pipe is laid.

C. Cutting Pipe: Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe or leaving a beveled end as recommended by the manufacturer. Dress cut ends to remove sharp edges or projections which may damage the rubber gasket.

D. Laying Pipe: Unless otherwise directed, lay pipe with bell end facing in the direction of the laying. For lines on an appreciable slope, face bells upgrade at the discretion of the Engineer. Pipelines intended to be straight shall not deviate from the straight line at any joint in excess of one (1) inch. Wherever it is necessary to deflect from a straight line, the maximum deflection per joint shall be as recommended by the pipe manufacturer.

E. Joining Push-On Joint Pipe: Lay and join pipe in strict accordance with the manufacturer's recommendations. Provide all special tools and devices, such as special jacks, chokers, and similar items required for the installation. Lubricant for the pipe shall be furnished by the pipe manufacturer.

F. Joining Mechanical Joint Pipe and Fittings: Install in accordance with manufacturer's recommendations. After cleaning ends and gasket, slip the gland and gasket on the plain end, lubricating if necessary to facilitate sliding the gasket into place. Guide the end of the pipe into the bell of the pipe previously laid, locating the spigot centrally in the bell. Place the gasket into position and insert the bolts in the holes. When tightening bolts, bring the gland up toward the flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. Tighten all nuts progressively at a time. Do not overstress bolts to compensate for poor alignment. If effective sealing is not attained at the maximum torque, disassemble the joint and reassemble after cleaning.

3.03 ROAD AND HIGHWAY UNDERCROSSINGS

A. Open Cut Undercrossings: Complete trench excavation and backfill for open-cut undercrossings as hereinbefore specified under Trench Excavation and Backfill.

1. All labor, equipment, and materials required to open cut road crossings as designated on drawings including but limited to excavation, boring, piping, pipe supports, casing, backfill, and clean-up, grassing, etc.. Payment shall be based on unit price.

B. Casing Installation:

1. Jacked or bored casings shall be continuously welded at joints for a rigid, watertight encasement.

2. All labor, equipment, and materials required to bore road crossings as designated on drawings including but limited to excavation, boring, piping, pipe supports, casing, backfill, and clean-up, grassing, etc..

3. Bored installations shall have a hole diameter which shall not exceed the OD of the casing pipe by more than one (1) inch. Where unstable soil conditions are found to exist, boring operations shall be conducted in such a manner as not to be detrimental to the facility being crossed. If excessive voids or too large a bored hole results, or if it is necessary to abandon a bored hole, prompt remedial measures shall be taken by the Contractor, subject to review by the Engineer and approval of the controlling agency of the facility being crossed.

4. Once boring and jacking operations are started, the Work shall be continuous until completed in order to guard against "freezing" of the casing due to settlement and compaction of surrounding soil. Casing shall be installed at a uniform slope.

C. Carrier Pipe Installation:

1. The entire length of casing shall be complete before any carrier pipe is placed therein. Carrier pipe materials and installation shall conform to the requirements specified elsewhere except as hereafter indicated or as required by the controlling agency permit.

2. Where timber cradles are required, strap the cradles to the pipe before sliding into casing. Pipe barrel shall bear continuously on cradles.

3. The carrier pipe may be pushed or pulled into the casing as pipe lengths are assembled. Pipe installation shall conform to requirements specified herein, including testing.

D. Pavement Replacement:

1. All Work associated with the pavement replacement shall be done in strict accordance with the State of Alabama Highway Department Standard Specifications.

2. Pavement shall be immediately replaced provided weather conditions or other factors permit. Should conditions prevent immediate repaving, apply a temporary approved cold patch for the full trench width and maintain until such time as the final asphalt surface course can be completed.

3.03 VALVE INSTALLATION

A. Valves:

1. Before installation, the valves shall be thoroughly cleaned of all foreign material, and shall be inspected for proper operation, both opening and closing, and to verify that the valves seat properly. Valves shall be installed so that the stems are set vertical. Jointing shall conform to AWWA C600 or AWWA C603 as applicable. Joints shall be tested with the adjacent pipeline.

2. Flange faces and mechanical joint sockets shall be thoroughly cleaned before the joint is assembled.

B. Valve Boxes:

1. Center the valve boxes and set plumb over the wrench nuts of the valve. Set valve boxes so that they do not transmit shock or stress to the valves. Set the valve box covers flush with the finished surface as shown. Cut extensions to the proper length so that the valve box does not ride on the extension when set at grade.

2. Backfill shall be the same a specified for the adjacent pipe. Place backfill around the valve boxes and thoroughly compact to a density equal to that specified for the adjacent trench and in such a manner that will not damage or displace the valve box from proper alignment or grade. Misaligned valve boxes shall be excavated, plumbed, and backfilled at the Contractor's sole expense.

C. Connection to Existing Water Mains:

1. Points of connection to existing water mains shall be exposed prior to trenching of the new line not less than forty-eight (48) hours prior to the anticipated connection time. The Contractor shall immediately notify the Engineer if the connection cannot be made in accordance with the Drawings.

2. All connections to the existing system and all testing of the new line must be with the authorization of, and in the presence of, the authorized representative of the water system. Opening of valves and use of water from the water system will be done by the system.

3. Connections to an existing system using a tapping machine shall be completed in accordance with the manufacturer's recommendations. Where cut-ins are permitted to be made in existing pipes, the Work shall be conducted at such a time and in such a manner as to minimize the interruption of service. Necessary pipe, fittings, and valves shall be assembled at the site ready for installation before water is shut off in the existing main. Once water service has been shut off, the Work shall be

prosecuted vigorously and shall not be halted until the line is restored to service.

3.04 SERVICE CONNECTIONS

A. Service pipe shall be laid with a minimum cover of thirty (30) inches, except on State and Federal highway rights-of-way the minimum cover shall be as required by the Highway Department but not less than thirty-six (36) inches.

B. Trenching and backfilling for services shall be hereinbefore specified for water mains, except pavements or sidewalks shall not be cut. Where the service pipe crosses a paved street or sidewalk it shall be laid by means of pushing, jetting or boring.

C. Copper tubing as hereinbefore specified shall be used for all standard service connections, including State, Federal and County Road crossings, unless otherwise noted. In general, service piping will extend from the main to a point near the property line designated by the water system.

D. Mains shall be tapped for service connections at an angle of not more than thirty (30^{o}) degrees to the horizontal. Use only suitable tapping equipment and the coupon removed from tapping the main must be delivered to the Engineer.

3.05 HYDROSTATIC TESTING

A. General: Make pressure and leakage tests on all newly laid pipe. The Contractor shall provide all necessary equipment and material, make all taps in the pipe as required, and conduct the tests. The Engineer will monitor and witness the tests before the installed pipe is approved. Pressure tests must be completed before payment is made for that section of pipe.

B. Test Pressure: Each section of pipe shall be slowly filled with water to the test pressure shown in the piping schedule or to the pressure class rating of the pipe. Pressure shall be applied by a motor-driven pump. The test duration shall be six (6) hours for covered pipe and three (3) hours for uncovered pipe. The Contractor shall provide a pressure chart recorder for the duration of each test.

C. Procedure: Before applying the specified test pressure, all air shall be expelled from the pipe. If necessary, taps shall be made at points of highest elevation and plugged afterward. At the end of the test period, the Contractor will inject a sufficient quantity of water into the pipe section to re-establish the specified pressure. The Contractor shall provide suitable means to determine the quantity of water lost by leakage during the test. The Engineer must witness the quantity of water leakage and pressure recording and sign both before approving the test.

D. Allowable Leakage: Exposed piping shall not have any visible leakage. For buried pipelines less than 500 LF the allowable leakage shall be zero (0) gallons. For lengths more than more than 500 LF the allowable leakage shall be less than the amount determined by the following formula:

$$L = \frac{(10)\ D\ Le}{126720}$$

Where L = Allowable leakage, gallons per hour

D = Nominal diameter of pipe, inches

Le = Length of pipe, feet

E. Allowable Loss of Pressure: The maximum allowable drop in pressure from the test pressure shall be no greater than five (5) percent of the test pressure.

F. Correction of Excessive Leakage: Should any test of pipe disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

3.06 DISINFECTION

A. General: After pipelines, valves, fittings, and appurtenances have been installed and tested, they shall be disinfected in accordance with AWWA C651 or as modified by any governing agency having jurisdiction. The Contractor shall provide all equipment and materials necessary to adequately disinfect all facilities.

B. Flushing: Before sterilizing, flush all foreign matter from the line. Flushing velocities shall be at least 2.5 feet per second. For large diameter pipelines where it is impractical to flush the pipe at this velocity, clean the pipeline in place from the inside by brushing, sweeping and swabbing, then flush the line at a lower velocity.

C. Disinfection: Disinfect with a chlorine solution having a free chlorine residual of fifty (50) ppm. The solution shall be injected into the pipe through a corporation stop or suitable tap in the top of the pipeline. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the existing water mains or so that contaminated water does not enter any disinfected mains.

D. Retention Period: The chlorine solution shall remain in the pipeline for twenty-four (24) hours or long enough to destroy all nonspore-forming bacteria, whichever is greater. Operate all valves, hydrants, and other appurtenances during disinfection to assure that the chlorine solution is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise

may not receive the solution. After the retention period is complete, flush the chlorinated solution from the line until a chlorine residual of 0.2 ppm has been achieved.

E. Bacteriological Samples: After flushing, collect a minimum of two (2) water samples for bacteriological analysis at a rate of at least one (1) per mile of water main disinfected and submit to a laboratory certified by ADEM. Where new connections to existing piping are made, at least one (1) sample per affected area of the system shall be collected and analyzed. All samples shall indicate absence of Total and Fecal Coliform. Contractor shall repeat disinfection procedure until satisfactory results have been obtained. The bacteriological results shall be sent directly to the Engineer.

END OF SECTION

SECTION 15002
GRAVITY SEWER, MANHOLES AND ACCESSORIES

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section covers the work necessary to furnish and install, complete, the gravity sewer, manholes and service laterals specified herein in order to complete the gravity sewer and laterals, including connections to existing facilities.

1.02 GENERAL

A. Like items of material provided thereunder shall be the end products of one manufacturer.

1.03 SUBMITTALS

A. Shop Drawings: Furnish the following:

1. Precast Manhole Base Sections: Details of construction.

2. Manhole steps.

B. Quality Control Submittals: Furnish the following:

1. Precast Manhole Sections: Manufacturer's results of tests performed on representative sections to be furnished.

2. Certified load test data for manhole steps.

PART 2 PRODUCTS

2.01 CARBON STEEL PIPE, AND FITTINGS

A. Pipe shall be carbon steel, seamless or electric resistance welded, ASTM A53, Grade B or ASTM A106, Grade B. Pipe wall thickness for two (2)-inch and smaller shall be Schedule 80, pipe wall thickness for 2½ inch and larger shall be Schedule 40 with wall thickness 0.375 inches. Pipe shall have an epoxy coating system inside and out as manufactured by Tnemec. Coatings shall be submitted with piping for approval.

B. Joints for two (2)-inch and smaller shall be threaded, all joints 2½-inch and larger shall be butt welded where required for connections to equipment.

2.02 DUCTILE IRON PIPE

A. Ductile iron pipe shall be centrifugally cast, Grade 60-42-10 iron, ANSI A21.51, AWWA C150, cement-mortar lined and seal coated in accordance with AWWA C110, Thickness Class 50.

B. Joints shall be flanged unless shown or required otherwise.

2.03 PVC PIPE

A. Polyvinyl chloride (PVC) pipe shall comply with ASTM D3034-81 for PVC materials and ASTM F679, minimum pipe stiffness 115 psi at 5% deflection, and shall meet the extra strength minimum of Standard Diameter Ratio 35. PVC pipe shall be supplied in lengths not less than 20 feet.

B. Joints shall be push-on type spigot and bell with integral bell homogeneous with the pipe. Gaskets shall be rubber meeting the requirements of ASTM F477 and D3212 and shall be locked in to the bell groove.

C. The pipe classes shown below shall be defined according to the Standard Pipe Diameter Ratio (SDR) as defined by ASTM D2241. Pipe class will be shown on the plans.

1. Class 160 pipe: SDR 26

2. Class 200 pipe: SDR 21

3. Class 250 pipe: SDR 17

4. Gravity sewer pipe: SDR 35

D. PVC pipe shall be as manufactured by North American Pipe Corporation, or equal.

2.04 TRENCH STABILIZATION MATERIAL

A. Trench stabilization material shall be three-inch minus river-run or pit-run gravel, crushed gravel, or crushed rock; free from clay balls, roots, and organic matter; well-graded from coarse to fine, with less than 8 percent by weight passing the 1/4-inch sieve.

2.05 GRANULAR PIPE BASE AND PIPE ZONE MATERIAL

A. Granular pipe base and pipe zone shall be Natural stone; washed, free of clay. Shale, organic matter; graded in accordance with ASTM C136 to meet the

requirements of AHD Std. Spec., Section 801, Size No. 6 or No. 57, stone may be used if approved by the Engineer.

2.06 GRANULAR FILL

A. Granular fill shall be natural sand or sand gravel, free from dirt, clay balls, and organic material, well graded from coarse to fine, containing sufficient finer material for proper compaction, and less than 20 percent by weight passing the No. 200 sieve.

2.07 CONCRETE

A. Concrete shall have 4,000 psi compressive strength at 28 days. Portland cement shall conform to ASTM C150, Type II.

2.08 MORTAR/GROUT

A. Mortar shall be standard premixed meeting ASTM C387, or proportion 1 part portland cement to 2 parts clean, well-graded sand which will pass a 1/8-inch screen.

B. Admixtures: May be included but do not exceed the following percentages of weight of cement:

1. Hydrated Lime: 10 percent.

2. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Consistency:

1. Tongue-and-Groove Type Manhole Joint: Such that mortar will readily adhere.

2. Confined Groove (Keylock) Manhole Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

2.09 PRECAST MANHOLE RISER SECTIONS

A. Minimum 48 inches in diameter, conforming to ASTM C478 and the following:

1. Minimum Wall Thickness: 5" inches.

2. Provide eccentric cones for manholes. Cones shall have same wall thickness and reinforcement as riser section.

3. Top and bottom of sections shall be parallel.

4. Manhole Steps: Cast in sections by the manufacturer.

5. Joints: Tongue-and-groove or confined groove with mastic. Confined Oring with rubber gaskets meeting ASTM C443.

6. Manhole couplings or flexible boots or sleeves either cast in or grouted into manhole wall for watertight seal on manhole-pipe connection.

B. Source Tests:

1. Prior to delivery of any size precast manhole section to job site, conduct yard tests at point of manufacture.

2. Precast sections to be tested will be selected at random from stockpiled material to be supplied for the job.

3. All test specimens shall be mat-tested and meet the permeability test requirements of ASTM C14.

2.10 PRECAST BASE SECTIONS AND BASES

A. Acceptable as an option if approved by ENGINEER.

B. Base Sections: Base slab integral with sidewalls.

C. Base Slab: Minimum 6 inches thick with No. 4 reinforcing bars, 8-inch centers, both directions in center of slab. Tie reinforcing steel to wall steel.

2.11 MANHOLE EXTENSIONS

A. Concrete Grade Rings for Extensions: Maximum 6 inches high with a minimum of one No. 2 reinforcing bar centered in the ring.

B. Manhole Encapsulation System: CCI Piping Systems WrapidSeal or approved equal

1. Shall be installed on the corbel and joint sections of the manhole. shall be installed from the frame to 4″ below the cone and lowest grade ring joint.

2. Installer shall follow all manufacturer's procedures and specifications to ensure proper application.

C. Preformed plastic manhole gaskets shall be used in lieu of mortar type joints between each concrete grade ring.

2.12 PREFORMED PLASTIC MANHOLE GASKETS

A. Provid in lieu of mortar type joints.

B. Conform to requirements of Federal Specification SS-S-00210.

C. Manufacturers:

1. Hamilton Kent Manufacturing Co., Box 178, Kent, OH 44240, Kent-Seal No. 2.

2. K. T. Snyder Co., Inc., Central National Bank Bldg., Houston TX 77002, Ram-Nek.

2.13 MANHOLE STEPS

A. Shall be PSI-PF, manufactured by M.A. Industries Inc., Kelly & Dividend Dr., Peachtree City, GA 30269, or equal.

B. Design: Provide certification that steps are capable of withstanding the vertical and horizontal load test specified in ASTM C478.

2.14 MANHOLE FRAMES AND COVERS

A. Shall be 24-inch clear opening as manufactured by Neenah Foundry R-1916-F. Frames shall have 4-1″ anchor bolt holes for bolting to concrete manhole. Frames shall be watertight with bolted lids. The word SEWER in raised 2″ letters shall be cast in lid.

2.15 PIPE AND FITTINGS FOR SERVICE LATERALS

A. All lateral connections shall be 4-inch nominal diameter comprised of the same material as the sewer main. Bedding and backfill requirements shall be the same as specified herein for the sewer mains.

B. Except by permission of the ENGINEER, long-radius bends shall be used at all changes in direction. Pipe and fittings for individual service connections shall be of one type of material throughout.

PART 3 EXECUTION

3.01 WELDING STEEL PIPE

A. General: In accordance with the latest edition of Section IX, ASME Boiler and Pressure Vessel Code.

B. Welding Procedure Specifications:

1. Qualify all welding procedure specifications prior to fabrication in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

2. Identify all welding procedure Specifications by number and reference the procedure number on all fabrication Drawings.

C. Welding and Welding Operators:

1. Qualify all welders and welding operators prior to fabrication in accordance with ASME Broiler and Pressure Vessel Code, Section IX.

2. Include qualifications for all welding positions to be employed in the fabrication.

D. Materials:

1. Use welding products within the limits recommended by their manufacturers.

2. Keep electrodes, filler wires, and fluxes clean, dry, and properly stored according to manufacturer's recommendations. Do not use electrodes, filler wires, or fluxes that are damp, greasy, or oxidized.

3. Do not use backing rings.

4. Consumable inserts may be used if included in the qualified welding procedure specification. Match the chemistry of the consumable insert with the base metal and weld metal chemistry.

3.02 FABRICATION OF STEEL PIPE

A. End Preparation:

1. Machine shaping of pipe ends is the preferred method.

2. Oxygen or arc cutting is acceptable only if the cut is smooth and true and all slag is removed either by chipping or grinding.

3. Beveled Ends for Butt Welding: Meet the requirements of ANSI B16.25.

B. Cleaning: After completion of shop or field fabrication and after erection, clean all piping inside and outside to remove all loose scale, weld spatter, dirt, loose debris, and foreign material.

C. Alignment and Spacing:

1. Align ends to be joined within existing commercial tolerances on diameters, wall thickness, and out-of-roundness.

2. Root Opening of the Joint: As stated in the welding procedure Specification.

3.03 CORROSION PROTECTION

A. Install coating as specified.

3.04 EXAMINATION, INSPECTION, AND TESTING OF STEEL WELDING

A. Required Examinations:

1. Perform examination in accordance with the ANSI Code for Pressure Piping B31.3 (Piping Code).

2. Perform examination for every pipe thickness and for each welding procedure, progressively, for all piping covered by this Section.

3.05 PIPE PREPARATION AND HANDLING - GENERAL

A. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed. The interior and exterior protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

B. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe.

C. Care shall be taken not to damage linings when handling pipe.

3.06 CUTTING PIPE

A. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.

B. Dress cut ends of pipe in accordance with the type of joint to be made. Dress cut ends of mechanical joint pipe to remove sharp edges or projections, which may damage the rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer. Dress cut ends of pipe for flanged coupling adapters as recommended by the manufacturer.

3.07 FABRICATION OF FLANGED PIPE - GENERAL

A. Flanged ductile iron pipe and steel pipe shall be fabricated in the shop, not in the field, and delivered to the job site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer. Flanges for ductile iron shall be faced after fabrication in accordance with ANSI A21.15/AWWA C115.

3.08 JOINTING PIPE - GENERAL

A. Flanged: Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to assure proper seating of the flange gasket. Bolts shall be tightened so the pressure on the gasket is uniform. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible. If joints leak, the gaskets shall be removed and reset and bolts re-tightened.

3.09 TRENCH EXCAVATION AND BACKFILL

A. General:

1. Trenches for mains shall be excavated in the locations shown on the plans or as directed by the ENGINEER.

2. All trees, telephone and power poles along the line of work shall be protected. Where clearing or partial clearing of the right-of-way is necessary, complete before the start of trenching. Cut trees and brush as near to the ground surface as practicable, remove all stumps, and remove for disposal. Do not remove trees over 2 inches in diameter unless they are within 4 feet of the pipe centerline, without permission from the ENGINEER. Protect from damage all privately owned shrubs or plants unless approved by the ENGINEER. If necessary for protection, remove and replace trees, shrubs, or plants by balling the root system and placing in stockpiled topsoil, watering as required. Should any tree, shrub, or plant that has been disturbed as a result of its removal, or otherwise damaged by the CONTRACTOR, die within 6 months from the time it was disturbed or damaged, it shall be replaced in kind and size by the CONTRACTOR.

3. Cut all bituminous and concrete pavements, curbs and sidewalks before excavation of the trenches with an approved pavement saw, hydrohammer, or approved pavement cutter. Pavement and concrete materials removed shall be hauled from the site and not used for trench backfill. No driveway or road shall be inaccessible at the end of the day's work and all street crossings shall be backfilled and opened to traffic each day.

4. All excess excavation not required or suitable for backfill or filling shall become property of the CONTRACTOR and shall be disposed of off the site.

B. Trench Excavation:

1. Trench widths shall be as required to properly install the mains, but not less than 24 inches wide. The trench depths shall be as shown on the drawings.

2. At all times provide and maintain ample means and devices to promptly remove and dispose of all water entering the trench excavation during the time the trench is being prepared for the pipe laying, during the laying of the pipe, and until backfill at the pipe zone has been completed.

C. Trench Backfill:

1. Provide imported granular pipe base material under gravity sewer pipe for full width of trench. Minimum depth of base shall be 4 inches unless otherwise directed by the ENGINEER.

2. The pipe zone shall be considered to include the full width of the excavated trench from the bottom of the pipe to the top of the pipe. Particular attention must be given to this area to ensure that firm support is obtained to prevent any lateral movement of the pipe during the final backfilling of the pipe zone. Pipe zone material shall be the same material used for the pipe base. This material shall be placed, in a manner approved by the ENGINEER, simultaneously on both sides of pipe in lifts not to exceed 4 inches. Backfill in the pipe zone shall be compacted by approved mechanical tamping methods. The minimum required compaction shall be 95 percent relative compaction, as determined by ASTM D 1557, latest edition.

3. The CONTRACTOR may backfill the trenches before air testing, but is responsible for locating and repairing all leaks until a satisfactory test is completed.

4. When backfill is placed mechanically, push the backfill material onto the slope of the backfill previously placed and allow to slide down into the trench. Do not push backfill into the trench in such a way as to permit free fall of the material until at least 2 feet of cover is provided over the top of the pipe. Under no circumstances allow sharp, heavy pieces of material to drop directly onto the pipe or the tamped material around the pipe. Do not use backfill material of consolidated masses larger than 1/2 cubic foot.

5. Backfill trenches beneath roads, paving and sidewalks by placing previously specified imported granular material in 6-inch lifts and compacting each lift with mechanical tampers or vibratory compactors to at least 95 percent of the relative maximum compaction as determined by AASHTO T99.

6. Backfill trenches in other areas by placing material in loose lifts as described herein before and leave the backfill material neatly mounded so that after normal settlement the finished surface will meet the existing grade.

7. Any excess or deficiency of backfill material which becomes apparent after settlement and within the warranty period shall be corrected by regrading, disposal of excess material, and adding additional material where required.

8. Any settlement noted in backfill, fill, or in structures built over the backfill or fill within the 1-year warranty period in accordance with the General Conditions will be considered to be caused by improper compaction methods and shall be corrected at no cost to the OWNER. Structures damaged by settlement shall be restored to their original condition by the CONTRACTOR at no cost to the OWNER.

3.10 PIPE INSTALLATION

A. Handling Material: Provide and use proper implements, tools, and facilities for the safe and proper prosecution of the work. Lower all pipe, fittings, and appurtenances into the trench, piece by piece, by means of a crane, slings, or other suitable means and in such a manner as to prevent damage to the pipeline materials and protective coatings and linings. Do not drop or dump pipeline materials into the trench.

B. Cleaning Pipe and Fittings: Remove all dirt, blisters, lumps, and excess coating from the bell and spigot ends of each pipe. Wipe the outside of the spigot and the inside of the bell until joints are clean, dry, and free from oil and grease before the pipe is laid.

C. Cutting Pipe: Cut pipe in a neat and workmanlike manner without damaging the pipe or lining and so as to leave a smooth end at right angles to the axis of the pipe or leaving a beveled end as recommended by the manufacturer. Dress cut ends to remove sharp edges or projections, which may damage the rubber gasket.

D. Laying Pipe: Lay pipe with bell end facing upgrade. Pipelines intended to be straight shall not deviate from the straight line at any joint in excess of 1 inch.

E. Joining Push-On Joint Pipe: Lay and join pipe in strict accordance with the manufacturer's recommendations. Provide all special tools and devices, such as special jacks, chokers, and similar items required for the installation. Lubricant for the pipe shall be furnished by the pipe manufacturer. Place sufficient amount of pipe zone material to secure the pipe from movement before the next joint is installed. Provide bell holes at each joint so that the joint can be assembled properly while maintaining uniform pipe support

F. Joining Mechanical Joint Pipe and Fittings: Install in accordance with manufacturer's recommendations. After cleaning ends and gasket, slip the gland and gasket on the plain end, lubricating if necessary to facilitate sliding the gasket into place. Guide the end of the pipe into the bell of the pipe previously laid, locating the spigot centrally in the bell. Place the gasket into position and insert the bolts in the holes. When tightening bolts, bring the gland up toward the flange evenly, maintaining approximately the same distance between the gland and the face of the flange at all points around the socket. Tighten all nuts progressively at a time. Do not over stress bolts to compensate for poor alignment. If effective sealing is not attained at the maximum torque, disassemble the joint and reassemble after cleaning.

G. Installation of Lateral Connection Tees or Wyes: Install tee or wye fittings in accordance with the Sewer Service Connection Details shown on the Drawings. Provide all tees with caps or plugs, as specified. Provide a minimum 2-foot wide compacted gravel base under tees installed in trenches less than 12 feet deep.

H. Line and Grade:

1. Laterals: Minimum slope for laterals shall be 1/4 inch per foot.

2. Sewer Mains: Do not deviate from line or grade, as established by the ENGINEER, more than 0.05% for grade, provided that such variation does not result in a level or reverse sloping invert. Measure for grade at the pipe invert, not at the top of the pipe, because of permissible variation in pipe wall thickness. Establish line and grade for pipe by the use of lasers or by transferring the cut from the offset stakes to batter boards set in the trench at maximum intervals of 25 feet. Match the existing line and grade of the manhole to manhole section being replaced. Maintain a minimum of three sets of batter boards with string line ahead of the pipe laying at all times. If batter boards in the trench prove impractical because of trench conditions, submit other methods of grade and alignment control the ENGINEER for approval. Hand-grade base to proper grade ahead of pipe laying. Base shall provide a firm, unyielding support along entire pipe length.

3.11 HIGHWAY & ROAD UNDERCROSSINGS

A. Open Cut Undercrossings: Complete trench excavation and backfill for open-cut undercrossings as hereinbefore specified under Trench Excavation and Backfill.

B. Pavement Replacement: As specified in accordance with the Alabama Department of Transportation Standard Specifications for Highway Construction, latest edition.

C. Casing Installation:

A. Casing pipe shall be steel, ASTM A139, Grade B with welded field joints. Casing wall thickness shall be min. 0.188 inches for all sizes thirty-six (36) inches and smaller and shall conform to State of Alabama Highway Department Section 862 for larger diameters. Casing pipe shall be shop coated with primer internally and externally, and final coated with bituminous paint on the exterior.

B. Carrier pipe shall be supported inside the casing with pressure-treated timbers, sized as shown on the Drawings. Straps for pipe supports shall be ½ inch wide stainless steel bands, or equal.

C. The approximate locations and lengths of encasements are shown on the Drawings for bidding information, but the exact location and length of encasement will be determined by the appropriate highway department.

3.12 LATERAL CONNECTIONS

A. Laterals shall be laid to the property line with a minimum cover of 3 feet at the locations shown on the Drawings.

B. Trenching and backfilling for services shall be as hereinbefore specified.

C. Maximum deflection permissible with any one fitting shall not exceed 45 degrees and shall be accomplished with long-radius curves or bends. Short-radius elbows or curves will not be permitted, except by permission of the ENGINEER or where shown on the Drawings.

D. Provide ends of all service connection lines and fittings with standard watertight plugs, caps, and stopper, suitably braced to prevent blowoff during internal hydrostatic or air testing.

3.13 LOW PRESSURE AIR TEST

A. General: Make pressure and leakage tests on all newly laid pipe after cleaning. The CONTRACTOR shall provide all necessary equipment and material, and conduct the tests. The ENGINEER will monitor and witness the tests before the installed pipe is approved. Pressure tests must be completed before payment is made for that section of pipe.

B. Air Test:

1. The test shall be conducted between each two adjacent manholes. All sewer sections within the installed system shall be tested.

2. All wyes, tees, or end of slide sewer stubs shall be plugged with flexible-joint caps, or acceptable alternate, securely fastened to withstand the

internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible-jointed lateral connection or extension.

3. Air shall be slowly supplied to the plugged pipe installation until the internal air pressure reaches 4.0 pounds/square inch greater than the average back pressure of any ground water that may submerge the pipe. At least 2 minutes shall be allowed for temperature stabilization before proceeding further.

   If piping is not below ground water, 5 psi may be applied and maintained for minimum times shown in after the 2 minute stabilization period.

4. The pipeline shall be considered to have passed the low pressure air test if the time required for the low pressure exfiltration pressure drops from 3.5 psi to 3.0 psi, (in excess of back pressure from ground water submerging the pipe) shall not be less than that shown in the following table.

5. Air Pressure Adjustment for Pipeline below Groundwater:

   The air pressure correction, which must be added to the 3.5 psig normal test starting pressure, shall be calculated by dividing the average vertical height in feet of ground water above the invert of the sewer pipe to be tested by 2.31. The result gives the air pressure correction in pounds per square inch to be added. (For example, if the average vertical height of groundwater above the pipe invert is 2.8 feet, the additional air pressure required would equal 2.8 divided by 2.31 or 1.2 psig. This would require a minimum starting pressure of 3.5 plus 1.2 or 4.7 psig). In not case should the starting pressure exceed 9.0 psig.

6. The pipeline will be considered to have passed the low pressure air test if the time required for the internal air pressure to drop not more than .5 psi is equal to or greater than that shown in the following table:

PIPE SIZE (Inches)	MINIMUM TIME (Minutes)
4″ Pipe	2.5
6″ Pipe	4.0
8″ Pipe	5.0
10″ Pipe	6.5
12″ Pipe	7.5
15″ Pipe	9.5
18″ Pipe	11.5

Note: For pipe size not indicated minimum time in minutes = pipe size (inches) x .625.

C. Correction of Excessive Leakage: Should any test of pipe disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

3.14 GRASSING

A. All disturbed areas within rights-of-way shall be seeded in accordance with Section 652 of the State of Alabama Highway Department Standard Specifications, latest edition.

3.15 MANHOLE BASE

A. Use approved precast manhole base with first manhole section integral with base.

B. If material in bottom of trench is unsuitable for supporting manhole, excavate below the base as directed by ENGINEER, and backfill to required grade with trench stabilization material, as hereinbefore specified.

3.16 PLACING PRECAST MANHOLE SECTIONS

A. Section Installation:

1. Thoroughly clean ends of sections to be joined.

2. Place mastic on groove of lower section.

3. Set next section in-place.

4. Rub seam joints inside & out with non shrink grout (hydraulic cement).

5. Fill all lift holes inside & out with non shrink grout (hydraulic cement).

6. Completed Manholes: Rigid and watertight.

B. Preformed Plastic Gaskets: If used in lieu of mortar joints, install in accordance with manufacturer's instructions and the following:

1. Carefully inspect precast manhole sections to be joined.

2. Do not use sections with chips or cracks in the tongue.

3. Use only pipe primer furnished by gasket manufacturer.

4. Install gasket material in accordance with manufacturer's instructions.

5. Completed Manholes: Rigid and watertight.

C. Rubber Gasketed Joints: Install in accordance with manufacturer's instructions.

3.17 MANHOLE INVERT

A. Construct as shown with smooth transitions to ensure an unobstructed flow through manhole. Remove sharp edges or rough sections which tend to obstruct flow.

3.18 DROP ASSEMBLIES

A. Construct drop assemblies as shown, at locations shown.

3.19 FLEXIBLE JOINTS

A. Provide joints in all pipe not more than 1-1/2 feet from manhole walls. Lay pipes entering manholes on compacted granular fill extending to undisturbed earth.

B. Where last joint of the line laid up to manhole is between 1-1/2 and 6 feet from manhole wall, provide a flexible joint in the manhole wall.

C. Shorten pipes laid out of manhole to ensure first joint is no more than 1-1/2 feet from manhole base.

3.20 MANHOLE EXTENSIONS

A. Install extensions as shown, to height not exceeding 12 inches.

B. Lay grade rings in mortar with sides plumb and tops level. Seal joints with mortar as specified for manhole sections, and make watertight.

3.21 MANHOLE FRAMES AND COVERS

A. Install on top of manholes to positively prevent infiltration of surface or groundwater into manholes.

B. Frame to bolt onto top of manhole. Surface of concrete manhole top to be coated with mastic prior to seating & bolting of frame.

C. Set tops of covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

D. At locations shown, install exterior manhole frame to structure seals in accordance with manufacturer's instructions.

3.22 FIELD QUALITY CONTROL

A. Hydrostatic Testing of Manholes:

1. When, in ENGINEER'S opinion, the groundwater table is too low to permit visual detection of leaks, hydrostatically test all project manholes.

2. Procedure: Plug inlets and outlets and fill manhole with water to height determined by ENGINEER.

3. A manhole may be filled 24 hours prior to time of testing, if desired, to permit normal absorption into the pipe walls to take place.

4. Leakage in each manhole shall not exceed 0.1 gallon per hour per foot of head above the invert.

5. Repair manholes that do not meet the leakage test, or do not meet specified requirements form visual inspection.

6. If more than 25 percent of the manholes tested fail the hydrostatic test, test all or as many manholes as ENGINEER deems necessary.

3.23 NEGATIVE AIR PRESSURE (VACUUM) TEST

A. General

1. The test method as outlined in ASTM C1244 shall be followed.

2. The contractor shall furnish all facilities, equipment and personnel as required to conduct the vacuum test.

3. The test shall be conducted after the manhole installation.

4. The contractor shall furnish evidence to the engineer that all test equipment is in proper working order.

5. The test shall be conducted in the presence of the Engineer.

B. Preparation

1. All pipes entering the manhole shall be temporarily plugged.

2. Care shall be taken to securely brace plugs as to prevent them from being drawn into the manhole during the test.

C. Procedure

1. The test head shall be placed at the top of the manhole.

2. A vacuum of 10 inches of mercury shall be drawn on the manhole.

3. The time shall be measured for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury.

4. The manhole shall pass if the time required for the vacuum reading to drop from 10 inches to 9 inches of mercury meets or exceeds the values listed.

5. If the manhole fails the vacuum test, the Contractor shall make all necessary repairs to the manhole and shall retest the manhole.

MINIMUM VACUUM TEST TIMES (SECONDS) FOR MANHOLES BASED ON DIAMETER AND DEPTH

MANHOLE DIAMETER (INCHES)

Manhole Depth (FT.)	48	60	72	96	120
8	17	26	33	45	57
10	21	33	41	54	67
12	25	39	49	63	77
14	30	46	57	72	87
16	34	52	65	81	97
18	38	57	73	90	107
20	42	65	81	99	117
22	46	72	89	108	127
24	51	78	97	117	137
26	55	85	105	126	147
28	59	91	113	135	157
30	63	98	121	144	167

Test times for manholes less than 8 feet shall be the same as indicated for the 8 feet depth manholes.

3.24 MANHOLE COATING

A. Coat the manhole interior with coal tar epoxy as manufactured by Sherwin Williams, or equal.

END OF SECTION

SECTION 15100
VALVES AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all materials, equipment and incidentals required to install complete and ready for operation, all valves shown on the Drawings and specified herein, including required specialty hardware, all bolts including flange bolts, threaded rods, anchor bolts, complete with washers and nuts. Bolts, threaded rods, nuts and washers to be galvanized steel. Anchor Bolts shall be type 316 stainless steel.

B. The equipment shall include, but not be limited to, the following. All items specified herein may not be included in this project.

1. Valve Actuators - General
2. Valve Actuators - Powered
3. Butterfly Valves for Fluid Service (Metal Body)
4. Butterfly Valves for Fluid Control (Cavitation and/or Metal)
5. Butterfly Valves for Air Service
6. Butterfly Dampers
7. Gate Valves
8. Resilient Seated Gate Valves
9. Knife Gate Valves
10. Plug Valves
11. Ball Valves
12. Check Valves
13. Globe Valves
14. Plastic Valves
15. Needle Valves
16. Pressure Regulating Valves
17. Solenoid Valves
18. Corporation Stop and Stop and Waste Valves
19. Air and/or Air/Vacuum Valves (General [and/or Sewage Use])
20. Air Release Valves
21. Air and Vacuum Valves for Vertical Turbine Pumps
22. Air/Vacuum Valves (Hydraulically Operated)
23. AirNacuum Valves (Normal Operation)
24. Vacuum Relief Valves
25. Combination Air and AirNacuum or Vacuum Relief Valves
26. Surge Relief Valves
27. Cone Valves
28. Telescoping Valves
29. Pinch Valves
30. Basin Pressure Relief Valves
31. Mud Valves (Plug Drain Valves)
32. Hose Hydrants

33. Flush-Type Hydrants
34. Flap Gates (Flap Valves)
35. Hose End Valves
36. Water Blender Assembly
37. Pressure Relief Valves
38. Gas Valves
39. Backwash Valves
40. Water Pressure Regulators
41. Insulating Fittings
42. Sleeve Type Valves

1.02 RELATED WORK

A. Piping and disinfection for potable water systems is included in the respective Sections 15110.

B. Valves on all HVAC systems, plumbing and/or chemical systems, not noted herein are included in their respective Sections of Division 15 and/or 11.

C. Pipeline appurtenances are included herein or in Section 15110.

1. Unions
2. Flanged Joints
3. Dielectric Connectors
4. Plugs and Caps
5. Miscellaneous Adaptors
6. Vents and Drains
7. Shock Absorbers
8. Line Strainers
9. Service Clamps
10. Cleanouts
11. Floor Drains
12. Quick-Connect Couplings
13. Mechanical Sleeve Seals
14. Flexible Connectors
15. Expansion Joints
16. Harnessing and Restraints
17. Pressure Gauges
18. Diaphragm Seals
19. Thermometers
20. Rotometers, Flow Indicators and Flow Meters
21. Static Mixers
22. Pipe Cleaning Equipment
23. Spray Nozzles
24. Batch Meters
25. Chemical Diffusers
26. Diffuser Sockets

27. Educator for Dry Chemical Handling

D. Pipe hangers, supports and anchorage are included in Section 15110.

E. Instrumentation and Electrical, not specified herein, are included in Divisions 13 and 16.

F. Valve tags are included in Division 1.

G. Field painting is included in Section 09900.

H. Sluice and Slide and Weir Gates are included in Division 11.

I. Certain appurtenances for individual types of pipe or systems are specified with the specific type of pipe or system. However, additional items are specified in this Section.

J. Certain items similar to those specified in this Section may be specified to be furnished and installed with individual equipment or systems. In case of a conflict, those individual equipment or system requirements shall govern.

K. Electric valve operators of all types, rate of flow controllers (including modulating valves and operators) and other types of valves which are part of the automated instrumentation (such as some solenoid valves) may be included herein. Valve operators shall be mounted at the factory on the valves as specified herein, as part of the work of this Section.

L. Buried valves and appurtenances are included in Section 2.09.A.3 below. 1.03 SUBMITTALS

M. Submit, in accordance with Section 01300, materials required to establish compliance with this Section. Submittals shall include the following:

1. Certified drawings showing all important details of construction and dimensions.
2. Descriptive literature, bulletins arid/or catalogs of the equipment.
3. The total weight of each item.
4. A complete bill of materials.
5. Additional submittal data, where noted with individual pieces of equipment.

N. Test Reports

1. Provide certified hydrostatic test data, per manufacturer's standard procedure or MSS-SP-61 for all valves.

O. Certificates

1. For each valve specified to be manufactured, tested and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests and certification of proper installation.

P. Operating and Maintenance Data

1. Operating and maintenance instructions shall be furnished to the Engineer as provided in Section 01730. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions and other information required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
3. ASTM A159 - Standard Specification for Automotive Gray Iron Castings.
4. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
5. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.
6. ASTIvI A436 - Standard Specification for Austenitic Gray Iron Castings.
7. ASTM A536 - Standard Specification for Ductile Iron Castings.
8. ASTM B30 - Standard Specification for Copper-Base Alloys in Ingot Form.
9. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings

B. American Water Works Association (AWWA)

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C500 - Metal-Seated Gate Valves Supply Service

3. AWWA C504 - Rubber-Seated Butterfly Valves
4. AWWA C507 - Ball Valves, 6-in Through 48-in (150mm Through 1200mm)
5. AWWA C508 - Swing-Check Valves for Waterworks Service, 2-in (50mm) Through 24-in (600mm) NPS
6. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service
7. AWWA C511 - Reduced-Pressure Principle Backflow Prevention

Assembly
8. AWWA C540 - Power-Actuating Devices for Valves and Sluice Gates
9. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants
10. AWWA C800 - Underground Service Line Valves and Fittings

C. American National Standards Institute (ANSI)

1. ANSI B2.1 — Specifications for Welding Procedures and Performance Qualifications
2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125 and 250
3. ANSI B16.10 - Face-to-Face and End-to-End Dimensions of Valves
4. ANSI B16.104 - Butterfly Valves

D. American Iron and Steel Institute (AISI)

E. Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)

1. MSS-SP-61 - Pressure Testing of Steel Valves.
2. MSS-SP-67 - Butterfly Valves.
3. MSS-SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
4. MSS-SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends.
5. MSS-SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.
6. MSS-SP-78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
7. MSS-SP-80 - Bronze Gate, Globe, Angle and Check Valves.
8. MSS-SP-82 - Valve Pressure Testing Methods
9. MSS-SP-98 - Protective Coatings for the Interior of Valves, Hydrants and Fittings.

F. National Electrical Manufacturers Association (NEMA)

G. Underwriters Laboratories (UL)

H. Factory Mutual (FM)

1. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

A. Qualifications

1. Valves and appurtenances shall be products of well established firms who are fully experienced, (minimum of 10 years), reputable and qualified in the manufacture of the particular equipment to be furnished.

2. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section as applicable.

3. All units of the same type shall be the product of one manufacturer.

B. Certifications

1. The manufacturers shall furnish an affidavit of compliance with Standards referred to herein as specified in Paragraph 1.03C above. Refer to PART 3 for testing required for certain items in addition to that required by referenced standards.

C. Provide the services of a qualified and factory-trained service representative of the manufacturer to provide operational and maintenance instruction, for a 1 day, 8 hour period for:

1. Valve motor operators, of any size.
2. Valve hydraulic operators, of any size.
3. Valve pneumatic operators, of any size.
4. Pressure regulating valves.
5. Air release, air and vacuum valves.
6. Surge relief valves.
7. Cone valves.
8. Dashpot-style check valves

D. Inspection of the units may also be made by the Engineer or other representative of the Owner after delivery. The equipment shall be subject to rejection at any due to failure to meet any of the specified requirements, even though submittal data may have been accepted previously. Equipment rejected after delivery shall be marked for identification and shall be removed from the job site at once.

1.05 SYSTEM DESCRIPTION

A. All of the equipment and materials specified herein is intended to be standard for use in controlling the flow of wastewater, sludge, air and chemicals, water as noted on the Drawings.

B. Valves, appurtenances and miscellaneous items shall be installed as shown on the Drawings and as specified, so as to form complete workable systems.

C. Unless otherwise noted all powered valve operators shall have:

1. Valves larger than 3-in: electric operators 460 Volt, 3 Phase, 60 Hz.
2. Solenoid valves: 120 volt, single phase, 60 Hz, NEMA 4 enclosure, continuous duty Class F coils and manual operator.
3. See other paragraphs for additional requirements.

1.06 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be received and stored properly to prevent damage or deterioration prior to installation.

B. Packing and Shipping

1. Care shall be taken in loading, transporting and unloading to prevent injury to the valves, appurtenances, or coatings. Equipment shall not be dropped. All valves and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired as acceptable to the Engineer.

2. Prior to shipping, the ends of all valves shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until installation.

a. All valves 3-in and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.

b. Valves smaller than 3-in shall be shipped and stored as above except that heavy cardboard covers may be used on the openings.

c. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until the valve is installed and put into use.

d. Any corrosion in evidence at the time of acceptance by the Owner shall be removed, or the valve shall be removed and replaced.

C. Storage and Protection

1. Special care shall be taken to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, to prevent deformation.

See the individual piping sections and manufacturer's information for further requirements.

a. MAINTENANCE

A. Special tools and the manufacturer's standard spare parts, if required for normal operation and maintenance for one year of service, shall be supplied with the equipment in accordance with Section 01730 and where noted, as specified herein.

B. Provide all special tools required for normal maintenance.

b. WARRANTY

A. The equipment manufacturer shall guarantee the valves against defect in design, material and workmanship for a period of twenty-four (24) months after date of shipment.

PART 2 PRODUCTS

2.05 MATERIALS AND EQUIPMENT - GENERAL

A. Reference is made to Division 1 for additional requirements, including nameplates, provisions for temporary pressure gauges, protection against electrolysis and anchor bolts.

B. The use of a manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

C. Valves and appurtenances shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.

D. Valves and appurtenances shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard referenced, cast in raised letters or indelibly marked upon some appropriate part of the body.

E. Unless otherwise noted, items shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher and suitable for the pressures noted where they are installed.

F. Joints, size and material - unless otherwise noted or required by the Engineer:

1. Valves and appurtenances shall be of the same nominal diameter as the pipe or fittings they are connected to.
2. Buried Valves shall have MJ connections where applicable.

3. End Connections for all valves:

Type	Size	End Connection
Gate	2" and Smaller	Screwed
	2½" and Larger	Flanged
Butterfly	12" and Larger	Flanged/MJ
Plug or Ball	2" and Smaller	Screwed
	2½" and Larger	Flanged/MJ
Check Valve	2" and Smaller	Screwed
	2½" and Larger	Flanged
Diaphragm	3" and Larger	Flanged

G. Provide all special adaptors required to ensure compatibility between valves, appurtenances and adjacent pipe.

H. Valves and actuators located outdoors but not within a building; within maximum 2-ft above liquid; in vaults; or where otherwise noted shall be especially designed for submerged service where water may completely submerge the valve and operator. All other units shall be, at a minimum, weather tight.

2.06 VALVE ACTUATORS - GENERAL

A. See the Paragraph 2.1-H above for submergence requirements.

B. The valve manufacturer shall supply and integrally, rigidly mount all actuators, including any type of manual or powered actuators, on valves at the factory. The valves and their individual actuators shall be shipped as a unit.

C. Unless otherwise noted, valves shall be manually actuated; nonburied valves shall have an operating wheel, handle or lever mounted on the operator; buried valves and those with operating nuts shall have a non-rising stem with an AWWA 2-in nut.

D. Except as otherwise shown on the Drawings or specified herein, all valves 3-in diameter or larger, with the valve center line located 7-ft or more above the operating floor, shall be provided with chain wheel operators complete with chain guides and hot dipped galvanized steel chain, which loop within 4-ft of the operating floor.

E. All actuators shall be capable of moving the valve from the full open to full close position and in reverse and holding the valve at any position part way between full open or closed.

F. Each operating device shall have cast on it the word "OPEN" or "CLOSE" and an arrow indicating the direction of operation.

G. Floor boxes for operating nuts recessed in concrete shall be standard cast iron type, cast-in-place, with fastening top by Clow or equal.

H. Stem guides shall be of the adjustable wall bracket type, bronze bushed, with maximum spacing of 10-ft as manufactured by Clow; Rodney Hunt or equal. Extended operating nuts and/or stems shall have universal joints and pin couplings, if longer than 10-ft and a rating of at least five times the maximum operating torque. Stem adaptors shall be provided.

I. Where required by the installation, or as specified, provide the following: extended stem; floorstand and handwheel; position indicator and etched or cast arrow to show direction of rotation to open the valve; resilient, moisture-resistant seal around stem penetration of slab.

J. Gear Actuators

1. Unless otherwise noted, gear actuators shall be provided for the following: all valves of larger than 8-in nominal diameter; all buried valves with operating shaft mounted horizontally (butterfly, plug, etc); where specified and/or indicated on the Drawings; where manual operator effort is greater than 80 ft-lbs rim pull.

2. Gear actuators shall be of the worm or helical gear type with output shaft perpendicular to valve shaft, having a removable hand wheel mounted on the output shaft. Unless noted they shall conform to AWWA C504, but except with butterfly valves, need not be certified.

3. Actuators shall be capable of being removed from the valve without dismantling the valve or removing the valve from the line.

4. Gearing shall be machine-cut steel designed for smooth operation. Bearings shall be permanently lubricated, with bronze bearing bushings provided to take all thrusts and seals and to contain lubricants. Housings shall be sealed to exclude moisture and dirt, allow the reduction mechanisms to operate in lubricant and be of the same material as the valve body.

5. Manual operator input effort to the handwheel shall be a maximum of 40 ft-lbs for operating the valve from full open to full close, under any conditions. Gear actuators shall indicate valve position and have adjustable stops. Maximum handwheel size shall be 24-in diameter.

K. Additional valve actuators are included with the individual valve types and as noted in Paragraph 1.02 above.

L. All position indication and direction of opening arrows shall be embossed, stamped, engraved, etched or raised decals.

M. Unless otherwise noted, all valves larger than 3-in nominal diameter shall be provided with position indicators at the point of operation.

2.07 VALVE ACTUATORS - POWERED

A. Electrical actuators furnished as part of this Section shall comply with AWWA C540.

B. Unless otherwise noted all electric or other powered actuators shall utilize worm gear or helical gearing for all size valves.

C. The motorized actuator shall comprise motor, reduction gearing, detachable drive bushing, thrust bearing and emergency hand wheel local position indicator, together with torque and position limit switches, thermostatically controlled space heater, terminals and integral controls. The actuator shall be a self-contained, totally enclosed unit with position lights, push buttons and position and status contacts.

D. The handwheel drive shall permit manual operation in a reasonable time, related to valve size. Failure of motor drive or gearing should not prevent manual operation. Handwheel shall not operate when motor operates. Motor shall be unable to operate when handwheel is operating.

E. Continuous mechanical dial indication of valve end positions shall be incorporated.

F. Open and close torque and/or position limit switches to suit the valve type shall be provided for travel control, with means to prevent unwanted tripping on torque during initial unseating.

G. Where required on the Drawings, furnish position indicating switches on valves. Switches shall be single pole, double throw, at either limit of open or close or both limits as shown. Switches shall be enclosed in a NEMA 4 enclosure and contacts shall be rated 5 Amps minimum 120 VAC.

2.08 BUTTERFLY VALVES FOR FLUID SERVICE (METAL BODY)

A. Butterfly valves and operators up to 72-in diameter shall conform to AWWA 0504, Class B, except as specified herein. The manufacturer shall submit an affidavit of compliance stating that the valves have been manufactured and tested in accordance with AWWA C504 and specifically listing all exceptions. Valves shall have a minimum 150 psi pressure rating or higher as noted on the Drawings or in this Section and be manufactured by Dezurik; Henry Pratt; Keystone or equal.

B. Butterfly valves for above grade shall be flanged end with face to face dimensions in accordance with Table 2 of AWWA C504 for short-body valve. All valves for dead end shut off service shall be flanged type.

C. Valve seats shall be full resilient seats retained in the body or on the disc edge in accordance with AWWA C504. Valve discs shall be constructed of cast iron, ASTM A48, Class 40; Ni-resist, ASTM A436, Type 1; or ductile iron, ASTM A536, Grade 65-45-12.

1. For valves 24-in in diameter and larger, when the resilient seats are attached to the body, discs shall have Type 304 stainless steel seating edges. When the resilient seat is attached to the disc, it shall be fastened with a one piece Type 304 stainless steel retaining ring, Type 304 stainless steel Nylock set screws and a mating Type 304 stainless steel ring shall be installed in the valve body.

2. Resilient seats shall be Hycar or equal. Seats shall be fully adjustable and replaceable with the valves in place for all valves 24-in in diameter and larger.

D. The valve body shall be constructed of close grain cast iron per ASTM A126, Class B with integrally cast hubs for shaft bearing housings of the through boss-type. Permanently self-lubricating body bushings shall be provided and shall be sized to withstand bearing loads. Stuffing box of liberal dimensions shall be provided at the operator end of the vane shaft.

1. Packing shall be of the self compensating V-type. A sealing element utilizing 0-rings shall also be acceptable for up to and including 24-in valves. Over 24-in, pull down seals using a square braid of graphite fiber is an acceptable alternate.

2. Packing shall be held in place by a bolted corrosion resistant retainer plate or gland; retainer clips are not acceptable. For 30-in or larger, use a stuffing box with follower gland.

3. Replacement of seals, for all size butterfly valves, shall not require removal of the valve from the line. In addition adjustment or replacement of seals on valves of 30-in or larger shall not require disturbing any part of the valve or operator assembly, except any packing follower gland.

E. The valve shaft shall be of Type 304 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic or seating torque. No reductions of shaft diameter will be allowed except at the operator connection. Any reduction shall have a full radius fillet.

F. In general, the butterfly valve actuator shall conform to the requirements of AWWA C504, insofar as applicable and as specified herein.

G. Gearing for the actuators where required shall be totally enclosed in a gear case in accordance with AWWA C504.

H. The manual actuators shall conform to AWWA C504, insofar as applicable. Actuators shall have permanent indicators with raised or engraved marks to show position of the valve disc.

3.03 BUTTERFLY VALVES FOR AIR SERVICE

A. Valves shall be wafer style, except for dead end service, where flanged valves shall be used. Valve body shall be cast iron ASTM A126 Class B. Disc shall be bronze, semi-steel or ductile iron ASTM A536 with a disc edge of IVIonel, Type 316 stainless steel, or welded nickel machined to a smooth surface. Valve shall have an air profile (undercut) disc. Resilient seats shall be reinforced Nordel (EPDM).

B. Air butterfly valves shall be suitable for 250 degree F continuous and 300 degree F intermittent operation.

C. All valves shall be furnished with self lubricated bearings of TFE coated stainless steel. Shaft seals shall be provided to prevent air leakage and to protect bearings from internal or external corrosion. Use EPDM or Buna-N 0-rings or self adjusting packing.

D. Shafts shall be one piece and shall be of Type 316 stainless steel. Shafts shall be finish ground and polished to minimize bearing and shaft seal wear. Shafts of 8-in and larger valves shall have a non-adjustable thrust collar.

E. Valves 8-in and smaller shall have 10-position levers. All manually actuated valves 10-in and larger shall be operated using a geared actuator. All units to have adjustable open and closed position stops with provision to prevent accidental adjustment changes. Operating shaft shall be supported axially and radially at input end by permanently lubricated bronze thrust and sleeve bearings. Actuators for throttling service shall conform to AWWA C504.

F. Butterfly valves for air service shall meet ANSI B16.104 and MSS-SP-67, except as modified herein. They shall be manufactured by DeZurik, Pratt, Keystone or equal.

G. Butterfly valves for air service, of pressures higher than [25] psi and/or larger than 24-in diameter shall comply with the above requirements.

- BUTTERFLY DAMPERS

A. Butterfly dampers shall be used at duct connections to tanks. Dampers shall provide shut-off of air flow from the tank into the duct system and shall be designed for 3-in w.c. of vacuum service to 5-in of water column.

B. Dampers shall be of fabricated Type 316 stainless steel, of circular configuration, with flanged end connections to match ANSI B16.1 flange drilling pattern. Dampers shall be resilient seating with Neoprene seats installed on the disc and

held in place by a fiberglass reinforced polyester retaining ring with FRP bolts and nuts. The disc shaft shall be supported by resilient bushings and shall utilize packing or 0-ring seals at the shaft connection to the operator.

C. The operator shall be a hand lever with ability to latch in either the fully opened or fully closed position.

- GATE VALVES (2-½ -IN AND SMALLER)

A. Gate valves 2-1/2-in diameter and smaller shall have flanged, screwed, or solder ends as required and shall be brass, or bronze, or Type 304 stainless steel solid wedge, union bonnet, rising-stem gate valves such as Figures 47 and 48 as manufactured by Jenkins Brothers or similar products as manufactured by Crane; Fairbanks; Kennedy Valve Manufacturing Co.; Lukenhiemer or equal.

B. All water valves 2-1/2-in and 3-in unless noted otherwise, shall be brass body gates and shall be Jenkins No. 1240, or Hammond 1B-647.

- GATE VALVES (3-IN AND LARGER)

A. General Requirements

1. Unless otherwise specified below, these requirements shall apply to all gate valves.

2. Gate valves shall meet the requirements of AWWA C500 and AWWA C509 as applicable to the type of valve specified.

3. Buried and submerged valves shall be furnished with mechanical joints and stainless steel hardware; non-rising stem design.

4. Exposed valves shall be furnished with Class 125 flanged ends; provide valves with outside screw and yoke.

5. All-metal valves shall be manufactured of ASTM A126 Cast Iron, Class B, with bronze mounting design.

6. Rising stem valves shall be sealed with adjustable and replaceable packing; valve design must permit packing replacement under operating system pressures with only moderate leakage.

7. Non-rising stem valves shall use a double 0-ring stem seal except that packing shall be used where geared operators are required.

8. Except as otherwise specified, valves shall be rated for the following working water pressures:

Valve Size	Pressure (psig)
3-in to 12-in	200
14-in to 20-in	150
24-in and greater	50

a. All valve bodies shall be hydrostatically tested to at least twice the rated working water pressure. In addition, valves shall be seat-tested, bi-directional at the rated working pressure, with seat leakage not to exceed one fluid ounce per inch of valve diameter per hour. Provide certificates of testing.

9. Flanged valves to have face-to-face dimensions per ANSI B16.10 and flanges per ANSI B16.1.

10. Exposed valves 16-in and larger to have valve by-pass.

11. All bonnet and packing gland bolts shall be zinc or cadmium electroplated steel; packing gland bolts shall have bronze nuts.

12. Exposed valves 16-in and greater indicated for horizontal stem installation shall be furnished with rollers, tracks and scrapers and enclosed bevel gear grease case.

13. Provide geared operator and chainwheel, chain and chain guides for valves with handwheel centerline more than 7-ft above operating level.

14. All valves shall be marked per AWWA Standards, including name of manufacturer, valve size and working pressure and year of manufacture.

15. Unless otherwise indicated, valves 12-in and smaller shall be capable of installation in the vertical or horizontal position, and sealing in both directions at the rated pressure.

16. Valve operation shall be counterclockwise for potable water; clockwise for wastewater and other non-potable waters. Provide permanent label showing "OPEN" and arrows.

17. Metal-seated valves shall be coated internally and externally with an asphaltic varnish, per AWWA C500. Resilient seated valves shall be coated, interior and exterior, with fusion bonded epoxy per AWWA C550.

B. Valve Applications

1. Valves for Potable Water Service.

   a. Double disc design manufactured by American-Darling Valve; Kennedy Valve; M&H Valve Company or equal.
   b. Double revolving disc manufactured by American-Darling Valve.

2. Valves for Wastewater Service

   a. Resilient seated design manufactured by American-Darling Valve; Kennedy Valve; IVI&H Valve or Clow Corp.
   b. Double revolving disc manufactured by American-Darling Valve.

3. At the Contractor's option and unless otherwise indicated, any of the listed valve styles may be used, at no additional cost to the Owner.

C. Valve Requirements

1. Double Disc

   a. Conform to AWWA C500.
   b. Wedging surfaces shall be bronze, monel or stainless steel.

2. Double Revolving Disc

   a. Conform to applicable provisions of AWWA C500.
   b. Wedging surfaces shall be monel or stainless steel.
   c. Discs fully free to rotate and guided in travel by cast surfaces.
   d. Disc rotation shall produce a self-cleaning action during opening or closing.
   e. Wedging forces applied only when discs are in seating position.

3. Solid Wedge

   a. Conform to AWWA C500,
   b. Tongue and grooved guides for wedges.

4. Resilient Seated

   a. Conform to AWWA C509. Also UL and FM approved.
   b. Internal and external epoxy coating of valve body, including bonnet, per AWWA C550.
   c. Gate shall be encapsulated with synthetic rubber. It shall be bonded and vulcanized in (
      accordance with ASTM D429 Method B.
   d. No recesses in valve body.

D. Buried Valves

1. Conform to the requirements above, except mechanical joint bell ends per AWWA C111.

a. All exposed valve hardware (nuts, bolts, washers, etc) including bonnet, bonnet cover, stuffing box, gear adapter shall be Type 304 stainless steel.

2. Non-rising stem design, double 0-ring seals for non-geared valves and shall incorporate packing for geared valves.

3. Provide valve box, 2-in operating nut and extension stem and stem cover.

E. Tapping Valves and Sleeves

1. Tapping valves shall comply with the same requirements as solid wedge or double disc gate valves except they shall have the flanged end and port opening modified for tapping service. Valves shall be capable of passing a full nominal sized cutter without damage to the valve. The tapping sleeve shall be gray cast iron or ductile iron mechanical joint type with the outlet flange conforming to MSS-SP-60.

2. All water valves, 4-in and larger, shall be iron body gates, bronze trim, flanged ends, 0.S.&Y. pattern, solid wedge, rising spindle, Jenkins No. 651, or Hammond 1R-1140.

1. KNIFE GATE VALVES

A. All knife gate valves shall be flanged knife gate valves for 150 psi working pressure. Valves shall be marked for direction of flow and round bar wedges and gate guides shall be installed in the liner body to force the gate against the seat. The gate shall be a beveled knife edge. Valves shall have metal to metal seating, with a raised seat face with a relief groove to allow the gate to push solid particles aside to prevent material packing in the seat area. All wetted surfaces shall be Type 304 stainless steel with ductile iron cast body and stainless steel trim. Packing gland bolts shall be Type 304 stainless steel with plated, self-locking nuts. Seats shall be solid stainless steel.

B. The valves shall have full port straight-through opening. Flanges shall be drilled to match connecting piping. Knife gate valves shall be Series L as manufactured by DeZurik Inc., similar model as manufactured by ITT; Red Valve Co. or equal].

C. Where noted the valve shall have a full bonnet.

1. PLUG VALVES

A. Plug valves shall be of the offset disc type, 1/4 turn, non-lubricated, serviceable (able to be repacked) under full line pressure and capable of sealing in both directions at the rated pressure. The disc shall be completely out of the flow path

when open. Plug valves specified herein shall be by DeZurik, Pratt, Keystone or equal. All manufacturers named or otherwise, must comply completely with this Section.

1. For clean liquid or screened sewage, all size plug valves shall have a minimum port area of 80 percent.

2. On sludge and scum lines, all valves 24-in and larger shall have a minimum 100 percent open port area; for all other valves, a minimum port area shall be 80 percent when measured by the percent cross-sectional area of equivalent size (nominal same diameter) pipe.

3. All plug valves for whatever service, shall be capable of passing "pigging" cleaning equipment (using a Girard or similar cleaning pig of full nominal pipeline diameter) in either direction and manufacturer shall so certify that this may be done without the use of special equipment.

B. Valves shall be rated at minimum 175 psi WOG (Water, Oil and Gas) working pressure for sizes 4-in to 12-in inclusive and at minimum 150 psi WOG working pressure for sizes 14-in and larger.

1. All plug valves under this Paragraph shall be performance, leakage and hydrostatically tested in accordance with AWWA C504, except as modified herein.

2. At the above rated minimum working pressures, the valves shall be certified by the manufacturer as permitting zero leakage for a period of at least 1/2 hour with pressure applied in either direction.

3. At the direction of the Engineer, the valve manufacturer may be requested to perform a valve seat leakage test, witnessed by the Engineer to prove compliance with this Section.

C. Valve bodies shall be of cast iron, 30,000 psi tensile strength, ASTM A126, Grade B, or of ductile iron, ASTM A536 and of the top entry, bolted bonnet design, cast with integral flanges conforming to the connecting piping. All exposed bolts, nuts and washers shall be zinc or cadmium-plated, except for buried or submerged valves, which shall have Type 316 stainless steel hardware.

D. The valve disc shall:

1. Be cast iron ASTM A126, Grade B, or ductile iron, ASTM A536, Grade 65-45-12.
2. Be removable without removing the valve from the line.
3. Have an integral upper and lower shaft which shall have seals on the upper and lower journals to prevent entrance of solids into the journals.
4. Be one piece for all valves up to 14-in and maximum two piece for larger [non-throttling] valves.

E. Shaft bearings shall be permanently lubricated, rigidly backed TFE, stainless steel or bronze at both upper and lower stem journals. The operator shaft shall have easily replaceable seals, which shall be externally adjustable and repackable without removing the bonnet from the valve, or shall have self adjusting packing.

F. The valve seating surface shall provide full 360 degree seating by contact of a resilient seating material on the disc mating with welded-in high nickel content overlay seating surface in the body.

1. The seating design shall be resilient and of the continuous interface type having consistent opening and closing torques and shall be non jamming in the closed position. Screw-in seats shall not be acceptable.
2. Discs shall have a full resilient facing of neoprene or Buna-N.

G. The methods of mounting the actuator to the valve shall provide an air gap between the two. Actuator shall clearly indicate valve position and an adjustable stop shall be provided. Construction of actuator housing shall be semi-steel. Hardware on actuators shall be of the same materials as the valves.

H. Unless otherwise required, due to location or operation, each valve 6-in and smaller shall be provided with its own securely attached lever. Provide adjustable limit stops for both opening and closing and a clearly marked position indicator.

I. Plug valves shall be installed so that the direction of flow through the valve and the shaft orientation is in accordance with the manufacturer's recommendations. Unless otherwise noted, shaft shall be horizontal, with plug opening up.

1. BALL VALVES

A. Stainless Steel Ball Valves

1. Ball valves for water service shall be stainless steel body, full bore, fire-safe, rated for a line pressure of 150 psig. Except as noted, ball valves shall comply with AWWA C507.

2. The design of the valve shall be such that it shall provide suitable seating in both directions. In order to determine the position of the ball within the valve (open or closed), there shall be an easily visible, permanent, indicator located conspicuously on the valve. Ball valves shall have Type 316 stainless steel seating surfaces. Seats shall Butadiene. The fully open port area shall be approximately 100 percent of the nominal pipe area.

3. Valve shafts shall be ground and polished and shall be Type 304 stainless steel. Teflon-lined bearings shall be supplied in both trunnions of the valve body.

4. The valves shall be constructed so that the seals, seats and balls are accessible for replacement without dismantling the piping. The valves shall not require lubrication but shall have stuffing boxes which can be packed with the valve in service without undue leakage. Ball valves shall be as manufactured by Henry Pratt Co., Aurora, IL; Willamette, Portland, OR or equal.

5. Valve actuators shall conform to AWWA C507 and as specified herein.

B. Ball valves for plant water piping shall be manual and electric actuated, bronze, resilient seated, regular port, threaded two piece bolted body type valves. The body and cap shall be of brass, ASTM B30, the ball and stem of Type 316 stainless steel and the seats and seals of TFE. The valves shall have full floating ball and shall be non lubricated. Valve seats shall be easily accessible and replaceable. Valves shall be rated to 250 psi and shall be as manufactured by Neles-Jamesbury; WKM or equal.

1. CHECK VALVES

A. Check valves for metallic lines of 2-in to 24-in diameter shall be swing type and shall meet the requirements of AWWA C508. The valves shall be iron body, bronze mounted, single disc, 150 psi working water pressure, nonshock and hydrostatically tested at 300 psi.

1. When there is no flow through the line, the disc shall hang lightly against its seat in practically a vertical position. When open, the disc shall swing clear of the waterway.

2. Check valves shall have bronze seat and body rings, extended bronze hinge pins and bronze nuts on the bolts of bolted covers.

3. Valves shall be so constructed that disc and body seat may easily be removed and replaced without removing the valve from the line. Valves shall be fitted with an extended hinge arm with outside lever and weight. The position of the weight shall be adjustable. Various weights shall be provided and installation approved by the Engineer. Lever shall be installed to the horizontal in the closed position, for both horizontal and vertical pipeline installations.

4. Check valves shall be by Golden Anderson; Clow; or equal.

B. Check valves 2-in and smaller for installation in copper and steel pipes shall be bronze, swing type, 125 lb with solder or screwed ends.

C. Wafer style check valves for air service shall be of the dual disk type with bodies constructed of cast iron, ASTM A126, Class B. Disc shall be fabricated of ductile iron, ASTM A536 and shall be electroless nickel plated. Body seat material shall be Buna-N. Spring material shall be Type 316 stainless steel. The ends shall be plain. The valve shall be by APCO; Val-Matic; GA; Keystone or equal.

D. Wafer style check valves for sludge and water service shall be iron body, semi lugged type with 316 SS spring, lever and weight. Valves shall installed between flanges while using a flange coupling adaptor or a dismantling joint. Valves shall be fitted with a Buna-N seat, Buna-N outside diameter seal and 316 stainless steel bolts. Disc plate, disc plate arm and stem shall be 316 stainless steel rated for a 125 PSI differential. Valves shall be Prince Model 813/815 or equivalent.

E. Ball check valves for [submersible pump discharges], [mainline], metallic piping shall have bodies constructed of cast iron, ASTM A159, Class 35. Sinking and/or Rising ball shall be type fabricated of hollow steel with vulcanized Nitrile rubber covering. Ball check valves shall be Type 2016 as manufactured by Flygt Corporation, similar by GA; Empire or equal.

F. All check valves 3-in and smaller shall be similar to Hammond 1B-940, or Jenkins No. 92A. Check valves 4-in and larger shall be flanged and similar to Hammond 1R-1124 or Jenkins No. 624.

G. Rubber flapper Swing Check Valves

1. The Rubber Flapper Swing Check Valve shall have a heavily constructed cast iron body and cover. The body shall be long pattern design (not wafer) with integrally cast-on end flanges. The flapper shall be Buna-N having an "0" ring seating edge and be internally reinforced with steel.

2. Flapper to be captured between the body and the body cover in a manner to permit the flapper to flex from closed to full open position during flow through the valve. Flapper shall be easily removed without need to remove valve from line. Check Valves to have full pipe size flow area. Seating surface to be on a 45° angle requiring the flapper to travel only 35° from closed to full open position, for minimum head loss and non-slam closure.

3. Buna-N Flapper (hi-strength coated fabric - coated both sides with 70 Duro) which creates an elastic spring effect, molded internally, to assist the flapper to close against a slight head to prevent slamming.

4. Valve designed for 175 psi working pressure for water, oil or gas. The Valve shall be suitable for above ground or buried service. Stainless cover bolts must be furnished for buried service.

5. Valve exterior to be painted Phenolic Primer Red Oxide for high resistance to corrosion.

6. The Valve Manufacturer shall have been regularly engaged in the design and manufacture of Rubber Flapper Swing Check Valves for at least five years and shall submit a list of at least five separate installations in service for a minimum of five years for engineer approval prior to release to manufacture.

7. Materials of construction shall be certified in writing to conform to ASTM specifications as follows:

   Body & Cover Cast iron ASTM A126 Gr. B
   Rubber Flapper Buna-N

8. Valves to be APCO Series 100 Rubber Flapper Swing Check Valve, as manufactured by Valve & Primer Corporation, Schaumburg, Illinois, U.S.A or equal by Val-Matic, GA or Crispin.

1. GLOBE VALVES

A. Globe valves for lines shall have a bronze body, renewable full plug stainless steel disc, renewable stainless steel seat and 400 lb cold water non-shock working pressure. Globe valves shall be Figure 3245P as manufactured by Walworth Co.; Valley Forge, PA or equal.

1. PLASTIC VALVES

A. General

1. All valves shall be certified as completely compatible with the intended and specified service; compatibility shall apply to the material of the valve and internal components, including all seals, gaskets, 0-rings and washers; solvents and primers used in valve joint make-up shall be specifically in conformance with the written instructions of the valve supplier. Service chemicals and service conditions are shown in the piping sections in Division 15.

2. Except as otherwise specified valve ends shall be socket-type designed for solvent welding. The valve manufacturer shall provide specific recommendations for solvent and primer.

3. Valve material shall be the same as the piping service except as specified.

   a. PVC shall be Type 1, Grade 1, per ASTM D1784 classification, made from unplasticized polymer, and generally suitable for service to 120 degrees F.
   b. CPVC shall be Type 4, Grade 1, per ASTM D1784, classification generally suitable for service to 180 degrees F.
   c. Polypropylene (PP) shall conform to the material requirements of ASTM D4101 for copolymer polypropylene. Generally suitable for service to 195 degrees F.
   d. PVDF (polyvinylidene fluoride) shall be manufactured from high molecular weight polymers of vinylidene fluoride. Generally suitable for service to 250 degrees F.
   e. The manufacturer of the valves shall retain material source quality documentation and shall furnish it to the Engineer upon request.

4. Unless otherwise specified:

    a. 0-rings, valve seats and stem seals shall be teflon, or teflon encapsulated elastomer. Alternative materials may not be substituted without complete documentation provided to the Engineer of service suitability.
    b. Gaskets shall be made from PTFE-bonded sheet material, GORE-TEX manufactured by W.L. Gore & Associates; AV Low-Torque gaskets by Asahi/America or equal.
    c. Valve external hardware shall be Type 316 stainless steel. No internal metallic components shall be exposed to the service fluid.
    d. No factory or field coatings shall be applied to the valves.

5. All valves, except butterfly valves shall have a non-shock service pressure rating of not less than 120 psig at 70 degrees F

6. All valves shall be given hydrostatic and pressure and leakage tests at the factory. Provide certified copy of test results.

7. Valves shall be the standard, catalogued products of the following manufacturers:

    a. Chemtrol
    b. Asahi/America
    c. Plast-O-Matic
    d. Hayward

8. Valves specified as furnished with equipment or equipment systems shall comply with these requirements.

B. Ball Valves

1. Ball valves shall be the socket-ended type, unless otherwise specified, with full-port opening.

2. Provide quarter-turn manual valve operator and valve seat adjustability.

3. Plastic valves in sodium hypochlorite service shall have the ball drilled to permit venting of pressure and gas from the confined ball cavity, when the valve is closed. The drilling shall vent to the upstream end of the valve. The drilling shall be 1/8-in opening, de-burred. An arrow shall be inscribed on the valve body to indicate direction of flow.

C. Butterfly Valves

1. Valves shall be of the lined body design with PVC body and PP disc with only the liner and the disc as wetted parts. The liner shall be molded and formed around the body, functioning as a gasket on each side of the valve. Double 0-ring seals on top and bottom disc trunnions will fully

isolate a Type 316 or 304 straight-through stem. Liner and seal shall be Buna-N.

2. The valves shall be of the lug or wafer style, suitable for dead-end service.

3. Each valve shall be furnished with a lever actuator on sizes through 6-in; gear operator on sizes 8-in and larger.

D. Diaphragm Valves

1. Valves shall have [flanged, socket or spigot, threaded, double-union] ends.

2. Valve body and bonnet shall be of solid [PVC, CPVC, PP, PVDF]

3. Diaphragms shall be [Teflon, EPDM, Buna-N, Butyl, Hypalon, Neoprene, Natural Rubber]

4. The valve shall have a full-width weir, designed for throttling, and complete bubble-tight closure.

5. Provide a handwheel valve operator, with a stainless steel stem, a cast stem sleeve and a clear plastic stem cover with a position indicator; provide an adjustable limit stop to prevent overtravel.

E. Needle Valves shall be designed for close control of flow throttling with a multi-turn valve handle.

F. Check Valves

1. Ball check valves shall be double-union style with socket ends, solid and completely spherical ball and capable of either horizontal or vertical mounting.

2 Swing Check valves shall be flanged, full-ported, with top entry access for disc inspection and removal. Furnish with outside lever and weight, with weight position along lever arm adjustable.

G. Backpressure Regulating/Control Valves

1. Spring-loaded diaphragm design, fully-adjustable pressure setting, set to assure continuous positive pressure at the pump discharge.

2. Furnish with teflon diaphragms and elastomer-coated springs.

H. Pressure Relief Valves

1. Angle-pattern design, with adjustable relief pressure and locking nut. Spring-loaded with pressure adjustable over range up to 100 psig.

2. The valve spring shall be elastomer-coated and isolated from the process flow. Provide teflon diaphragms.

3. Relief valves shall be piped as indicated, and if not indicated, the relief piping shall be directed to the floor or adjacent gutter or drain.

4. Pressure relief valve settings shall be set to a pressure as recommended by the pump or equipment supplier and adjusted at the time of equipment testing, inspection and start-up.

1. NEEDLE VALVES

A. Needle valves shall have a cast bronze body and be constructed in accordance with ASTM B62 and shall be designed for an operating pressure of 125 psi and a 200 psi maximum test pressure. Ends shall be ANSI B2.1 threaded. The valves shall have a rising bronze stem and non-slip malleable iron hand wheel.

B. The needle valves shall be Figure 680 as manufactured by the William Powell Company, Cincinnati, OH, or Figure 88 as manufactured by Crane Company, Valve Division, Chicago, IL or equal.

1. PRESSURE REGULATING VALVES

A. Pressure regulating valves shall be factory tested. Outlet pressure shall be easily field adjustable over the pressure ranges and meet the criteria noted on the Drawing.

B. All pressure regulating valves shall have flanged connections, or shall have unions mounted in the pipe on each side of the valve.

C. Strainers for installation upstream of pressure regulating valves are specified elsewhere. The pressure regulating valve manufacturer shall specify the screen mesh or size of perforations that are required to protect the regulating valve. The valve supplier shall furnish both valve and strainer.

D. Pressure Regulating Valves - 3-in and larger

1. Valves 3-in and larger and for pressure regulating shall be flanged with globe body, fully bronze mounted, external pilot operated, diaphragm type single seat with seat base equal to size of valve and shall be equal to the Figure 4500D Pressure Reducing Valve as manufactured by GA Industries Inc., Pittsburg, PA; Clayton Model 90 by Cla-Val Company, Newport Beach, CA; Bailey, Fresno, CA; similar models by Ross; OCV; Watts/Muesecos or equal.

2. The valve shall be packed with teflon material acceptable to the Engineer to ensure tight closure and prevent metal to metal friction and sticking. The valve shall be furnished with indicator rod, to show position of opening of the piston, and pet cocks for attachment to valve body for receiving gauges for testing purposes.

3. The pilot valve, controlling operation of the main valve, shall be easily accessible and so arranged to allow for its removal from the main valve, while the main valve is under pressure. The pilot valve shall be easily adjustable without removal of the springs, weights or use of special tools. The control piping on the valves shall have strainers to prevent plugging of control mechanisms.

4. The design shall be such that repairs and dismantling internally of main valve may be made without its removal from the line.

5. The unit shall be flanged. The valve body shall be constructed of cast iron.

6. The valve shall [maintain pre-adjusted downstream pressure for varying rates of flow through the positioning of the [piston] [diaphragm] by the pilot without causing: water hammer or waste of water and without cavitation].

E. Pressure Regulating Valves - 2-in and Smaller

1. Pressure regulating valves 2-in and smaller shall be rated 150 psig working pressure, with bronze and brass body; renewable stainless steel seat and flexible diaphragm of suitable material. Outlet pressure shall be easily field adjustable over the pressure ranges tabulated.

2. Pressure regulating valves 2-in and smaller shall be Figure No. 43D as manufactured by GA Industries, Inc.; Model 30A by Bailey or equal.

2.17 SOLENOID VALVES

A. Solenoid valves shall be packless piston type direct acting for sizes less than 1-in and internal pilot operated for sizes 1-in and larger, 2-way or 3-way, valves and shall be ASCO Valve; Red Hat by Automatic Switch Co., similar by Atkomatie Valve Co. or equal for air and water service.

B. Valves shall be energize to open, except for valves on water seal lines to pumps which shall be energize to close.

C. Valves shall have forged brass bodies, NPT end connections of the connected piping Type 304 stainless steel internal parts, and Buna-N or Ethylene Propylene valve seats. Valves shall have a minimum 150 psig safe working pressure and zero minimum operating pressure differential. Connections shall be threaded.

1. Except as otherwise specified herein, valves shall be as noted in PART 1.

D. Solenoid valves on bypass piping shall be installed whether shown or not.

E. Note that solenoid valves may be shown on Electrical and/or Mechanical Drawings, or may only be specified.

2.18 CORPORATION STOPS AND STOP AND WASTE VALVES

A. Corporation stops shall be of bronze or brass and shall be designed and manufactured in accordance with AWWA C800, except as modified herein.

B. Corporation stops shall have Mueller inlet threads except that corporation stops for use with service clamps shall have IPS threads. Where corporation stops are used with plastic pipe, a brass companion flange shall be provided on the outlet of each corporation stop.

C. Stop and waste valves shall be similar to corporation stops as manufactured by Crane; Ford; McDonald or equal.

2.19 AIR AND/OR AIR/VACUUM VALVES - GENERAL

A. This Section applies to all air release, air/vacuum, hydraulically operated air/vacuum valves, vacuum relief, combination air and air/vacuum or vacuum relief or similar valves.

B. Valves shall be supplied with shutoff gate or ball valves with operator handle or lever removed. Valves shall be properly vented and piped to drain.

C. Attention is directed to the requirement that valve's pressure rating be at least equal to the attached pipe's rating.

D. Valves shall be [special non-clean water type or other] proper model by Val-Matic; APCO; GA; Crispin or equal.

E. For service on sewage, sludge (of any type) and non-screened water, the valves shall be of the special sewage type, performing similar functions for specific type of valve as noted for water.

1. The valves shall have Type 316 stainless steel trim and float, with an adjustable viton seat and be supplied with backwash accessories

2. A valved outlet with hose connections for flushing water connection (where flushing accessories are required) shall be provided within a distance that hoses, supplied with the valve, may reach. Proper cross connection prevention shall be provided.

2.20 AIR RELEASE VALVES

A. Air release valves shall be installed to release any small accumulations of air which may collect while pipe is in operation and under pressure.

The small orifice assembly air release valve shall automatically release air accumulations from the pipe while under positive pressure. When the valve body fills with air, the float ball shall fall to open the small orifice and exhaust the air to atmosphere. When the air has been exhausted, the float ball shall be buoyed up and tightly close the small orifice.

C. The small orifice assembly shall be furnished with cast iron body and cover (ASTM A126 Class B). The float ball shall be constructed of stainless steel and attached to a stainless steel lever mechanism. A resilient, Buna-N seat shall be attached to the lever mechanism for drop-tight closure.

D. Separate air release valves shall be manufactured by APCO; Val-Matic; GA; Crispin or equal of the special type for use with non-clean water.

2.21 AIR AND VACUUM VALVES FOR VERTICAL TURBINE PUMPS

A. Air and vacuum valves for vertical turbine pumps shall be designed to allow large quantities of air to escape out the orifice when the pump is started and close water tight when the liquid enters the valve. The air valve shall also permit large quantities of air to re-enter through the orifice when the pump is stopped to prevent a vacuum from forming in the pump column.

B. The valve shall consist of a body, cover, baffle, (of ASTM A48 Cast Iron) and Buna-N seat. The baffle will be designed to protect the float from direct contact of the rushing air and water to prevent the float from closing prematurely in the valve. The seat shall be fastened into the valve cover, without distortion and shall be easily removed, if necessary.

C. For valves up to and including 3-in, the entire float and baffle assembly must be shrouded with a perforated water diffuser (brass) to prevent the water column entering the valve, slamming the float shut and to eliminate water hammer in the system. For valves of 4-in and larger, the valves shall be mounted on top of a surge, slow-closing check valve.

D. The discharge orifice shall be fitted with an adjustable throttling device (iron) to regulate the flow of air escaping, to establish a pressure loading on the rising column of water, to minimize shock to the pump and check valve. The valve shall have non-slamming closing feature.

E. The float shall be ASTM A240 stainless steel, designed to withstand a minimum of 1000 psi. The float shall be center guided and not free floating for positive seating.

F. Air and vacuum valves for vertical turbine pumps shall be of special design for this service. The manufacturer of the valve shall confirm in writing that unit is suitable for type and size of pump, as shown on Drawings and as specified herein. Unit shall be by Val-Matic; APCO; GA; Crispin or equal.

2.22 AIR/VACUUM VALVES (HYDRAULICALLY OPERATED)

A. Where noted, air/vacuum valves of the hydraulically operated type shall be used alone or piped with separate air release valves specified elsewhere in this Section.

B. The main body shall be three piece construction, having a flanged inlet and flanged outlet. The cross-sectional flow area throughout shall be greater than the

equivalent inlet pipe size. The float shall be non-collapsible heavy cast bronze or stainless steel, center guided from both ends with a one piece stainless steel shaft. The stainless steel shaft shall connect to the top cylinder piston rod by means of an alignment coupler. The coupler shall prevent any shaft or piston rod binding due to misalignment and allow the float to move freely to shut-off or open.

C. The valve shall be normally open and vent large volumes of air during filling of the water pipeline without restriction. Fluid velocity, upon entering and discharging through the valve, shall cause the float to shut-off into a resilient seat, at a controlled rate. The hydraulic control closing system shall be independent from the line fluid, but an integral part of the valve.

D. The hydraulic control system shall be pressurized by means of a hydropneumatic oil accumulator, with sufficient pressure to overcome any friction losses due to contact between guide bearing surfaces and to ensure the valve will open under vacuum conditions. Pressure may be increased in the accumulator to cause the valve to open in advance of the vacuum condition forming.

E. The adjustable control valve, for setting the time cycle of shut-off, shall be located externally and easily accessible, so that adjustments can be made without the need of dismantling any portion of the valve.

F. Upon demand of a negative pressure in the pipeline, the hydraulic control closing system shall not interfere and the valve shall open freely, allowing large volumes of air to enter the system to break the vacuum. Returning secondary surge wave shall not cause the valve to shut-off fast. Instead the returning surge wave will be dissipated through the open valve, while the time cycle of controlled shut-off is repeated.

G. The heavy cast bronze float and stainless steel guide shaft assembly shall be counter- balanced in a manner to be virtually in a state of equilibrium.

H. Unit shall be Series 7000 APCO Hydraulically Controlled Air & Vacuum Valve, as manufactured by Valve & Primer Corp.; Val-Matic Series 1100; RCAV; GA or equal.

I. Any revision in the design and/or construction of the vaults, piping, appurtenances, equipment and other items required by the use of other units, shall be made at no additional cost to the Owner and be as approved by the Engineer.

2.23 AIR/VACUUM VALVES (NORMAL OPERATION)

A. The large orifice assembly air and vacuum valve shall automatically exhaust air from a pipeline during the initial filling of the pipeline. The large orifice assembly shall not blow shut while exhausting air, even while venting air at sonic velocity. When all air has been exhausted from the pipeline, the large orifice float ball shall be buoyed up to seat tightly against a resilient seat ring. The large orifice float ball shall remain tightly closed while the pipeline is under

positive pressure. Should the pipeline pressure fall below atmospheric pressure (such as during draining or a line break), the large orifice float ball shall automatically fall away from the seat ring and permit air to enter the pipeline.

B. The large orifice assembly shall be furnished with cast iron body and cover (ASTM A126 Class B). A resilient, Buna-N seat ring shall be affixed to the valve cover. The float ball shall be constructed of stainless steel with a minimum pressure rating of 1,000 psi. The float ball shall be free floating within the valve body; guide stems, linkages or levers attached to the float are not acceptable.

C. Unit shall be manufactured by GA; APCO; Val-Matic or equal. Special type for use with non-clean fluids shall be provided.

2.24 VACUUM RELIEF VALVES

A. Units shall be similar to the Air/Vacuum valve specified above, except only having the vacuum portion of operation.

B. Unit shall be manufactured by GA; APCO; Val-Matic; Crispin or equal. Special type for use with non-clean fluids shall be provided.

2.25 COMBINATION AIR AND A1RNACUUM OR VACUUM RELIEF VALVES

A. Units shall be a small orifice (air release) valve mounted on a large orifice air/vacuum relief valve of the proper type and size as noted on the Drawings. Individual valves shall be as specified previously.

B. The small orifice valve shall be piped to the body of the large orifice valve by non-corrosive piping equal in size to the small orifice inlet connection. An isolating stop valve (with operator removed) shall be furnished between the small and large orifice valves.

C. One piece units performing all functions may be utilized, as acceptable to the Engineer. Component valves shall be as previously specified and by one manufacturer. Special type shall be supplied for non-clean fluid.

2.26 SURGE RELIEF VALVES

A. The valve manufacturer shall submit to the Engineer calculations confirming that unit's size is proper for the system to be installed.

B. Surge relief valves shall function to open when the system pressure exceeds the pressure for which the field adjustable pilot valve is set. Valves shall open rapidly and close slowly at a predetermined rate of speed. Provision shall be made to regulate the closing speed of the valves. The valves shall be completely piped ready for installation.

C. The main valve shall operate on the differential piston principle such that the area on the underside of the piston is no less than the pipe area and the area on the upper surface of the piston is of a greater area than the underside of the

piston. No diaphragm will be permitted within the main valve body.

D. The valve piston shall be guided on its outside diameter by long stroke stationary Vee ports which shall be downstream of the seating surface to minimize the consequences of throttling. Throttling shall be accomplished by the valve Vee ports and not the valve seating surfaces.

E. The valve shall be capable of operating in any position and shall incorporate only one flanged cover at the valve top from which all internal parts shall be accessible. There shall be no stems, stem guides, or spokes within the waterway. There shall be no springs to assist the valve operation.

F. The valve body shall be of east iron ASTM A126 with flanges and pressure rating as noted. The valve shall be extra heavy construction throughout. The valve interior trim shall be bronze, ASTM B62, as well as the main valve operation. The valve seals shall be easily renewable. All controls and piping shall be of non-corrosive construction. A visual valve piston position indicator shall be provided.

G. Valve shall be Figure 6700-D by GA Industries; Series 3000 (angle-pattern) or Series 6500 (globe-pattern) by APCO or equal. Layout shown is based on GA Industries unit.

2.27 CONE VALVES

A. The valve manufacturer shall have a minimum of 10 years experience in the manufacture of cone valves. Valves to be by Willamette, Portland, OR or equal.

B. Each cone valve shall consist of three main parts:

1. Conical closing element, referred to as the plug, shall be the principle moving element within valve body. Plug shall have full unobstructed waterway equal to diameter of body and adjacent piping.

2. Valve body shall have full unobstructed circular inlet and outlet equal to nominal diameter of specified size of valve and adjacent piping.

2.03 Valve head shall be so designed that it will totally enclose the large diameter of valve body and support valve operating mechanisms.

C. Operating mechanism shall permit adjustment of seating, include a threaded lift nut to perform the seating function and a rotator attached to the valve shaft which shall impart a rotary motion to the plug. Operation of cone valve shall employ an axial motion to lift plug from its seat, followed by a rotary movement of plug to open valve. Closing movement of valve plug shall be in reverse order.

D. An indicator plate shall be provided on the mechanism cover and an indicator attached to outer end of valve shaft, which will indicate position of plug opening with respect to opening in body. A bushing shall be included where the shaft extends through the mechanism cover.

E. Inlet and outlet part of cone valve body shall be provided with seat rings of monel electrically fused into body materials and sufficiently raised above internal surface of body to assure free operation. Watenvay flanges of body shall be furnished with flanges of minimum rating same as pipe. Body shall be flanged to accommodate valve head, which shall make a registered connection with valve body.

F. Plug shall be provided with one set of raised monel seat rings electrically fused into plug material, one each at right angles to plug openings for seating when valve is closed.

G. Upper and lower plug trunnions shall be cast integrally with valve plug. Trunnions and pivot bearings in body and head shall be bronze bushed and designed to withstand full maximum bearing loads possible for the operating conditions specified. Maximum allowable pressure on projected area of trunnion bearings shall not exceed 3000 psi.

H. Valve shaft shall be hard chrome overlaid where it passes through stuffing box in valve head.

I. Packing for all stuffing boxes shall be replaceable and adequate for service to which it is applied.

J. Cone valve of all sizes, or if rated less than 250 psi but 16-in diameter and larger, shall be provided with bypass piping including a bypass ball or cone valve. Bypass piping diameter shall be as noted in AWWA C500 for gate valves.

1. Gearing shall be designed so the maximum load under the specified operating conditions can be transmitted on one tooth without exceeding the maximum permissible unit stresses. An efficiency of not more than 30 percent shall be used in computing the torque output by the worm gear reduction units.

2. Gear reduction shall be designed such that valve closure will occur in a period of no less than 5 minutes under the specified handwheel pull (valve closure defined as 100 percent open to completely closed). Provide a weatherproof, metallic sign listing "Minimum Closure Time to be 5 Minutes - Manual Operation Only"

3. All gearing shall be enclosed in dustproof and watertight steel housings. The gearing shall be grease lubricated. Worms shall be heat-treated alloy steel with the threads carburized and ground. All other gears shall be alloy steel. The shaft shall be supported on anti-friction or bronze-bushed bearings. All bolted connections between the valve components and the operating mechanism components shall be doweled.

4. This shall also apply for the universal gearbox required to provide a vertical output shaft.

5. The operator, designed for submerged service, shall be able to operate the valve under maximum specified differential seating pressure with a pull as previously specified in PART 2.

6. Provide a tee handle operating wrench to fit the operating nut.

2.28 TELESCOPING VALVES

A. Each telescoping valve shall be a complete assembly, consisting of nonrising stem, telescoping slip tube, valve stand with indicator and motor. Valve stands shall be of fabricated steel and shall be furnished with base flange drilled for anchorage bolts. Anchor bolts and hardware shall be of Type 316 stainless steel.

B. The valve stand shall support the valve lifting stem and a travel indicating device calibrated in 1/2-in increments, geared down so that the full distance travel registers on a 2-fl scale. The valves shall each have a handwheel with handle grip for rapid adjustment.

C. The sliding valve tube shall be seamless brass or Type 304 stainless steel [5.50-in] outside diameter with a minimum wall thickness of 1/8-in to prevent corrosion and to ensure proper operation at all times and arranged to slide inside of the sludge draw-off pipe shown on the Drawings. The valve tube shall have two V-notched weirs located 180 degrees apart. A companion flange shall be mounted to allow sliding, but prevent sludge escaping through the sliding joint.

D. The telescopic valve shall be operated by means of a motorized valve actuator. The valve shall be complete with tube guide collar made of steel and Neoprene gasket for sealing. The actuator local control shall be mounted remotely within reach of the operator.

E. The valve and actuator mounting bracket shall be capable of withstanding, without damage, the stall torque of the actuator with torque and limit switches disconnected. The bearing shall be oil-bath lubricated and provide lost-motion hammerblow for unseating.

F. The operating speed of the actuator shall be approximately 15 to 20-in per minute and shall be able to provide an unseating torque at least 50 percent in excess of the required valve seating torque at the specified voltage, neglecting harnmerblow effect.

G. Telescoping valve shall be as manufactured by Envirex; FMC; Jeffery; Waterman] or equal.

2.29 PINCH VALVES

A. Pinch valves shall be furnished, as required, with an open 125 psi ANSI flanged cast iron body.

1. The closing mechanism shall be designed so that the upper and lower pinch bars move at the same time as the handwheel or motorized

operator is operated. The sleeve shall be natural rubber and shall close to form a leak-proof seal. The inside diameter of the sleeve shall be equal to the inside diameter of the pipe.

2. Pinch valves shall be Series 75 as manufactured by Red Valve Co; ONYX;or equal.

2.30 HOSE HYDRANTS

A. Hose hydrants for installation on the potable water lines shall consist of a in globe valve with two (2) 3 in hose connections and one 4in "steamer" connection as detailed on the Drawings.

2.31 FLUSH-TYPE HYDRANTS

A. Fire Hydrants shall meet as manufactured by Mueller "Super Centurian".

B. Proper back flow prevention devices shall be provided in accordance with local regulations.

2.32 MUD VALVES

A. Mud valves shall be flanged, bronze mounted, non-rising stem. Frame, cover, yoke, and stem extension shall be cast iron. The stem shall be stainless steel and lift nuts shall be bronze. Provide stem extension and upper stem support. The stem shall be designed for operation by a standard tin square wrench. The upper stem support shall be supported from the channel walls, not the grating.

B. Mud valves shall be Clow Fig. F-3075; Mueller; Troy, Waterman; or equal.

2.33 FLAP GATES (FLAP VALVES)

A. Flap gates and accessories shall be of the size, type, material and construction as shown on the Drawings and as specified herein. Flap gates shall be as manufactured by [Hydro Gate; Rodney Hunt; Waterman; Clow (circular smaller units only)] or equal with opening sizes as indicated.

B. The seat shall be flat back and shall be east in one piece with a raised section around the perimeter of the waterway opening to provide for mounting the seating faces. The raised section shall provide a seating plane diverging top to bottom, from the plane of the mounting flange to assist in positive closure of the cover. The seat shall be shaped to provide two bosses extended above the top of the waterway opening for mounting the pivot lugs. Pivot lug bosses and the back of the seat shall be drilled and tapped for mounting studs.

C. Unless otherwise indicated, flap gates shall be provided with mountings to enable bolting directly to a circular pipe flange. Gaskets and mounting bolts shall be provided.

D. Where not indicated to be mounted on pipe flanges, wall thimbles shall be supplied, of heavy one piece castings of the "F" type. Length of thimbles shall be as follows

GREATEST GATE DIMENSION	MINIMUM THIMBLE LENGTH
Gates 36-in and smaller	8-in
Gates 42-in through 90-in	12-in
Gates 96-in and larger	15-in

1. The surfaces to be cast into the concrete shall be free of paint, oil and grease at time of installation. Studs and nuts shall be provided for attaching the gate. Mastic shall be provided to form a seal between the front face of the thimble and the back of the gate seat.

2. The front flange shall be machined to a plane and shall be drilled and tapped to mate to the gate seat.

3. The vertical centerline shall be clearly shown at the top and bottom by permanent marks on the machined face. The word "top" shall be stamped in the machined face near the top centerline.

E. Each pivot lug shall be cast in one piece. Lugs shall have double bosses to place the top hinge pins in double shear when they are assembled through the link. The lugs shall be adjustable in the horizontal plane without removal of the cover from the gate links. The adjustment shall allow the top pivot point to be moved toward the gate seat for reduced sensitivity of the cover, or moved away from the gate seat to provide opening with minimum differential head. Two corrosion resistant studs shall be used to connect each pivot lug to the gate seat.

F. The links connecting the cover and pivot lugs shall be heavy duty and cast in one piece. Each link shall be provided with commercial grade corrosion resistant brushings at each pivot point. The manufacturer shall certify that bushings and links are permanently lubricated. The bottom of the links shall be provided with an adjusting screw to properly align seating faces on the cover with respect to the seat. The links shall be designed to limit the double hinge action, preventing the cover from rotating sufficiently to become wedged in the open position.

G. The cover shall be cast in one piece with necessary reinforcing ribs, with a lifting eye for manual operation and with bosses to provide a pivot point connection with the links. Bosses shall be designed to place the hinge pins in double shear when the gate is assembled.

H. A full width dovetail slot shall be machined around the perimeter of the cover and the seat. Corrosion resistant dovetail seating faces shall be mounted in the slot and held securely without use of screws or other fasteners. The seating faces shall be machined to a plane with a minimum 63 micro-inch finish.

T. All anchor bolts, assembly bolts, screws, studs and nuts shall be of ample section to safely withstand the forces created by operation of the gate under the heads indicated on the Drawings or 25-ft minimum. Quantity and size of the fasteners shall be as recommended by the manufacturer and acceptable to the Engineer.

J. Machined surfaces shall be coated with a water-resistant, rust preventive compound (certified for potable water). All cast iron parts shall be shop cleaned and painted in accordance with the manufacturer's standard practice.

K. Materials shall conform to the following:

Part	Material	ASTM Standard
Wall Thimble	N1-Resist	A436, Type 2
Gate:		
Seat/cover	NI-Resist	A436, Type 2
Face (seat)	Stainless Steel	A276 (AISI 316)
Face (cover)	Stainless Steel	A276 (AISI 316)
Pivot lugs/links	NI-Resist	A436, Type 2
Bushings	Stainless Steel	A276 (AISI 316)
Fasteners	Stainless Steel	A276 (AISI 316)

1. All stainless steel shall be Type 316. NI-Resist refers to austenitic gray iron castings. The manufacturer shall certify that all materials, including coatings, are suitable for constant submersion operation in a potable water and wet chlorine environment.

L. Where noted, flap gates subjected to mild slamming action shall have a rubber seating face on the seat. Rubber seating faces shall be mounted in a dovetail slot and held securely without use of pins or screws. The seating face on the cover shall be as specified above.

2.34 HOSE END VALVES

A. Hose end valves shall be globe pattern valves, similar to Fairbanks Fig. 074; Jenkins Fig. 112 or equal. Furnish cap and chain.

2.35 PRESSURE RELIEF VALVES

A. Pressure relief valves shall be for positive displacement pumps and shall be iron body, with Type 304 stainless steel trim and spring, with a relieving capacity equal to the pump capacity. Valves shall be threaded on inlet and outlet and shall have an outside test lever. Valve setting shall be adjustable in the range of 50 to 100 psi. See drawings for further details.

2.36 GAS VALVES

A. Gas valves 2-in and smaller shall be bronze body with threaded ends equal to Hammond BV711-T, Watts B-6800 (YRPV) or Jenkins Bros. 30-A, modified with tee handles.

B. Gas valves larger than 2-in shall be lubricated plug valves equal to valves manufactured by Powell, Homestead and Rockwell.

C. Gas valves on high pressure gas shall be lubricated plug valves.

D. Gas valves shall be listed suitable for natural gas service.

2.37 BACKWATER VALVES

A. Shall be similar to Zum Industries Inc. Z-1090-3 for Type "A" and Z-1091 for Type "B". Valves as manufactured by Josam Mfg. Co. or J.R. Smith will be considered equal.

2.38 WATER PRESSURE REGULATORS (PRV)

A. Shall be Watts IVlueseo Regulator Co. Series 115 for 1-114-in and larger and Model 223-S for units smaller than 1-1/4-in or equal with strainer and of size noted on the Drawing. Shall be diaphragm type, pressure reducing globe valves.

B. Provide a three valve full size bypass around each PRV.

C. Provide strainers same material as the PRV ahead of each PRV with pressure gauges on high and low side.

D. Smaller PRV shall have pressure setting 10 psi less than main valve.

E. Pressure regulators and components shall be securely anchored to wall or floor at a height as directed by Engineer.

F. Provide an adjustable pressure relief valve downstream of each PRV station.

G. Provide concrete vault with access lid for below grade installation. Provide insulated FRP box for above grade installations. Boxes shall be sized to contain the PRV, valves and bypasses.

2.39 INSULATING FITTINGS

A. Fittings shall be of type to provide control of electrolysis and similar to "Dielectric" as manufactured by Watts Regulator Co., or equal.

2.40 SURFACE PREPARATION AND SHOP COATINGS

A. Not withstanding any of these specified requirements, all coatings and lubricants in contact with potable water shall be certified as acceptable for use with that fluid.

B. If not specified herein, coatings shall comply with the requirements of Section 09901. In case of a conflict, the requirements of this Section govern.

C. If the manufacturer's requirement is not to require finished coating on any interior surfaces, then manufacturer shall so state and no interior finish coating will be required, if acceptable to the Engineer.

D. The exterior surface of various parts of valves, operators, floor-stands and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer such as Inertol Primer No. 621 shall be applied in accordance with the instructions of the paint manufacturer or other primer compatible with the finish coat provided.

E. Unless otherwise noted, interior ferrous surfaces of all valves shall be given a shop finish of an asphalt varnish conforming to AWWA C509, (except mounting faces/surfaces) or epoxy AWWA C550 with a minimum thickness of 4 mil.

F. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating. Mounting surfaces shall be especially coated with a rust preventative.

G. Special care shall be taken to protect uncoated items and plastic items, especially from environmental damage.

2.41 FACTORY INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

A. Factory inspection, testing and correction of deficiencies shall be done in accordance with the referenced standards and as noted herein.

B. See Division I for additional requirements. Also refer to PART 1, especially for required submission of test data to the Engineer.

C. In addition to all tests required by the referenced standards, the following shall also be factory tested:

1. Pressure regulating valves shall be factory tested at the specified pressures and flows.
2. The non-cavitating butterfly valves, to demonstrate its non-cavitating capabilities.
3. All types of air and vacuum valves.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. All valves and appurtenances shall be installed per the manufacturer's instructions in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.

B. Install all brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings or otherwise required. Before setting these items, check all Drawings and figures which have a direct bearing on their location. The Contractor shall be responsible for the proper location of valves and appurtenances.

C. All materials shall be carefully inspected for defects in construction and materials. All debris and foreign material shall be cleaned out of openings, etc. All valve flange covers shall remain in place until connected piping is in place. All operating mechanisms shall be operated to check their proper functioning and all nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the Owner.

D. Where installation is covered by a referenced standard, installation shall be in accordance with that standard, except as herein modified, and the Contractor shall certify such. Also note additional requirements in other parts of this Section.

E. Unless otherwise noted, joints for valves and appurtenances shall be made up utilizing the same procedures as specified under the applicable type connecting pipe joint and all valves and other items shall be installed in the proper position as recommended by the manufacturer. Contractor shall be responsible for verifying manufacturers' torquing requirements for all valves.

F. Valves smaller than 24" shall be direct-buried with a valve box. Valves, 24" and larger, shall be buried in a vault under a minimum of 3' of cover.

G. Each valve operator shall be tagged with a brass or stainless steel tag bearing the tag number corresponding to the tag number assigned to the valve in the Drawings. The number shall be stamped, engraved, or otherwise affixed to the tag in a manner that will not fade with time or weather.

3.02 INSTALLATION OF MANUAL OPERATIONAL DEVICES

A. Unless otherwise noted, all operational devices shall be installed with the units at the factory, as shown on the Drawings or as acceptable to the Engineer to allow accessibility to operate and maintain the item and to prevent interference with other piping, valves and appurtenances.

B. For manually operated valves 3-in in diameter and smaller, valve operators and indicators shall be rotated to display toward normal operation locations.

C. Floor boxes, valve boxes, extension stems and low floor stands shall be installed vertically centered over the operating nut, with couplings as required and the elevation of the box top shall be adjusted to conform with the elevation of the finished floor surface or grade at the completion of the Contract. Boxes and stem guides shall be adequately supported during concrete pouring to maintain vertical alignment.

INSPECTION, TESTING AND CORRECTION OF DEFICIENCIES

A. See also Division I. Take care not to over pressure valves or appurtenances during pipe testing. If any unit proves to be defective, it shall be replaced or repaired to the satisfaction of the Engineer.

B. No testing shall be performed until the manufacturer has provided written certification to the Engineer that the following installed equipment has been examined and found to be in complete accordance with the manufacturer's requirements:

C. Functional Test: Prior to plant startup, all items shall be inspected for proper alignment, quiet operation, proper connection and satisfactory performance. All units shall be operated continuously while connected to the attached piping for at least four (4) hours, without vibration, jamming, leakage, or overheating and perform the specified function.

D. The various pipelines in which the valves and appurtenances are to be installed are specified to be field tested. During these tests any defective valve or appurtenance shall be adjusted, removed and replaced, or otherwise made acceptable to the Engineer.

E. Various regulating valves, strainers, or other appurtenances shall be tested to demonstrate their conformance with the specified operational capabilities and any deficiencies shall be corrected or the device replaced or otherwise made acceptable to the Engineer.

CLEANING

A. All items specified on the drawings or carrying potable water (including valve interiors) shall be cleaned prior to installation, testing, disinfection, and final acceptance.

DISINFECTION

A. Disinfection of valves and appurtenances on all potable water lines and where otherwise noted, shall be as noted in Paragraph 1.02B above.

END OF SECTION

SECTION 15105
AIR RELEASE VALVES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all materials, equipment and incidentals required to install complete and ready for operation, all air release valves shown on the Drawings and specified herein.

1.02 WARRANTY

A. Two-year warranty shall be provided.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Air Release Valves shall be APCO model ARV as manufactured by DeZURIK, Inc., or engineer-approved equal.

2.02 AIR RELEASE VALVES

A. Air Release Valves shall automatically release small pockets of air which accumulate at the high points of a system after it is filled and under pressure.

B. Air Release Valves shall have the ability to open against internal pressure because it has a small orifice and a leverage mechanism which multiplies the force of the float. This force must be greater than the internal pressure across the orifice in order to open the valve when a pocket of air needs to be vented.

C. Air Release Valves shall be manufactured and tested in accordance with American Water Works Association (AWWA) Standard C512.

D. Valve cover shall be bolted to the valve body and sealed with a flat gasket.

E. Valve needle and seat shall be replaceable and resilient seat seals shall provide drop tight shut off to the full valve pressure rating.

F. Valve float shall be constructed of stainless steel.

G. Mechanical linkage shall provide sufficient mechanical advantage so that the valve will open under full operating pressure.

H. Simple lever designs shall consist of a single pivot arm.

I. Compound lever designs shall consist of multiple levers.

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 15110
PIPING AND ACCESSORIES

PART 1 GENERAL

1.01 WORK INCLUDED

A. This Section covers the Work necessary to furnish, install, and complete, the plant piping specified herein.

1.02 GENERAL

A. Like items of material provided hereunder shall be the end products of one (1) manufacturer.

B. To assure uniformity and compatibility of piping components in grooved end piping systems, fittings and coupling shall be furnished by the same manufacturer.

C. See CONDITIONS OF THE CONTRACT and Section GENERAL REQUIREMENTS, which contain information and requirements that apply to the work specified herein and are mandatory for this Project.

1.03 SUBMITTALS

A. In addition to the requirements of Division 1, GENERAL REQUIREMENTS, the following information shall be provided:

1. Shop Drawings:

a. For piping systems greater than three (3) inches in diameter, provide double-line Drawings of each piping system to the scale stated on the Contract Drawings, locating each support, identifying the type by catalog number or shop Drawing detail number, and showing anchor locations and identifying them by shop Drawing detail number.

b. Detailed information for piping thrust protection systems used at all specified locations, which enable the Engineer to determine the adequacy and acceptability of the system being submitted for review.

2. Manufacturer's written certification that the factory-applied coating system(s) is identical to the requirements specified herein. Where, in the manufacturer's opinion, the coating system(s) exceeds the requirements specified herein, submit complete technical literature of the proposed system(s) to the Engineer for review.

PART 2 PRODUCTS

2.01 GENERAL

A. The general materials to be used for the piping systems are shown on the Drawings and listed by service in the Piping Schedule at the end of this section. Specific material requirements are contained herein.

2.02 PIPE IDENTIFICATION PAINTING

A. All non-submerged or non-buried piping shall be painted, color coded, and labeled as specified in Section PAINTING. Color coding shall be as specified in the Piping Schedule. Submerged piping shall be coated for corrosion protections as specified in Section PAINTING. Buried piping shall receive manufacturer's standard protective coating. Pipes to receive field coatings shall be either non-primed or shop primed according to the required paint system.

2.03 PIPE JOINTS

A. Pipe joints for exposed piping shall be flanged (or welded as applicable) end for pipe larger than two (2)-inches in diameter and welded (solvent or solder, as applicable) or screwed for smaller piping, except as modified herein.

B. Pipe joints for buried piping (excluding subaqueous portion) shall be mechanical joint or push-on joint for ductile iron pipe and PVC pipe. Pipe joints for pressure services shall be provided with thrust restraint designed for the test pressures specified in the Piping Schedule. Ductile iron pipe shall be restrained using proprietary restrained joint pipe and fittings. Pressure service PVC pipe shall have solvent welded joints.

C. Pipe joints for ductile iron subaqueous service shall be flanged or restrained joint and restrained flexible joint as shown on the Drawings.

D. Pipe joints for steel piping shall be threaded for pipe sizes two (2)-inches and smaller and flanged or welded for pipe larger than two (2)-inches.

E. Grooved end pipe joints shall be used where required to join to the Owner-furnished package filters. At the Contractor's option, grooved end pipe joints may be used on exposed piping fourteen (14)-inches and smaller. All grooved end joints shall be rigid type, victaulic or equal.

2.04 DUCTILE IRON PIPE

A. Centrifugally cast, Grade 60-42-10 iron, ANSI A21.51, AWWA C151, cement-mortar lined, Class fifty (50), one hundred-fifty (150) psi minimum working pressure. Buried pipe shall be seal coated in accordance with ANSI 21.4. Non-buried pipe to receive paint for color coding shall be bare or primed for

compatibility with the final coating system. Pipe joints shall be as shown on the Drawings.

B. Fittings:

1. Gray or ductile iron, two hundred-fifty (250) psi minimum working pressure, cement-lined and seal-coated (buried applications only). Where taps are shown on fittings, tapping bosses shall be provided. ANSI B16.1 fittings shall be used only for nonstandard fittings not manufactured under ANSI/AWWA C110.

2. Flanged: ANSI/AWWA C110 and ANSI B16.1, faced and drilled one hundred twenty-five (125) pound ANSI standard.

3. Restrained: ANSI/AWWA C110 and ANSI/AWWA C111, American Cast Iron Pipe Company “Lok-Ring” or U.S. Pipe and Foundry TR Flex, or equal.

4. Mechanical Joints: ANSI/AWWA C110, ANSI/AWWA C111, and ANSI/AWWA C153.

5. Push-on: ANSI/AWWA C110 and ANSI/AWWA C111, American Cast Iron Pipe Company "Fastite" or U.S. Pipe and Foundry "Tyton" or equal.

C. Flanges:

1. Ductile iron, ANSI A21.15/AWWA C115, threaded, two hundred-fifty (250) psi working pressure, ANSI one hundred twenty-five (125) pound drilling.

2. Flange adapters shall be Series 1000 E-Z Flange as manufactured by EBAA Iron, or equal.

D. Bolts

1. For Class 250 FF Flanges: Carbon steel, ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts.

2. For Mechanical Joint: Manufacturer's standard.

3. Gaskets for mechanical or push-on joints shall be rubber, conforming to ANSI A21.11, AWWA C111.

4. Gaskets for flanged joints shall be 1/8-inch thick, red rubber conforming to applicable parts of ANSI B16.21 and AWWA C115, unless otherwise specified. Gasket material shall be free form corrosive alkali or acid ingredients and suitable for use in potable waterlines. Gaskets shall be full-face type and shall be suitable.

E. Lubricant for mechanical joint end piping shall be manufacturer's standard.

2.05 STAINLESS STEEL PIPE AND FITTINGS

A. Pipe shall be 304L stainless steel, seamless or electric resistance welded. SST pipe shall meet all requirements of AWWA C220-12. Pipe wall thickness for two (2)-inch and smaller shall be Schedule 80, pipe wall thickness for 2½- inch and larger shall be Schedule 40.

B. Joints for two (2)-inch and smaller shall be threaded, all joints 2½-inch and larger shall be welded or flanged where required for connections to equipment.

C. Fittings for pipe two (2)-inch and smaller shall be threaded, one hundred-fifty (150) pound, dimensions conforming to ANSI B16.3. Fittings for pipe larger than two (2) inch shall be butt-welded, stainless steel, meeting the requirements of ANSI B16.9, to match pipe wall thickness. Unions shall be three-hundred (300) pound stainless steel, dimensions conforming to ANSI B16.3, brass to iron seat.

D. Branch connections for pipe two (2)-inch and smaller shall be screwed tees, as specified above for fittings. Larger than two (2)-inches shall be standard weight forged steel, ASTM A105, Grade II, commercial welding branch fittings with butt-welded outlet. Straight or reducing tees shall be as specified above for fittings.

E. Flanges shall be ASTM A182, Class 60 slip-on or welding neck type, face and drilled one hundred-fifty (150) pound, 1/16-inch raised face, ANSI B16.5 Standard, or AWWA C220, Class D hub, faced and drilled one hundred twenty-five (125) pound flat-face, ANSI B16.1 Standard. Provide welding neck flanges when abutting butt weld fittings. Welding neck bore shall match pipe ID. Machine off the raised face of steel flange when mating with a cast iron flat face flange. Flanges and gaskets for air blower piping shall be appropriate for temperatures to 300 F.

F. Bolting shall be 316L stainless steel.

G. Gaskets shall be 1/16-inch thick compressed nonasbestos composition flat ring type.

H. Thread lubricant shall be teflon tape or joint compound that is insoluble in water.

I. Gaskets for process air (blower) pipe shall be Viton temperature resistant gaskets, capable of operating to 210 C.

2.06 POLYVINYL CHLORIDE (PVC) PIPE (PRESSURE SERVICE)

A. PVC pipe for pressure service shall be Schedule 80, Type I, Grade 1, or Class 1254-B, conforming to ASTM D1784 and ASTM D1785.

B. Joints shall be socket-welded or threaded, except where connecting unions, valves, and equipment with flanged connections that may require future disassembly. Flanges shall be one (1) piece, molded hub type flat faced, one hundred twenty-five (125) pound Standard. Gaskets shall be full-face, 1/8 inch thick fabricated from ethylene propylene rubber (EPR).

C. Fittings shall be Schedule 80 as specified above, conforming to the requirements of ASTM D2467 for socket type.

D. All socket connections shall be joined with PVC solvent cement conforming to ASTM 2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility.

2.07 POLYVINYL CHLORIDE (PVC) PIPE (GRAVITY SERVICE)

A. PVC pipe for gravity service shall comply with ASTM D3034-81 for PVC materials and ASTM F679, minimum pipe stiffness one hundred-fifteen (115) psi at five (5%) percent deflection, and shall meet the extra strength minimum of Standard Diameter Ratio twenty-six (26). PVC pipe shall be supplied in lengths not less than twenty (20)-feet.

B. Joints shall be push-on type spigot and bell with integral bell homogeneous with the pipe. Gaskets shall be rubber meeting the requirements of ASTM F477 and D3212 and shall be locked in to the bell groove.

C. Fittings shall be gray or ductile iron, cement-lined and seal-coated, ANSI/AWWA C110, or C153, mechanical joint unless shown otherwise.

2.08 COPPER PIPE

A. Pipe shall be seamless copper, ASTM B88, Type L hard drawn. Tubing for lines smaller than ½-inch shall be Type K soft copper, ASTM B88, with commercially pure wrought copper solder joint fittings.

B. Fittings shall be commercially pure wrought copper, socket, joint, ASTM B75, dimensions conforming to ANSI B16.22.

C. Solder shall be 95-5 wire solder, ASTM B32, Grade TA. Do not use cored solder.

2.10 FLEXIBLE CONNECTIONS TO EQUIPMENT

A. Pump seal water lines and drains, hydraulic lines to valves and their drains, and air line connections to equipment must have the flexibility to isolate equipment vibration.

2.11 PIPING SUPPORT SYSTEMS

A. General:

1. Piping shall be supported, in general, as described hereinafter and as shown by the pipe support details on the Drawings. Manufacturers' catalog figure numbers are typical of the types and quality of standard pipe supports to be employed.

2. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any Drawings shall not relieve the Contractor of the responsibility for providing them throughout the facility.

3. All piping supports, guides, and fasteners shall be type 316 stainless steel.

4. All support anchoring devices, including anchor bolts, inserts and other devices used to anchor the support onto a concrete base, roof, wall or structural steel works, shall be of the proper size, strength and spacing to withstand the shear and pullout loads imposed by loading and spacing on each particular support.

5. Where piping connects to equipment it shall be supported by a pipe support and not by the equipment. All piping shall be supported in a manner which will prevent undue strain on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings, and where otherwise shown.

6. Pipe support system components shall withstand the dead loads imposed by the weight of the pipes filled with water, plus any insulation. Commercial pipe supports and hangers shall have a minimum safety factor of five (5).

2.12 INSULATION AND HEAT TRACING

A. Insulation on all exterior, exposed piping shall be foamed glass with a maximum K-factor of 0.4 Btu-in/hr.-sq. ft. -F at thirty (30) degrees F, a permeability rating of 0.00 perm-inch, and a maximum absorption of 0.2 percent by volume. Insulation shall be Foamglas, as manufactured by Pittsburg Corning or equal. Insulation thickness shall be two (2)-inches for pipes three (3)-inches and smaller and 1½-inches for pipes four (4)-inches to eight (8)-inches. Pipes greater than eight (8)-inches will not require insulation.

B. Insulation on aboveground piping shall be covered with minimum 0.016-inch thick aluminum jacket. The jacket shall be held in place by a continuous friction type joint, providing a positive weatherproof seal over entire length of jacket. The circumferential joints shall be secured with preformed snap straps containing weatherproof sealant. Cover outdoor fittings with matching preformed aluminum jackets, two (2) piece elbows and flange covers, secured with stainless steel bands. Fitting covers shall be as manufactured by Childers, Papco, or equal.

C. Heat Tracing: Furnish self-limiting one hundred-twenty (120) volt electrical heating strip for exterior exposed pipes two (2)-inches and smaller. System shall be thermostatically controlled and guaranteed by the manufacturer for a period of two (2) years. System shall be listed by Underwriter Laboratories as a self-limiting pipe tracing material for freeze protection application in ordinary locations. Heat tracing shall be manufactured by Smith-Gates Corporation, Chemlex Corporation, or equal.

2.13 CASING PIPE

A. Casing pipe shall be steel, ASTM A252 Grade 2 with welded field joints. Casing wall thickness shall be min. 0.250 inches for all sizes thirty-six (36) inches and smaller and shall conform to State of Alabama Highway Department Section 862 for larger diameters. Casing pipe shall be shop coated with bituminous paint on the exterior.

B. Carrier pipe shall be supported inside the casing with casing pipe spacers. Spacers shall be stainless steel min. 14 gauge T304 Model CCS-ER as manufactured by Cascade Waterworks Manufacturing Company, Yorkville, IL or approved equal.

C. The approximate locations and lengths of encasements are shown on the Drawings for bidding information, but the exact location and length of encasement will be determined by the appropriate highway department.

PART 3 EXECUTION

3.01 WELDING STEEL PIPE

A. General: In accordance with the latest edition of Section IX, ASME Boiler and Pressure Vessel Code.

B. Welding Procedure Specifications:

1. Qualify all welding procedure specifications prior to fabrication in accordance with the ASME Boiler and Pressure Vessel Code, Section IX.

2. Identify all welding procedure Specifications by number and reference the procedure number on all fabrication Drawings.

C. Welding and Welding Operators:

1. Qualify all welders and welding operators prior to fabrication in accordance with ASME Boiler and Pressure Vessel Code, Section IX.

2. Include qualifications for all welding positions to be employed in the fabrication.

D. Materials:

1. Use welding products within the limits recommended by their manufacturers.

2. Keep electrodes, filler wires, and fluxes clean, dry, and properly stored according to manufacturer's recommendations. Do not use electrodes, filler wires, or fluxes that are damp, greasy, or oxidized.

3. Do not use backing rings.

4. Consumable inserts may be used if included in the qualified welding procedure specification. Match the chemistry of the consumable insert with the base metal and weld metal chemistry.

3.02 FABRICATION OF STEEL PIPE

A. End Preparation:

1. Machine shaping of pipe ends is the preferred method.

2. Oxygen or arc cutting is acceptable only if the cut is smooth and true and all slag is removed either by chipping or grinding.

3. Beveled Ends for Butt Welding: Meet the requirements of ANSI B16.25.

B. Cleaning: After completion of shop or field fabrication and after erection, clean all piping inside and outside to remove all loose scale, weld spatter, dirt, loose debris, and foreign material.

C. Alignment and Spacing:

1. Align ends to be joined within existing commercial tolerances on diameters, wall thickness, and out-of-roundness.

2. Root Opening of the Joint: As stated in the welding procedure Specification.

3.03 CORROSION PROTECTION

A. Install coating as specified in Section PAINTING.

3.04 EXAMINATION, INSPECTION, AND TESTING OF STEEL WELDING

A. Required Examinations:

1. Perform examination in accordance with the ANSI Code for Pressure Piping B31.3 (Piping Code).

2. Perform examination for every pipe thickness and for each welding procedure, progressively, for all piping covered by this Section.

3.05 PIPE PREPARATION AND HANDLING - GENERAL

A. Each pipe and fitting shall be carefully inspected before the exposed pipe or fitting is installed. The interior and exterior protective coating shall be inspected, and all damaged areas patched in the field with material similar to the original. Clean ends of pipe thoroughly. Remove foreign matter and dirt from inside of pipe and keep clean during and after laying.

B. Use proper implements, tools, and facilities for the safe and proper protection of the pipe. Carefully handle pipe in such a manner as to avoid any physical damage to the pipe. Do not drop or dump pipe.

C. Care shall be taken not to damage linings when handling pipe.

3.06 CUTTING PIPE

A. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.

B. Dress cut ends of pipe in accordance with the type of joint to be made. Dress cut ends of mechanical joint pipe to remove sharp edges or Projections which may damage the rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer. Dress cut ends of pipe for flanged coupling adapters as recommended by the manufacturer.

3.07 FABRICATION OF FLANGED PIPE - GENERAL

A. Flanged ductile iron pipe and steel pipe shall be fabricated in the shop, not in the field, and delivered to the job site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the manufacturer. Flanges for ductile iron shall be faced after fabrication in accordance with ANSI A21.15/AWWA C115.

3.08 JOINTING PIPE - GENERAL

A. Flanged: Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to assure proper seating of the flange gasket. Bolts shall be tightened so the pressure on the gasket is uniform. Torque-limiting wrenches shall be used to ensure uniform bearing insofar as possible. If joints leak, the gaskets shall be removed and reset and bolts re-tightened.

B. Mechanical and Push-on Joint: Join pipe with mechanical or push-on type joints in accordance with the manufacturer's recommendations. Provide all special tools and devices, such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes will be permitted under any circumstances. Thrust restraint of pressure and gravity piping shall be as specified herein and as shown in the Drawings.

3.09 INSTALLATION OF BURIED PIPING - GENERAL

A. Trench excavation and backfill requirements are specified in Section EARTHWORK.

B. All buried pipe shall be prepared as hereinbefore specified and shall be laid on the prepared sub-grade and bedded to ensure uniform bearing. No pipe shall be laid in water or when, in the opinion of the Engineer, trench conditions are unsuitable. Take all precautions necessary to prevent uplift and floating of the pipe prior to backfilling.

C. When the pipe laying is not in progress, including the noon hours, the open ends of pipe shall be closed, and no trench water, animals, or foreign material shall be permitted to enter the pipe.

3.10 INSTALLATION OF EXPOSED PIPING - GENERAL

A. Unless shown otherwise, piping shall be parallel to building lines. Hangers on adjacent piping shall be aligned where possible on common size ranges.

B. All pipe flanges shall be set level, plumb, and aligned. All flanged fittings shall be true and perpendicular to the axis of the pipe. All bolt holes in flanges shall straddle vertical centerline of pipes.

C. Unions shall be installed where required for piping or equipment installation, even though they are not shown on the Drawings.

D. Piping shall be installed without springing or forcing the pipe in a manner which would set up stresses in the pipe, valves, or connected equipment.

E. Valve handwheels shall be oriented to permit easy access to the handwheels, and to avoid interference.

F. Tubing shall be installed straight with smooth bends. Tubing lengths shall be minimized by using hard piping up to the equipment items before transitioning to tubing.

3.11 INSTALLATION OF FLEXIBLE COUPLINGS AND FLANGED ADAPTERS

A. Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Workmen tightening bolts shall use torque limiting wrenches.

3.12 INSULATION

A. All piping shall be insulated in accordance with manufacturer's instructions including types of insulating cements, lagging adhesives, and weather-proof mastics.

B. All insulation shall be applied over clean, dry surfaces with all joints butted firmly together, but not until piping system has been pressure tested and any leaks corrected. Insulation shall not extend beyond flanges nor cover nameplates or code inspection stamps. Insulation shall run continuous through wall openings, ceiling openings, and pipe sleeves, unless otherwise noted.

C. Insulate all valve bodies, flanges, and pipe couplings. Provide removable insulation sections on all devices that require access for maintenance of equipment or removal.

D. Finished appearance of all insulation shall be smooth and continuous. Provide coating of insulated cement where needed to obtain this result. Joints shall be lapped and the integrity of vapor seals maintained in strict accordance with manufacturer's instructions. Staples and screws shall not be used to secure components of systems that are vapor sealed.

3.13 INTERIM CLEANING

A. Care shall be exercised during fabrication to prevent the accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, etc. within piping sections. All piping shall be examined to assure removal of these and other foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.14 FINAL CLEANING

A. Following assembly and testing and prior to final acceptance, all pipelines installed under this section shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5-feet per second. Protect connected equipment by using strainers or disconnecting the equipment. Accumulated debris shall be removed through drains two (2)-inches and larger by dropping spools and valves.

3.15 HYDROSTATIC TESTING

A. General: Make pressure and leakage tests on all newly laid pipe. The Contractor shall provide all necessary equipment and material, make all taps in the pipe as required, and conduct the tests. The Engineer will monitor and witness the tests before the installed pipe is approved. Pressure tests must be completed before payment is made for that section of pipe.

B. Test Pressure: Each section of pipe shall be slowly filled with water to the test pressure shown in the piping schedule or to the pressure class rating of the pipe. Pressure shall be applied by a motor-driven pump. The test duration shall be six (6) hours for covered pipe and three (3) hours for uncovered pipe. The Contractor shall provide a pressure chart recorder for the duration of each test.

C. Procedure: Before applying the specified test pressure, all air shall be expelled from the pipe. If necessary, taps shall be made at points of highest elevation and plugged afterward. At the end of the test period, the Contractor will inject a sufficient quantity of water into the pipe section to re-establish the specified pressure. The Contractor shall provide suitable means to determine the quantity of water lost by leakage during the test. The Engineer must witness the quantity of water leakage and pressure recording and sign both before approving the test.

D. Allowable Leakage: Exposed piping shall not have any visible leakage. For buried pipelines less than 500 LF the allowable leakage shall be zero (0) gallons. For lengths more than more than 500 LF the allowable leakage shall be less than the amount determined by the following formula:

$$L = \frac{(10)\ D\ Le}{126720}$$

Where L = Allowable leakage, gallons per hour

D = Nominal diameter of pipe, inches

Le = Length of pipe, feet

E. Allowable Loss of Pressure: The maximum allowable drip in pressure from the test pressure shall be no greater than five (5) percent of the test pressure.

F. Correction of Excessive Leakage: Should any test of pipe disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

3.16 PNEUMATIC TESTING (PRESSURE SERVICES)

A. All gas-carrying piping shall be tested using pneumatic leak tests. Pneumatic testing shall be performed using accurately calibrated instruments and oil-free, dry air. Tests shall be performed only after piping has been completely installed, including all supports, hangers and anchors, and trench backfill. All parts of the piping system shall be subjected to the test pressure specified in the piping schedule.

B. Pneumatic tests shall begin by placing approximately twenty-five (25) psi to the piping system and inspecting for leaks using soap bubbles. After major leaks have been repaired, pressure shall be increased to approximately half of the test pressure, then increased in small increments until the required test pressure is reached. The pneumatic test pressure shall be continuously maintained for a minimum time of ten (10) minutes and for such additional time as may be necessary to conduct a soap bubble examination for leakage. The piping system shall show no evidence of leakage.

3.17 LOW PRESSURE AIR TEST (GRAVITY SERVICES)

A. General: make pressure and leakage tests on all newly laid pipe after cleaning. The Contractor shall provide all necessary equipment and material, and conduct the tests. The Engineer will monitor and witness the tests before the installed pipe is approved. Pressure tests must be completed before payment is made for that section of pipe.

B. Air Test: Standard five (5) psig air test in accordance with UNI-B-6-90.

C. Correction of Excessive Leakage: Should any test of pipe disclose leakage greater than that allowed, locate and repair the defective joints or pipe until the leakage of a subsequent test is within the specified allowance.

3.18 DISINFECTION

A. General: After pipelines, valves, fittings, and appurtenances have been installed and tested, they shall be disinfected in accordance with AWWA C651 or as modified by any governing agency having jurisdiction. The Contractor shall provide all equipment and materials necessary to adequately disinfect all facilities.

B. Flushing: Before sterilizing, flush all foreign matter from the line. Flushing velocities shall be at least 2.5 feet per second. For large diameter pipelines where it is impractical to flush the pipe at this velocity, clean the pipeline in place from the inside by brushing, sweeping and swabbing, then flush the line at a lower velocity.

C. Disinfection: Disinfect with a chlorine solution having a free chlorine residual of ifty (50) ppm. The solution shall be injected into the pipe through a corporation stop or suitable tap in the top of the pipeline. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the existing water mains or so that contaminated water does not enter any disinfected mains.

D. Retention Period: The chlorine solution shall remain in the pipeline for twenty-four (24) hours or long enough to destroy all nonspore-forming bacteria, whichever is greater. Operate all valves, hydrants, and other appurtenances during disinfection to assure that the chlorine solution is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the solution. After the retention period is complete, flush the chlorinated solution from the line until a chlorine residual of 0.2 ppm has been achieved.

E. Bacteriological Samples: After flushing, collect a minimum of two (2) water samples for bacteriological analysis at a rate of at least one (1) per mile of water main disinfected and submit to a laboratory certified by ADEM. Where new connections to existing piping are made, at least one (1) sample per affected area

of the system shall be collected and analyzed. All samples shall indicate absence of Total and Fecal Coliform. Contractor shall repeat disinfection procedure until satisfactory results have been obtained. The bacteriological results shall be sent directly to the Engineer.

3.19 PAINTING

A. All exposed, non-insulating piping, valves, and accessories shall be painted as specified in Section PAINTING and as directed by the Engineer. Colors shall be selected by the Owner according to submitted color charts.

END OF SECTION

(Pipe Schedule Follows)

PIPING SCHEDULE

Service	Legend	Test Pressure and Type (psig-x)	Operating Pressure (psig)	Size (In.)	Material	Paint Color	Label	Remarks
Air Compressed	A	150-P	150	1 <1	Stainless Steel	None	Yes No	
Process Air	PA	20-P	12	4-12	Stainless Steel	None	Yes	
Plant Influent	PI	150-H	40	4-16	DIP	Light Brown	Yes	Pressure
Plant Influent	PI	150-H	40	4-16	Stainless Steel	None	Yes	Pressure
Chlorine Solution	CS	100-H	80	1	Sch80 PVC	None	Yes	Pressure Service
Drain	DR	5-P	-----	1-3	Sch80 PVC	None	Yes	Pressure Service
Clarified Effluent	CI	5-P	10	12-16	DIP	Light Green	Yes	Gravity Service
Filtered Effluent	FE	100-H	5	14-16	DIP	Lt Purple	Yes	Gravity Service
Plant Water	PW	150 H	80	>3	DIP	Lt Purple	Yes	Above Grade
Potable Water	WM	120 H	60	>2″	Cl 200 PVC	None	No	Buried
Potable Water	WM	100-H	60	¾-2	Sch80 PVC	Label Only	Yes	Pressure Service
Sample	SA	100-H	60	≤ 1	PVC	None	Yes	Pressure Service
Sludge	SL	5-P	-----	4-8	DIP	Dark Brown	Yes	Gravity Service
Sludge	SL	100-H	-----	4-8	DIP	Dark Brown	Yes	Presurre Service

General Piping Notes:

1. Buried DIP shall be interior cement lined and exterior asphaltic coated.
2. Exposed SST and PVC pipe shall not be coated (provide labels only).
3. Exposed plant water and potable water pipe less than 6″ shall be insulated and heat traced.
4. Non-buried DIP shall be coated according to Section 09900 Painting. Including exposed pipe in valve/meter pits and chemical dosing manholes.

END OF SECTION

SECTION 15150
DOUBLE WALL CHEMICAL PIPE SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install buried (or installed in pipe trench), double walled plastic piping and appurtenances as shown on the Drawings and as specified herein.

1.02 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM F438 – Standard Specification for Socket-Type Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe Fittings, Schedule 40.

2. ASTM F441 – Standard Specification for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80.

3. ASTM F493 – Standard Specification for Solvent Cements for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe and Fittings.

4. ASTM D2657 – Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.

1.03 SUBMITTALS

A. Shop drawings and product data, in accordance with Section 01300, shall include the following:

1. Shop drawings including piping layouts and schedules shall be submitted to the Engineer and shall include dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.

2. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layout for each piping submittal.

1.04 QUALITY ASSURANCE

A. All double walled plastic pipe and fittings shall be furnished by a single manufacturer who is experienced in the manufacture of the items to be furnished. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall be suitable for the intended service.

1.05 DELIVERY, STORAGE AND HANDLING

A. During loading, transportation and unloading take care to prevent damage to pipes and coating. Carefully load and unload each pipe under control at all times. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation to ensure no injury to pipe and lining.

1.06 SYSTEM DESCRIPTION

A. Double walled piping systems shall be installed in those locations as shown on the Drawings.

B. The equipment and materials specified herein are intended to be standard types of plastic pipe and fittings for use in transporting chemicals.

C. Pipe materials shall be chemically compatible with the chemical system for which they are used at up to 100 degrees F.

D. Double-walled piping systems shall be utilized for the following chemical systems:

1. System: Sodium Hypochlorite

   a. Carrier Pipe and Fittings Material: ½″ to 2″ PVC – Schedule 80

   b. Containment Pipe and Fittings Material: 2″ to 4″ PVC-Schedule 80

   c. Pressure: Atmosphere to 100 psig

   d. Flow Velocity: Up to 10 fps

   e. Special Conditions: Pulsation from reciprocating diaphragm pumps

2. System: Caustic Soda

   a. Carrier Pipe and Fittings Material: ½″ to 2″ PVC – Schedule 80

   b. Containment Pipe and Fittings Material: 2″ to 4″ PVC-Schedule 80

c. Pressure: Atmosphere to 100 psig

d. Flow Velocity: Up to 10 fps

e. Special Conditions: Pulsation from reciprocating diaphragm pumps

3. System: Phosphate

a. Carrier Pipe and Fittings Material: ½″ to 2″ PVC – Schedule 80

b. Containment Pipe and Fittings Material: 2″ to 4″ PVC-Schedule 80

c. Pressure: Atmosphere to 100 psig

d. Flow Velocity: Up to 10 fps

e. Special Conditions: Pulsation from reciprocating diaphragm pumps

4. System: Fluoride

a. Carrier Pipe and Fittings Material: ½″ to 2″ PVC – Schedule 80

b. Containment Pipe and Fittings Material: 2″ to 4″ PVC-Schedule 80

c. Pressure: Atmosphere to 100 psig

d. Flow Velocity: Up to 10 fps

e. Special Conditions: Pulsation from reciprocating diaphragm pumps

1.07 MAINTENANCE

A. Furnish all special tools and test equipment required for the proper servicing of all equipment.

B. All spare parts shall be properly protected for long periods of storage and packed in containers that are clearly identified with indelible markings as to contents.

C. Furnish spare parts recommended by the manufacturer.

PART 2 PRODUCTS

2.01 DOUBLE WALL PIPING

A. Each contained piping system shall consist of PVC primary piping system supported within a PVC secondary containment housing. Carrier fitting sizes 1/2" through 4" will use molded supports minimizing the number of field (factory assembled) fitting joints. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be made from Polypropylene supports and shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment may be readily drained and manually checked for leaks.

B. Pipe shall be manufactured from PVC compounds meeting ASTM D1784, Class 12454-B. The pipe shall be manufactured in accordance with ASTM D1785. The pipe shall have a minimum hydrostatic design stress of 2,000 psi at 73 degrees F and shall be suitable for field cutting and solvent welding. Pipe shall be of the sizes indicated above and shall be Schedule 80. Fittings shall be socket type for solvent weld joints conforming to ASTM F439. The burst pressure of the fittings shall be not less than the burst pressure of the size and thickness of the pipe with which it is to be used in accordance with ASTM D2467.

C. Access tees shall be provided at locations shown on the Drawings. Access tees shall be of the same resin as the containment pipe.

D. Double wall chemical piping shall be Guardian as manufacturerd by IPEX, or equal by Spears, or Engineer Approved Equal.

E. Fabricated valve boxes shall be provided to contain isolation valves, check valves, backpressure valves, etc. within the piping system.

PART 3 EXECUTION

3.01 INSTALLATION OF DOUBLE WALLED PVC CHEMICAL PIPE SYSTEM AND PVC SECONDARY CONTAINMENT PIPING

A. Double walled PVC chemical pipe systems shall be installed in accordance with the manufacturer's technical data, printed instructions and field instruction.

B. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

C. All pipe shall be sound and clean before installation. When installation is not in progress, including lunchtime, the open ends of the double walled chemical pipe systems shall be closed by watertight plug or other approved means. Good alignment shall be preserved during installation. Fittings, in addition to those shown on the Drawings, shall be provided, if required, in crossing utilities which may be encountered upon opening the trench.

D. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe.

E. Joints for PVC pipe shall be solvent welded. In making solvent welded connections, clean dirt and moisture from the pipe, bevel pipe ends slightly with emery cloth to remove any shoulder or burrs created by the cutting of the pipe. Solvent welded joints shall be made in accordance with ASTM D2855. IPS "Weld-on" # 724 Heavy-bodied grey CPVC/PVC Cement formulated for improved chemical resistance to caustics including Sodium Hypochlorite solutions shall be used as manufactured by IPS Corporation Compton, CA or equal. Primer shall be used whenever recommended by the pipe manufacturer and in all cases for joints on the pipe systems 4-in in diameter or larger.

F. Precautions shall be taken to prevent flotation of the pipe in the trench.

G. Where plastic pipe passes through wall sleeves, the space between the pipe and sleeve shall be sealed with a mechanical sealing element.

3.02 FIELD TESTING – PVC PIPE SYSTEMS

A. All pipelines shall remain undisturbed for the minimum curing time specified for each type of pipe material but no less than 24 hours to develop full curing and complete strength at all joints. Prior to installation of the split fittings, all primary carrier pipe systems shall be flushed clean and then subjected to a hydrostatic pressure test as specified in Section 15010.

B. After testing of the carrier pipe, the containment fittings shall be installed and the containment system shall be tested pneumatically at 5 psig for a duration of two hours prior to backfilling. All containment piping joints shall be checked for leaks by applying a soapy solution to the joints. Furnish all necessary equipment and labor to perform the air test, including air compressor, gauges, conduit caps, temporary pipe and connections, etc. and complete the test to the satisfaction of the Engineer.

C. After backfilling is completed, a 5 psig air test of the containment pipe shall be conducted to the satisfaction of the Engineer.

D. All leaks detected during the pressure test shall be repaired and the pressure/temperature test rerun. A successful test shall be a test in which no leaks are detected and the pipe system pressure can be maintained within 10 percent of the specified value.

E. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during the tests.

F. The Contractor shall notify the Owner a minimum of 48 hours prior to testing of containment and carrier pipes.

END OF SECTION

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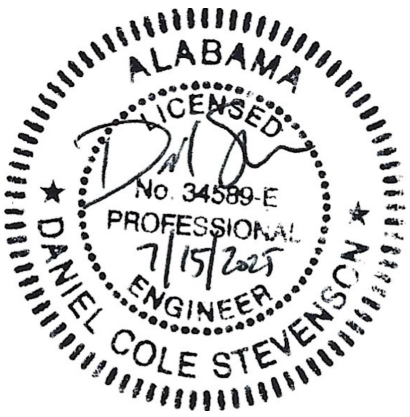

SECTION 13300

PROCESS CONTROL SYSTEMS GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the furnishing and installation of an instrumentation and control system designated as the Process Control System (PCS).

B. Contractor shall procure the services of a Process Control System Integrator (PCSI). The PCSI shall be responsible for the following:

1. Coordinate all process control system-related items.
2. Furnish and install all materials, equipment, labor, and services required, except for those services and materials specifically excluded.
3. Achieve a fully integrated and operational PCS as specified herein, in the associated Specification Sections, and as detailed in the Contract Drawings.
4. Check out and calibrate instruments.
5. Perform all testing, training, and startup activities specified to be provided.

C. Equipment and software furnished under this section and under other related sections listed in the Scope of Work paragraph above shall be designed, coordinated, and supplied by the PCSI or supplier.

D. PCSI shall procure the services of an Application Services Provider (ASP) to provide all work specified in Section 13306 – Application Engineering Services including Programmable Logic Controller (PLC), Human Machine Interface (HMI), and network configuration and programming for a complete and fully functional system that meets the design intent. The PCSI may also provide the ASP services if they meet all ASP requirements.

E. Work shall include, but not necessarily limited to the following:

1. Provision of the booster station Remote Telemetry Unit (RTU). Programming and integration associated with the RTU shall be performed by the ASP.
2. Programming and Integration the new booster pump VFDs – to be performed by the ASP.
3. Provision and configuration of the storage tank level instruments – level transducer and float switches. Configuration/programming and integration of the instruments shall be performed by the ASP.
4. Provision and configuration of the booster pump discharge pressure transducer and flow meter. Configuration, programming, and integration

of the instruments shall be performed by the ASP.

F. Items specifically excluded from the PCSI's scope of work, but included within the ASP's scope of work, include the following:

1. PLC programming, testing of PLC logic, and startup and training activities associated with the programmed PLC applications.
2. HMI graphics development, HMI software configuration, database development, report development, historical database, related software applications, and startup and training activities associated with the configured PCS system.

G. Associated Sections

This section encompasses the equipment and services specified in the following sections:

SECTION	SPEC TITLE
13306-1	Application Engineering Services
13315-1	Process Control System Submittals
13320-1	Process Control System Testing
13330-1	Process Control System Training
13340-1	Process Control System Input/Output List
13340-2	Input Output List CEWSA
13350-1	Process Control Descriptions
13350-10	Booster Pump Station
13420-1	Programmable Logic Controllers
13500-1	Instruments
13500-2	Instrument Device Schedule
13510-1	Flow Measurement
13511-1	Magnetic Flow Meters
13515-1	Variable Area Flow Meters
13530-1	Level Measurement
13531-1	Ultrasonic Level Meter
13542-1	Level Switches
13550-1	Pressure Measurement
13554-1	Gauge Pressure Transmitters

H. PCSI shall coordinate with the Contractor, Owner, Engineer, and ASP, for all

scheduling, installation, testing, startup, and training services.

I. Instrumentation specified in other Divisions shall meet the requirements of the Process Control Systems Sections of Division 13.

1.02 GENERAL

A. The Drawings and Specifications indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary by PCSI, details of such departures and the reasons shall be submitted to Engineer for review with of before the first submittal. No departures shall be made without prior written acceptance.

B. The specifications describe the minimum requirements for hardware and software. Where PCSI's standard configuration includes additional items of equipment or software features not specifically described herein, such equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.

C. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

D. Requirements specified in this Section apply to all equipment specified in the above Sections, unless otherwise stated. In the case of a conflict, the most stringent requirements shall prevail.

E. The PCSI shall supply, install, and configure all instruments specified in Division 13 and as shown on the drawings.

F. All equipment and installations shall satisfy applicable Federal, State and local codes.

G. Drawings

1. The Drawings indicate locations and arrangements of equipment and may include installation details and block and one-line diagrams showing connections and interfaces with other equipment. Section 13340 – Process Control System Input/Output List contains the input/output (I/O) points.
2. Principal components of the instrumentation systems shall be as indicated on the P&ID drawings and Section 13500 – Instruments.

H. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area

indicated on the Drawings is based on typical values.

2. The PCSI shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications requisite for proper installation subject to acceptance by Engineer.
3. At least three feet of clear access space shall be provided in front of all instrumentation and control system components.

I. Workmanship and Materials

1. PCSI shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice.
3. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field.
4. Like parts of duplicate units shall be interchangeable.
5. Equipment shall not have been in service at any time prior to delivery, except for testing.

J. Corrosive Fluids

1. All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials.
2. PCSI shall submit certification that the instrument manufacturer approves the selection of materials of primary elements that are in contact with the specified process fluid to be inert to the effects of the process fluid.

K. Permits and Agency Approvals

1. Contractor shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment.

1.03 GOVERNING CODES AND STANDARDS

A. All work performed covered by this section and all equipment, materials, and installation shall be in accordance with the National Electrical Code (NEC), with applicable Federal, State, and Local regulations and ordinances, and with the latest edition of the following codes and standards. (Note: Codes and standards are referred to in the text by basic designation only. Where a date is given for reference standards, that edition shall be used. Where no date is given for reference standards, the latest edition in effect at the time of bid opening shall apply.)

1. American National Standards Institute (ANSI)
2. American Society for Testing and Materials (ASTM)
3. Code of Federal Regulations (CFR)
4. Canadian Standards Association (CSA)
5. Factory Mutual (FM)
6. Federal Communication Commission (FCC)
    a. Part 15 – Class A
7. Institute of Electrical and Electronics Engineers (IEEE)
    a. IEEE 519 – Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
    b. IEEE C37.90 – Standard for Relays and Relay Systems Associated with Electric Power Apparatus
8. International Society of Automation (ISA)
9. Insulated Cable Engineers Association (ICEA)
10. National Electric Safety Code (NESC)
11. National Electrical Manufacturers Association (NEMA)
    a. NEMA ICS 1 – Industrial Control and Systems General Requirements
12. National Fire Protection Agency (NFPA):
    a. NFPA 70 – National Electrical Code (NEC)
    b. NFPA 79 – Industrial Control Equipment
13. Occupational Safety and Health Administration (OSHA)
14. Underwriters Laboratories, Inc. (UL):
    a. UL 508 – the Standard for Safety for Industrial Control Equipment
    b. UL 508A – the Standard for Safety for Industrial Control Panels
    c. UL 61010-1 – the Standard for Safety Electrical Equipment For Measurement, Control, and Laboratory Use: General Requirements
    d. UL 61010-2-201 – the Standard for Safety Electrical Equipment For Measurement, Control, and Laboratory Use: Particular Requirements for Control Equipment
    e. UL 50 – the Standard for Safety for Enclosures for Electrical Equipment
    f. A nationally recognized testing laboratory, as approved by the Authority having jurisdiction, may substitute for UL listing on commercial off the shelf products.
15. United States Defense Standard (MIL-STD)

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

C. If the issue of priority is due to a conflict or discrepancy between the provisions of the contract documents and any referenced standard, or code of any technical society, organization or association, the provisions of the contract documents shall take precedence if they are more stringent or presumptively cause a higher level of performance.

D. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between laws and regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Owner and/or Engineer.

E. In accordance with the intent of the contract documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in contract price or an extension in contract time nor limit in any way, the Contractor's responsibility to comply with all laws and regulations at all times.

1.04 RELATED WORK

A. All equipment and work provided under any division of these project specifications including but not limited to vendor supplied instrumentation and control panels shall fully comply with the relevant requirements of Division 13 Sections.

B. Conduit and Cable

1. Process Control conduit systems are specified in Electrical Division 16.
2. Instrumentation signal cable and alarm, control, and status wiring are specified in Electrical Division 16.

C. The contract documents indicate both vendor and PCSI supplied instruments, devices, and control panels. The distinction between equipment suppliers shall be shown on the Drawings, Instrument Device Schedule, and Panel Schedules. PCSI shall provide all equipment as instruments, devices, and control panels that are not listed as supplied by vendors.

D. Related Equipment, Materials, and Appurtenances

1. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.
2. PCSI shall provide all auxiliary and appurtenances devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, signal boosters, signal converters, intrinsic safety barriers,

signal isolators, special power supplies, special cable, special grounding, software, and drivers to interface with existing equipment or equipment provided by others under other sections of these specifications, whether they are shown on the Drawings or not.

3. All equipment shall be designed and installed in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.

E. Coordination

1. Systems supplied under this section shall be designed and coordinated by PCSI for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment.
2. The PCSI shall coordinate with the Contractor, Owner, Engineer, ASP and other suppliers of Instrumentation and Controls equipment specified under other Divisions that interface with the PCS for all scheduling, installation, testing, startup, and training services.

1.05 PCSI AND ASP'S QUALIFICATIONS.

A. General

1. Successfully completed work of similar or greater complexity on at least three previous projects within the last five (5) years. Successful completion shall be defined as a finished project completed on time, without any outstanding claims or litigation involving the PCSI/ASP. Potential references shall be for projects where the PCSI/ASP's contract was of similar size to this project.
2. Been in the same industry performing the type of work specified in this specification section for a minimum of 15 years.
3. Maintain competent and experienced service personnel to service the hardware and software furnished for this project.
4. Hold an adequate Certificate of Insurance for the project work specified herein and in other related Sections.
5. Submit a team organization chart, resumes, and training certifications.
6. Employ personnel who have completed and hold certificates for required training.
7. Certifications and training credentials of all individuals working on Owner's systems must be submitted and approved prior to commencing work.
8. If the PCSI/ASP has worked with the Owner, provide a list of projects previously completed. The PCSI/ASP may be rejected based on past performance on Owner's projects, and may not use rejection to claim

additional compensation or time.

9. Be capable of responding to on-site problems, at a minimum, within 12 hours of notice. Provide an on-site response within 4 hours of notification starting at two months before scheduled startup to two months after startup completion.
10. Being listed in this specification does not relieve any potential PCSI/ASP from meeting the qualifications and criteria specified in this section.
11. Any proposed PCSI/ASP firm not shown on the pre-qualified list below, must be identified and submitted a minimum of 10 days prior to bid opening and must be approved by the Owner. Owner will announce via the addendum process a minimum of five days prior to Bid if the proposed PCSI/ASP has been accepted. Owner reserves the right to accept or reject any firm based on Owner's evaluation of qualifications, past performance, or experience (or lack thereof) with Owner.

B. PCSI's Qualifications

1. The PCSI shall be a "systems integrator" regularly engaged in the business of supplying and installing computer-based monitoring, control, data acquisition systems, instrumentation, and their associated subsystems as they are applied to the municipal water and wastewater industry.
2. The PCSI shall have the following minimum qualifications:
    a. Maintain a permanent, fully staffed, and equipped service facility within 200 miles of the project site with full time employees capable of designing, fabricating, installing, calibrating, testing, and troubleshooting the systems specified herein.
    b. Hold a valid UL-508 certification for their panel fabrication facility.
3. The following PCSIs, listed in no particular order, have been pre-approved for this work by the Owner:
    a. DFA
    b. NO EXCEPTIONS

C. ASP'S Qualifications.

1. The ASP shall have the following minimum qualifications:
    a. Employ personnel who have previously completed five projects of this size or larger in dollar value and complexity. PLC, OIT, and HMI programmers must be from the same firm.
    b. Staff proposed shall be certified in the HMI SCADA software and Historian development and in the programming of PLC specified.
2. The following ASPs, listed in no particular order, have been pre-approved for this work by the Owner:

a. DFA

b. NO EXCEPTIONS

1.06 SUBMITTALS

A. Refer to Section 01300 – Submittal Procedures for general submittal requirements.

B. Refer to Section 13315 – Process Control System Submittals for the specific submittal requirements.

1.07 SPARE PARTS

A. Refer to the individual specification sections for the spare parts requirements.

1.08 HAZARDOUS AREAS

A. Equipment, materials, and installation in areas classified as hazardous on the drawings shall comply with NEC Articles 500, 501, 502 and 503.

B. Equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classification.

1.09 SHIPPING, STORAGE, AND HANDLING

A. Shipping, storage, and handling shall be in accordance with Section 01600 - Product Delivery, Storage, And Handling.

B. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage in accordance with the manufacturer's instructions. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be always kept dry, and shall not be exposed to adverse ambient conditions.

C. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

D. Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.

E. Manufacturer's special instructions for field handling, storage and installation required for protection, shall be securely attached to the packaging for each piece of equipment prior to shipment. The instructions shall be stored in resealable plastic bags or other means of protection.

F. Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.

G. Instrument shipment and storage requirements shall be coordinated with Engineer or Owner prior to shipment. PCSI shall provide adequate storage and be ready to accept the shipment before shipping any equipment to the site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.

H. Equipment shall be installed in its permanent, finished location shown on the drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.

I. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during jobsite storage, and after equipment is installed in permanent location, until equipment is placed in service.

J. Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

K. If any apparatus has been damaged, such damage shall be repaired at no additional cost to the Owner.

1.10 WARRANTIES

A. Manufacturer's warranties shall start from date of Substantial Completion in accordance with Section 01760 – Warranties and be as specified in each specification sections.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 COORDINATION MEETINGS

A. Refer to Section 13306 - Applications Engineering Services for ASP work related meeting and workshop requirements.

B. PCSI/ASP Kick-off Meeting

1. A project kick-off coordination meeting shall be held within two weeks after submitting the first phase submittals including Deviation List, Project Plan, and Schedule Submittals. The purpose of the meeting shall be to discuss the following:
    a. The PCSI and ASP's Project Plan and Schedule Submittal
    b. To summarize the PCSI and ASP's understanding of the project
    c. Any proposed substitutions or alternatives
    d. Schedule testing and delivery deadline dates
    e. Provide a forum to coordinate hardware and software related issues
    f. Request any additional information required from the Owner
2. Prepare and distribute an agenda for this meeting a minimum of one week before the scheduled meeting date.
3. The meeting will last up to two hours.
4. Meeting minutes shall be provided for each meeting to the Owner and Engineer within five (5) working days of the meeting date. Sections shall be established within the minutes that clearly identify project team decisions and action items with responsible party. Final minutes shall be prepared and submitted to the Engineer following receipt of input from the meeting attendees.
5. The kick-off meeting shall include ASP kick-off meeting requirements from Section 13310 - Applications Services.

3.02 INSTALLATION REQUIREMENTS

A. The installation of equipment furnished hereunder shall be by the Contractor or their assigned subcontractors.

B. Refer to the individual specification sections for the specific installation requirements.

C. Field Wiring
    1. Field wiring materials and installation shall be in accordance with the electrical section.
    2. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.

D. Salvage of Existing Equipment
    1. Existing equipment and materials removed or replaced under this contract shall be delivered to Owner at a location designated by Owner or shall be properly disposed of at Owner’s discretion. Care shall be taken to avoid

damage to equipment delivered to Owner.

2. Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring, or openings that remain after removal of equipment and support hardware shall be removed or repaired in a manner acceptable to Owner and Engineer. Transmitters or switches containing mercury shall be removed and disposed of by personnel trained in the handling of hazardous materials and using approved procedures.

3.03 SYSTEMS CHECK

A. PCSI shall provide the services of a trained and experienced field supervisor to assist the installation contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation.

1. Field Manager

a. PCSI shall appoint a field services manager who shall be responsible for the coordination of all system check-out and startup activities, and who shall be immediately available to Engineer and Owner by phone or on site for the duration of this project.

B. Field Inspection at Delivery

1. The field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.

C. Field Calibration of Instruments

1. After each instrument has been installed, a technical representative of PCSI shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final settings. A typical instrument calibration report is attached to the end of the Section 13320 - Process Control System Testing.
2. The adjustments of calibrated instruments shall be sealed or marked, insofar as possible, to discourage tampering.
3. Instrument calibration shall be done before checkout of the system operation.

D. Training for Installation Personnel

1. The field supervisor shall train the installation personnel in reading and understanding submittal drawings, and in the correct installation and wiring procedures for the equipment. PCSI/ASP shall submit a Certification of training to the Owner and Engineer. Certification shall be issued for each installation personnel and shall state that the personnel completed the training.

E. Field Inspection Prior to Start Up

1. After installation and wiring connections are complete, the field supervisor, with additional PCSI's personnel shall verify that each external connection to the system is correctly wired and field process components and devices are functioning as intended. PCSI shall be responsible for completing the following scope of work.

   a. Analog Signals – Analog input signals shall be simulated at the transmitting source and verified to be received at the proper register address in the control system. Analog outputs shall be generated at the control system, and verified to be received with the correct polarity, at the respective receiving device.

   b. Discrete Signals – Discrete input and output signals shall be simulated and verified that they are received at the respective receiving device, and at the proper voltage.

   c. Devices by Other Suppliers – If interrelated devices furnished by other suppliers, under other contracts, or by Owner, such as valve actuators, motor controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

   d. System Check Out Report – The PCSI shall submit a written report on the results of such tests to Engineer. Additional documentation shall be furnished as requested by Engineer to establish responsibility for corrective measures. PCSI shall verify, in writing, to Engineer or Owner that PCSI has successfully completed the external connection check before beginning system startup or field acceptance testing.

F. Start Up Assistance – After the field supervisor has completed the system check and submitted his report, PCSI shall supply a factory-trained engineer to provide on-site start up assistance. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components.

END OF SECTION

SECTION 13306

APPLICATION ENGINEERING SERVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The PCSI (Process Control System Integrator)/ASP (Application Services Provider) shall furnish all Process Control System (PCS) programming, configuration, and related services required to achieve a fully integrated and operational system as specified herein and in other Division 13 Specification Sections.

B. All equipment shall be controlled in full conformity with the Contract Drawings, process control descriptions, specifications, engineering data, instructions, and recommendations of equipment manufacturer. Coordinate the control system for proper operation with related equipment and materials furnished by other suppliers under other Sections of these specifications and with related existing equipment:

1. Programmable Logic Controllers (PLC) programming, testing of PLC logic, and startup and training activities associated with the programmed PLC applications.
2. Configure PLCs provided for all equipment shown on the Drawings, except for control equipment shown being provided as part of a vendor package system.
3. Provide Human Machine Interface (HMI) and Operator Interface Terminal (OIT) graphic screens development, HMI and OIT software configuration, report development, and related software applications. The ISA standards shall be followed to develop the graphics.
4. Existing HMI and OIT graphic display screens will be modified to incorporate work defined in the Contract Documents.
5. Provide startup and training activities associated with the configured PCS system, including equipment provided by vendor package systems.
6. Provide configuration of the SCADA Historian Software.
7. Provide for and test communications and functionality between all connected devices such as PLCs, Remote Terminal Units (RTUs), and HMI software packages, including devices supplied by others such as power monitoring equipment, as depicted on the system architecture drawings in order to provide a comprehensive working system of data collection, storage and reporting.
8. PCSI/ASP to configure and test data collection and interactivity between all software packages, PCs, UPS units, and SNMP devices in order to provide a comprehensive working system of data collection and storage.

9. Coordinate with vendors supplying PLC control systems and other Ethernet devices to establish peer-to-peer communication monitoring programs (e.g., “watch-dog” or “heartbeat”) and to coordinate read/write passing of data via peer-to-peer communications.
10. Auxiliary and accessory programming structures necessary for proper system operation and performance shall be included whether or not they are shown on the Drawings.
11. The PCSI/ASP shall coordinate and schedule all testing procedures with the General Contractor, Engineer, and Owner.
12. Refer to the Owner’s PLC and HMI Standards.
13. Abide by Owner’s remote access policy when working on the SCADA system. If remote access is not allowed, then all the personnel must be on site during startup/commissioning.

C. All work shall be coordinated with plant operating personnel to minimize impacts on daily operation. Delays caused for any reason shall be noted and formally submitted to the Engineer and the Owner in the form of a letter.

D. Associated Sections

1. This section encompasses the services specified in the following sections:

SECTION	SPEC TITLE
13300-1	Process Control System General Provisions
13320-1	Process Control System Testing
13330-1	Process Control System Training
13340-1	Process Control System Input/Output List
13350-1	Process Control Descriptions

1.02 ASP’S QUALIFICATIONS.

A. Refer to the Section 13300 - Process Control System General Provisions.

1.03 WARRANTY

A. All application work shall be warranted from the date of Substantial Completion in accordance with Section 01760 – Warranties and be as specified in each specification sections.

B. Provide telephone technical support within 4 hours of warranty claim. If issues cannot be resolved by telephone, provide onsite technical support within 48 hours of warranty claim.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. The system specified herein shall perform the following generalized functions:

1. The system shall allow the operator to control equipment such as pumps and valves as defined in the control loop drawings and control loop descriptions. Role based permissions should be implemented with specific permissions and access level assigned to each group. Refer to the access/roles defined in the Owner's active directory.
2. Perform real-time process control, including proportional integral derivative (PID) control action, sequencing, process calculations, etc.
    a. All process control functions including PID, calculations, sequencing, timing, etc., shall be done in the process controller.
    b. The plant operators will not have the ability to change the PID parameters and setpoints that are tuned by the programmers and Engineer.
3. Collect, calculate, and store accurate, reliable operating information for present and future uses.
4. Assist remote site operating personnel by noting and communicating on normal operating conditions and equipment failures.
5. Accumulate and store equipment start counts for use in preventative maintenance.
6. Provide color graphic displays and reports for use by the system operating and supervisory personnel.
7. Provide trending for all analog values, discrete input/output change of states, and setpoints.
8. Provide control system diagnostics.
9. Provide process screen navigation.
10. The system shall allow the operator to manually control (by keyboard entry and mouse type pointing device) the status of pumps, valves, etc. (i.e., on off, open close, setpoint value, etc.) when viewing the appropriate graphic screen on the HMI.

3.02 COORDINATION MEETINGS

A. General

1. Meeting and workshop minutes shall be provided for each meeting to the Owner and Engineer within five (5) working days of the meeting date.

2. Sections shall be established within the minutes that clearly identify project team decisions and action items, and responsible party it pertains to.
3. Prepare and distribute an agenda noting the meetings a minimum of one week before the scheduled meeting date.
4. Final minutes shall be prepared and submitted to the Engineer following receipt of input from the meeting attendees.

B. PCSI/ASP Kick-off Meeting

1. Schedule and conduct a Kick-off meeting.
2. Refer to Section 13300-1 – Process Control System General Provisions for PCSI/ASP Kick-off Meeting requirements.

C. Preliminary Graphics Display and Control Narrative Workshop

1. PCSI/ASP to schedule and conduct a preliminary Graphics Display Workshop and Control Narrative workshop.
2. The purpose of this workshop shall be to present draft graphics for the Owner's and Engineer's review and feedback prior to creating the full set of graphics for review.
3. The PCSI/ASP shall submit an itemized list of information required to create a draft submittal of HMI and OIT display screens and PLC Control Narrative prior to this meeting. This request should also include any Supporting Documents required (Owner provides integrator with latest HMI configuration files, existing PLC program if needed, I/O list template if available, etc.).
4. Owner/Engineer meets with the PCSI/ASP to discuss control strategy and answer questions pertaining to control narratives and also discuss basic display layout and answer questions pertaining to graphic displays. The PCSI/ASP shall produce a basic set of graphic displays showing overall layouts and display hierarchy. These graphic displays consist primarily of major pieces of equipment and how they will be arranged. For repetitive graphics such as graphics for multiple process trains, include an example of the first graphic only for discussion. Include discussion of process and overview displays, examples of pop-ups, trends, and system navigation tools. This allows the Owner/Engineer an opportunity to confirm the information can be displayed as requested and to make adjustments.
5. PCSI/ASP to expect major comments, and to incorporate any changes resulting from those comments.
6. This workshop shall be held prior to submitting the graphic display and control narratives submittals.

D. Final Graphics Display, Control Narrative, and Historical Data Workshop

1. PCSI/ASP to schedule and conduct a final Graphics Display, Control Narrative, and Historical Data Workshop.
2. PCSI/ASP shall meet with the Owner/Engineer after submitting the Preliminary Graphic Displays to discuss final display layouts and answer questions pertaining to graphic displays.
    a. The PCSI/ASP shall display the HMI and OIT graphics and lead discussions to finalize displays.
    b. This meeting shall allow Owner/Engineer an opportunity to confirm the information can be displayed as requested and to make adjustments. PCSI/ASP to bring a working HMI system to allow for a live demonstration of the graphics. This meeting to be held at the Owner's facility.
3. PCSI/ASP shall discuss with Owner and Engineer the storage and management of historical data, format of daily, monthly and yearly reports for the development of data entry templates, and user interface displays for accessing and generating reports for the Project.
4. This workshop shall be held after return of the draft graphics submittal and incorporation of comments.

3.03 CONTROLLER PROGRAMS

A. All applications programs shall be developed in a structured manner per the ISA and IEC programming standards and shall follow an intuitive arrangement so that an instrumentation technician with basic programming knowledge will be able to understand. Programs shall utilize standard program templates or subroutines for repetitive logic such as equipment control, flow total calculations, equipment runtime calculations.

B. Make changes to the application programs and software configuration, based on comments during the submittals, the factory tests, the field tests, and during the commissioning process to meet the design intent, at no additional cost to the Owner.

3.04 GRAPHIC DISPLAYS - GENERAL

A. All displays shall contain and continuously update the displayed process variables, date and time of day. All process variables shall be displayed on their associated display(s) with correct engineering units as defined by the National institute Standards and Tests (NIST). All displays shall incorporate references to both instrumentation tag numbers and plant equipment numbers. Process variables shall display their associated data quality in same manner.

B. For the critical equipment as directed by the client, all operator commands related to controlling field devices or system attributes shall require multiple

keystrokes or mouse actions to protect against inadvertent operations. The operator shall receive confirmation of the selected point to be controlled, at which time a cancellation of the control can be affected.

C. Process graphic displays shall be based on the Piping and Instrumentation Diagrams (P&IDs), site plan drawings, mechanical drawings, and electrical drawings included in the Contract Documents. The graphic displays shall depict process flow streams, process structures, and all major items of process equipment and control devices in a schematic format. When situational awareness graphics are implemented, the graphic screens shall follow the City's Standards and Conventions if available and/or ANSI/ISA-101.01-2015 - Human Machine Interfaces for Process Automation Systems. Screens shall be developed using the four-level display hierarchy methodology as described in ISA-101.

D. All main graphical screens shall include a title bar, main graphic area, navigational buttons, and alarm summary bar.

1. Title bar shall be displayed on the top of each screen and include display name, description and time/date.
2. The main graphical area shall contain primary screen data in graphical format.
3. Navigational buttons shall include a minimum of main menu, trends, main alarm summary, and security log in.
4. The alarm summary bar shall display the last three valid alarms on the bottom of each screen.

E. Animation shall be provided to mimic level changes in tanks or vessels. Valve colors shall change when opened and closed.

F. Unless specifically noted, all timers, setpoints, alarm actuation levels, etc., shall be adjustable from the operator interface.

G. The system shall show field conditions with text that can alternate (i.e., OPEN/CLOSE, START/STOP, HIGH/LOW) and change color correspondingly. Field devices that are tri-state must be represented in three conditions.

H. Conditions in the field designated as alarm conditions shall report to the operator workstation, actuate an audible alarm, and provide a visual blinking image on the associated graphic page. All alarms and events shall be displayed on the screen and archived.

I. All interlocks that affect equipment operation shall be identified both by alarm and by HMI indication.

J. All analog inputs shall be checked for out of range (via high and low limit

checks) and alarmed.

K. The PCSI/ASP shall not change the HMI display layout or screen Navigation Toolbar.

L. All process flow streams shall be labeled, and color coded using the project color schedule. All structures and equipment shall be identified by name and appropriate equipment and loop tags.

M. Automatically record all alarm and events should any of the following sequences or events occur:

1. Date/Time entry
2. Limit changes
3. Any commanded or un-commanded change of any point
4. Alarm conditions
5. PLC comms loss
6. Operator login or logout activity

N. There may be additional general programming requirements that impact the HMI configuration. PCSI/ASP shall furnish up to an additional 30% quantity of HMI graphic screens and PLC ladder logic programming to provide controls and monitoring of any additional I/O at no additional cost to the Owner.

O. Hierarchical Structure

1. PCSI/ASP shall not change graphic display hierarchical structure.
2. Color conventions and animation are referred to HMI Display and Equipment Global Objects that include analog valve displays, digital point status displays, setpoint entry, equipment animations, equipment color, equipment popup screen, alarm and event display, and trend screens.
3. PCSI/ASP shall use standard HMI displays and equipment global objects for instruments and equipment.
4. All developed HMI displays and equipment shall be in compliance with existing HMI color conventions and animations.

3.05 SPECIFIC GRAPHIC SCREENS

A. At a minimum, provide the following types of graphic screen indicated below.

1. Plant Overview screen shall include a site plan representation, indicating the geographic location of each process, and each building.
2. Main menu screen shall be developed to link to all screens and process areas. The screen shall be a complete and logical listing of the names and number of all screens.

3. Overall plant process block flow diagram screen shall show all major processes in block form with flow arrows.
    a. Each block shall include a text description of key individual treatment processes.
    b. Navigational buttons to the individual treatment processes shall be performed by pressing on the text description.
4. Individual treatment process screens shall graphically screen key process variables and equipment.
    a. No operator entries shall be done from these screens. Individual process flow screens for each process shall include all process components, including tanks, pumps, blowers, mixers, drives, flow meters, valves, mechanical devices, as well as manual shutoff and isolation valves.
    b. These diagrams shall be generally depicted from the P&ID's and there shall be at least 1 screen per P&ID on average.
5. Individual unit process screens depicted from the P&ID's are used for control and screen of each major item of process equipment, process variables, and control devices, including pumps, blowers, valves, gates, mixers, drives etc.
    a. Navigational buttons shall consist of the P&ID's flow arrows to other individual unit processes. The unit process screens shall provide the ability for the operator to go to individual equipment popup screens.
    b. These diagrams shall be generally depicted from the P&ID's and there shall be at least 2 screens per P&ID on average.
6. Popup screens shall be provided for each piece of equipment to start/stop equipment, open / close valves, implement automatic control, adjust set points, establish and adjust tuning parameters, set alarm limits and initiate a sequence.
7. PLC system diagnostic screens, showing the operational status, and fault conditions of all PLC components, including processors, I/O modules, OIT's, power supplies and UPS units.
8. Communications diagnostic screens, showing the details of network status, communications status of all major components including Operator Workstations, peripheral devices and network components.
9. Maintenance screens shall screen the raw value for each analog and digital I/O point in the system. They shall also allow the operators and maintenance personnel to enter an override value for an analog point that is then used by the system instead of the value read from the input card / communications link.
10. Trend screens with the capability to screen up to eight, operator assigned, analog and/or digital process variables. Each analog value will be shown

on a trend screen.

11. Main alarm summary screen shall screen the following information on each alarm: Time, tag name, description, alarm type, current value and status.
    a. An acknowledge alarm button shall acknowledge all new unacknowledged alarms.
    b. The acknowledged and unacknowledged alarms shall be different colors.
    c. Acknowledged alarms shall clear automatically after the condition is corrected.
12. Analog variable screens showing a tabular summary of all plant process variables, in operator assigned groupings.

3.06 SECURITY

A. All HMI process operational functions, such as an operation button or alarm acknowledgement, shall be configured and implemented with security to prevent unauthorized access. The system shall allow authorized changes to system operation through defined user accounts and password verification. PCSI/ASP shall configure the security areas and functions to points and displays.

B. Coordinate with Owner user account information, including login name and password for each account.

C. Security levels of "display only", "operator mode", "supervisor mode", and "engineer mode" shall be available through assignable passwords.
    1. On system startup, the "display only" security level shall automatically be entered. In the "display only" mode, information is available to be displayed on the screen but no changes may be made.
    2. In the "operator mode", changes may be made to process set points, times, etc.; however, the overall control concepts may not be modified.
    3. In the "supervisor mode", all operator functions can be modified and any special reports or critical process set points (data can be modified; however, the overall control concepts may not be modified).
    4. In the "engineer mode" level, all user modifiable parameters of the system shall be available for modification.

3.07 ALARM/EQUIPMENT STATUS REPORTING

A. The alarm log shall display all alarms as they occur. The alarm message shall include the time of occurrence, tag name, tag number, and whether it is a low, high, or failure alarm. When the point in alarm returns to normal, the time, point identification number, and return to normal shall be displayed. All

reports shall include the plant equipment number of the associated device.

B. The equipment status shall be logged whenever a change in status occurs (i.e., start, stop). The equipment status log shall include the time, equipment name, tag number, and the particular change in status.

3.08 HISTORICAL DATA MANAGEMENT

A. The following features shall be provided for processing and storage of system historical data:

1. Each system point (analog or discrete, real or pseudo) shall have the capability of being historically logged. A point shall have the capability of being deleted from historical log at any time. It shall be easy to add or delete system points using minimal keystrokes.
2. All process analogs and discrete points and setpoint values, and all flow totals and run time indications of all primary process equipment motors shall be sampled and stored in the historical data management system.
3. Data Processing – The real time instantaneous values shall be stored in a historical log file on the hard disk at defined sampling rates.
4. Data Correction – Historical data shall be manually modifiable by personnel with appropriate security levels. Such data shall be differentiated from actual monitored values on reports, in the database and in trends.
5. Data Quality – Data Quality flags shall propagate to the next higher level of the history based on user selectable percentage determining tolerance levels for averages and totals. If the percentage of suspect data exceeds the tolerance level, the suspect data flag propagates to the next higher level. Maximums and minimums shall be taken from good data.

3.09 REPORTS

A. Quantity and format of reports shall be determined at the Graphics Display, Control Narrative, and Historical Data workshop, and as a minimum shall include shift, daily, monthly and yearly reports.

B. The system shall be able to generate reports from on-line historical data files or prompt the user for the appropriate archived data files.

C. Reports shall be initiated automatically based upon time of day or manually upon operator request.

D. User interface displays for report generation shall be developed with easy recall of reports by entering time:day:year target values.

E. User interface displays shall allow the operator to define the destination of the report (e.g., display, printer, computer file, etc.) and when it is to be printed

(e.g., immediately, on demand, or automatically at a specified time).

F. It shall be possible to print quality tags alongside the value.

G. Values for which there are no data available shall be identified with a special character. Thus, only values which are actually zero shall be printed as such.

H. Operational Report Types. The following operational report types shall be provided with the system:

1. Shift Operation Summary Report:
    a. An operator-adjustable time interval shift operation report shall summarize plant operation from the start and finish time of operation.
    b. The report format shall consist of the following: correct date, plant name, report name, page number, group headings, subheadings, point identification, and engineering units.
2. Daily Operation Summary Report
    a. The daily operation report shall summarize plant operation for the previous day. The printed information shall be the stored values (not averages) including scanned, lab, and manually entered data.
    b. The report format shall consist of the following: correct date, plant name, report name, page number, group headings, subheadings, point identifications, and engineering units.
    c. The daily minimum, average, maximum, and total where applicable shall also be calculated and printed for each point and stored.
3. Monthly Operation Summary Report:
    a. The monthly operation summary report shall summarize plant operation for the previous calendar month.
    b. The report format shall be arranged so that the first several pages shall conform to the requirements of the state regulatory agencies and may be separated from the rest of the monthly operation report for transmittal to the regulatory agency.
    c. The report format shall be similar to the daily operation summary report and shall consist of the following: month and year, plant name, report name, page number, group headings, sub-headings, point identifications, and engineering units.
    d. Monthly minimum, average, maximum, and totals, where applicable, shall also be printed for each column of points printed.
4. Annual Operation Summary Report:
    a. The annual operation summary report shall summarize plant operation for the previous calendar year. The report shall consist of scanned data, lab data, and manually entered data.

b. The format of the report shall be identical with the monthly operation summary report except for replacing month with year in the heading and replacing date with calendar month.

END OF SECTION

SECTION 13315

PROCESS CONTROL SYSTEMS SUBMITTALS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the submittal requirements for the process control system.

B. Associated Sections

1. This section encompasses the equipment and services specified in the following sections:

SECTION	SPEC TITLE
13300-1	Process Control System General Provisions
13306-1	Application Engineering Services
13320-1	Process Control System Testing
13330-1	Process Control System Training
13340-1	Process Control System Input/Output List
13350-1	Process Control Descriptions
13350-10	Booster Pump Station
13420-1	Programmable Logic Controllers
13500-1	Instruments
13510-1	Flow Measurement
13530-1	Level Measurement
13550-1	Pressure Measurement

1.02 GENERAL

A. General submittal requirements:

1. Refer to Section 01300 – Submittal Procedures for general submittal requirements.
2. Submittals shall demonstrate that the equipment and services to be furnished comply with the provisions of these specifications and shall provide a complete record of the equipment as manufactured, delivered, installed, and placed in service.
3. Submittals shall be complete and include equipment dimensional, assembly, and installation drawings, wiring and schematic diagrams, connection details, specifications, ranges, installation requirements, and

data covering the materials used and the parts, devices and accessories forming a part of the system furnished. Submittals consisting of only general sales literature shall not be acceptable.

4. Individual drawings and data sheets submitted at random intervals will not be accepted for review.
5. Equipment tag numbers or identifications used on the Drawings shall be referenced where applicable.
6. Shop drawing title blocks shall include, as a minimum, the PCSI/ASP's registered business name and address, Owner and project name, drawing name, revision level, and shall identify personnel responsible for the content of the drawing.
7. Incomplete or partial submittals not complying with the submittal requirements outlined in this section will be rejected without review.
8. Submittals shall be bound in separate three-ring binders. Each binder shall include an index and sectional dividers. Each section shall have a uniquely numbered tab divider, and each component within each section shall have a separate binder tab divider. The cover and edge of each volume shall contain the information as specified in Section 01730 – Operation and Maintenance Data. All drawings shall be reduced to a maximum size of 11-inches by 17-inches and Z-folded to 8.5-inches by 11-inches for inclusion inside the binder. Maximum binder thickness shall be 3 inches.
9. All electronic submittals shall be submitted in a searchable PDF format. The PDF file shall include an index and be bookmarked by section and individual device or component. Submittals that are not bookmarked shall be rejected without review.
10. PLC Programs shall be submitted in the native format of the PLC as suggested by the manufacture and as a PDF printout.
11. The Engineer and Owner will review shop drawings a maximum of two times. The cost of review for the second resubmittal and for each subsequent review by the Engineer and Owner shall be charged to the Contractor in the form of a deductive change order.

B. Submittal Order

1. First Stage Submittals
    a. Qualifications and Deviation List, Project Plan, and Schedule submittal may be submitted together.
    b. Qualifications Submittal – Within 30 calendar days after Notice to Proceed.
    c. Deviation List, Project Plan, and Schedule (PCSI and ASP) - Within 45 calendar days after Notice to Proceed.

d. Submittal requirements are specified within this section.

2. Second Stage Submittals
   a. Submit on second stage submittals only after the first stage submittals have been approved.
3. Third Stage Submittals
   a. Submit on third stage submittals only after the second stage submittals have been approved.
4. Fourth Stage Submittals
   a. Preliminary O&Ms shall be submit prior to any factory testing and/or field installation of equipment and instruments.
   b. Submittal requirements are specified within this section.
   c. Refer to Section 01730 – Operation and Maintenance Data for general O&M requirements.
   d. Separate submittals shall be made for each submittal listed below in the order they are shown.

Submittal Group Title	Individual Submittal Title	First Stage	Second Stage	Third Stage	Fourth Stage
Qualifications and Deviation List, Project Plan, and Schedule submittal	13300 Process Control System General Provisions - Qualifications Submittal	√			
	13300 Process Control System General Provisions - Deviation List, Project Plan, and Schedule	√			
Control Panel Hardware Submittal	13420 Programmable Logic Controllers		√		
Field Instruments Submittal	13500 Instruments		√		
	13500A Attachment A - Instrument Device Schedule		√		
	13511 Magnetic Flow Meter		√		
	13530 Level Measurement		√		
	13542 Level Switches		√		
	13542 Gauge Pressure Transmitters		√		
Process Control and Input/Output (IO) List Submittal	13340 Process Control System Input/Output List			√	
	13340A Attachment A - PCS Input/Output List			√	
	13350 Process Control Descriptions			√	

Submittal Group Title	Individual Submittal Title	First Stage	Second Stage	Third Stage	Fourth Stage
Process Control Graphics HMI Screens and Controller Program Submittal	13306 Application Engineering Services			√	
Testing Plan Submittals (PCSI and ASP)	13320 Process Control System Testing			√	
Training Plan Submittals (PCSI and ASP)	13330 Process Control System Training			√	
Spares, Expendables, and Test Equipment Lists Submittal	13300 Process Control System General Provisions			√	
Process Control System Operations and Maintenance (O&M) Manuals	13300 Process Control System General Provisions				√
	13306 Application Engineering Services				√

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 SUBMITTAL REQUIRMENTS

A. Qualifications Submittal

1. Detailed information on staff and organization to show compliance with the Quality Assurance requirements of this section.
2. Submit details of personnel assigned to the project and the organizational structure including the PCSI/ASP's project manager, project engineer, lead project technicians, quality assurance reviewer, etc. Include project roles, and contact information, and key individual resumes and specify in

writing their commitment to this project.

3. The Qualifications submittal shall be submitted and approved before any other submittals from this section will be accepted. Failure to meet the minimum requirements shall be grounds for rejection as a PCSI. The Qualifications Submittal shall, as a minimum, contain the following:
    a. Copies of ISA CCST Level 1 certificates for all field technicians or resumes demonstrating a minimum of 10 years of verifiable plant start-up experience.
    b. Notarized statement from the firm's financial institution demonstrating ability for the firm to meet the obligations necessary for the performance of the work.
    c. Copy of UL-508 certificate for panel fabrication facilities.
    d. Project references for water or wastewater projects as defined in the Quality Assurance paragraphs.
    e. Documentation to demonstrate the ability to complete this project including resumes of key staff, financial capacities, details on engineering, design, fabrication, and field service capacity, and location of staff responsible for responding to the site within four hours to resolve startup issues.

B. Deviation List, Project Plan, and Schedule Submittal
    1. Deviation List Submittal
        a. Submit a detailed list of any exceptions, functional differences, or discrepancies between the system proposed by PCSI and this specification.
        b. The Deviation List shall consist of a paragraph-by-paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception, the proposed substitution, and details of any contract financial credits offered so that an evaluation may be made by the Engineer.
        c. If no exceptions are taken to the specifications or drawings the PCSI shall make a statement as such. If there is no statement by the PCSI, then it is acknowledged that no exceptions are taken.
        d. The acceptability of any device or methodology submitted as an "equal' or "exception" to the specifications shall be at the sole discretion of the Engineer.
    2. Project Plan Submittal
        a. The PCSI/ASP Project Plan submittal shall be submitted prior to scheduling the PCSI/ASP Kickoff Meeting.
        b. The Owner/Engineer will not accept subsequent submittals until the PCSI/ASP Project Plan submittal is approved.

c. A brief and concise description of the proposed system by the PCSI/ASP showing the understanding of the project work, including major hardware and software components, proposed work schedule, startup, and coordination.

d. A preliminary system architecture drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships to each other and other systems.

e. Approach to work including replacement of existing equipment with new, switchover (Maintaining Plant Operations during system transition), startup and commissioning, testing, training, and any other tasks as required by these specifications.

f. Preliminary list of HMI software, PLC software, and PLC hardware, including version numbers, solely to determine compliance with the requirements of the Contract Documents prior to beginning development of system programming. Review and approval of software and hardware systems as part of this Project Plan stage shall not relieve the PCSI of meeting all the functional and performance requirements of the system as specified herein. Substitution of manufacturer or model of these systems after the submittal is approved is not allowed without Engineer approval.

g. Sample formats of the shop drawings to be submitted and in conformance with the requirements of the Specifications. At a minimum include samples of panel fabrication drawings, loop, and I/O wiring diagrams.

h. Preliminary coordination meeting agendas as specified herein.

i. Training plan outline.

3. Project Schedule Submittal

a. Project schedule shall be prepared in Gantt chart format clearly showing task linkages for all tasks and identifying critical path elements. PCSI schedule must be based on and coordinated with the General Contractor’s and ASP’s project schedule to meet all project milestones including all meetings, field installation, testing, and start-up milestones in their schedule.

b. The project schedule shall illustrate PCS related major project milestones including the following:

1) Schedule for all subsequent project submittals. Include the time required for Contractor submittal preparation, Engineer's review time, and a minimum of two complete review cycles.

2) Proposed dates for all project coordination meetings.

3) Hardware purchasing, fabrication, and assembly (following approval of related submittals).

4) Software purchasing and configuration (following approval of related submittals).
5) Shipment of instrument and control system equipment.
6) Installation of instrument and control system equipment.
7) Dates and duration of all required testing. Testing schedule shall include submittal approval of test procedures with a minimum of 30 days prior to testing commencement.
8) Schedule shall include submittal of documentation of completed testing activities for review and approval by the Engineer prior to equipment shipment, startup, or subsequent project work.
9) Schedule for system switchover, startup, and/or going on-line for each major system. At a minimum include the schedule for each process controller and HMI server/workstation provided under this Contract.
10) Schedule for all training including submittal and approval of O&M manuals, factory training, and onsite training.
11) Incorporate time constraints for ASP activities as defined in Section 13306 – Application Engineering Services.

C. Hardware and Software Submittal
1. General
a. Submittals including only general sales literature will not be accepted.
b. Shop Drawing and manufacturer data sheet submittals shall be complete, fully demonstrating compliance with all Specification requirements and features.
c. Selected features and options shall be clearly indicated by highlighting, circling, or pointing arrows to each selection that makes up the manufacturer ordering/model number code.
d. Physical details shall include, at a minimum, physical layout and dimensions, construction details, NEMA rating, hazardous area rating, electrical power requirements and consumption, communication ports, signal connection ports, heat dissipation and installation requirements.
e. Functional details shall include, at a minimum, details of internal features such as communication protocols, control functions, programming parameters, jumper settings, software features, and licensing requirements.
f. Provide Ethernet switch port assignment schedules for any modifications to the existing switches and for the new switches. Existing switch port assignment table is available upon request.

g. Manufacturer warranty details shall include, at a minimum, the length of term, level of on-site support (if any), and speed of replacement.

2. System Architecture Diagram (PCSI)

   a. Submit a complete system architecture diagram showing in schematic form, the interconnections between major hardware components including control centers, panels, power supplies, consoles, computer and peripheral devices, networking equipment, PLC processors, PLC I/O modules, local operator interfaces, and equipment. The system architecture shall be complete and shall depict all required cables, media type between components, raceway requirements (conduit, wireway, etc.), raceway identification, network protocol used at each network level, details on connection requirements such as cable pin-outs, port numbers, and rack slot numbers. The intent of this specification requirement is for the PCSI to develop a diagram that is complete in every aspect to allow purchase of all required equipment by part number, and to allow a qualified technician to interconnect all equipment without having to refer to additional manuals or literature. Minimum sheet size shall be 11x17 (inch) however use of a larger sheet size or more than one sheet is also acceptable.

3. Software

   a. Provide a complete software list or Bill of Materials (BOM) including all software items and quantities to be supplied by the PCSI.

   b. Details of all stand-alone computer software packages required by the Specifications.

   c. Submit details of the process controller, local operator graphic panel, and HMI software application packages to be used for each piece of equipment. All standard and optional features to be provided shall be indicated.

   d. Submit details of all other required software packages to be provided including, but not limited to, network/communication utility (OPC, SNMP, UPS), field instrument utility (HART, Fieldbus, etc.), and computer software (MS Office, Adobe Acrobat, etc.).

   e. Provide details of all software license and software support license agreements indicating quantities and assignment of licenses to the Owner.

   f. An Installation Work Plan shall be submitted following these requirements:

      1) Submit a cable pull and splicing work plan a minimum of 45 days before initiation of any cable pulling. The cable pulling and splicing work plan must be approved a minimum of 15 days before pulling cable. Include the following:

a) Pull tension calculations.
b) Detailed description of pull operation methods for all conduit runs.
c) Tolls and equipment to be used for cable installation and testing.
d) Physical location of equipment setup and type.
e) Exact locations of splice points.
f) Safety and manual assist cable-pulling operations.
g) Detailed schedule for pulling and testing cables.
h) The name and qualifications of the supervisory personnel directly responsible for the installation of the conduit system.
i) Sample fiber optic cable test sheets.
j) All signed test sheet results.

g. Test Reports shall be submitted following these requirements:
1) Submit the results of all specified testing.
2) Test forms shall include the following information at a minimum:
a) Test type.
b) Test location.
c) Date and time the test results were saved in the memory of the tester.
d) Wavelength.
e) Index of refraction.
f) Cable identification.
g) Fiber type.
h) Fiber number in accordance with the specified naming convention.
i) Fiber color.
j) Result of the value of the tested parameter.
k) The overall Pass/Fail evaluation of the link-under test including the attenuation worst-case margin (margin is defined as the difference between the measured value and the test limit value).
l) Electronic documentation of general and detailed test information.
3) Furnish hard copy and electronic copy for all Optical Time Domain Reflectometer (OTDR) traces.

4) Submit certification that the fiber optic cable has passed each testing stage.
    a) Submit separate documentation for each testing stage result.

D. Instrumentation Submittal:
1. The submittal shall include a complete instrument list or Bill of Materials (BOM) including all instruments to be supplied by the PCSI. Instrument tagging shall adhere to the loop numbering and tagging scheme shown within the Drawings and Specifications.
2. Submit complete documentation of each field instrument using an ISA S20 (TR20) style data sheet format in electronic and 8.5x11 (inch) print format. Instrument data sheets shall include the following information, at a minimum:
    a. General (Header):
        1) Instrument type (Title).
        2) Specification reference.
        3) Document revision number and date.
    b. Sensor/Controller/Field Meter/Transmitter:
        1) Sensor, Controller, Field Meter, and Transmitter details shall include, at a minimum:
            a) Physical: Size and dimensions of equipment. Materials of construction for enclosure and wetted parts.
            b) Ratings: NEMA rating, hazardous area classification and temperature ratings for the equipment.
            c) Sizing Calculations: Provide details of equipment selection based on any manufacturer required sizing, calculations, configurations, etc.
            d) Electrical Requirements: Note voltage, power requirements (two-wire or four-wire) and power consumption data.
            e) Inputs/Outputs: Input and output characteristics and types.
            f) Heat Dissipation: Note manufacturer’s listed heat dissipation value for the equipment.
            g) Installation Details: Mounting details in sufficient detail to determine compliance with the requirements of the Contract Documents.
            h) Internal Features: Communication protocols, control functions, programming parameters, jumper settings, software features, and licensing requirements.

i) Range, size, and graduations in engineering units.

j) Complete manufacturer/model number.

c. Accessories and Special Requirements:

1) List all required accessories, special options, software, tools and calibration equipment to be provided. Provide complete manufacturer/model numbers for each accessory and/or manufacturer option codes.

2) Submit details of digital network interface requirements including type, wiring requirements, configuration details, device addressing, and process control system interface.

d. Instrument Tag List:

1) Provide specific project information for all instruments, of each type, included on the ISA-S20 (TR20) style data sheets. Instrument information shall include, at a minimum:

a) Plant equipment number and ISA tag number per the P&IDs and/or Engineer's Instrument List.

b) Instrument description including plant area/system location.

c) Instrument scale range and engineering units (or setpoints for discrete instruments).

d) Project drawing reference(s).

E. I/O List Submittal

1. The PCSI/ASP generates a detailed I/O list to be submitted to the Engineer for review and approval.

a. The ASP CANNOT progress in the PLC development process before receiving official approval of this submittal.

b. Engineer shall verify naming convention conforms with PLC and HMI Procedures.

c. The I/O List shall follow the I/O List format and be submitted as a Microsoft Excel electronic document and 8-1/2 inch by 11-inch hard copy.

d. The I/O List shall include all active points and spare points for the system.

e. The I/O list shall be arranged such that each PLC, RTU, or control panel system has a dedicated worksheet. At a minimum, I/O worksheet tables shall include the following information:

1) Tag name(s): The identifier assigned to a device that performs a function in the control system. As part of this information, the loop

number of the tag shall be broken out to allow for sorting by loop. PLC and HMI tag names shall be the same.

2) Description: A description of the function of the device (text that includes signal source, control function, etc.) Include the text “Spare Points” for all I/O module points that are not connected to equipment.
3) Engineering Range/State: The range in engineering units corresponding to an analog 4-20 mA signal, or the state at which the value of the discrete points is “1.”
4) Engineering Units: The engineering units associated with the Analog I/O.
5) Alarm Limits: Include alarm limits based on the control descriptions and the drawings.
6) Alarm State:
7) Alarm Priority: Include alarm priority based on OWNER’s preference.
8) HMI Update Rate
9) Historical Logging
10) Modbus Address: The Modbus address for peer-to-peer data points.
11) PLC and HMI Address
12) Wiring Information: The physical wiring termination points at the PLC designated by rack, slot, and channel.
13) Signal Type: use DO - Discrete Output, DI - Discrete Input, AO - Analog Output, AI - Analog Input, PI - Pulse Input, or PO – Pulse Output.
14) Instrument Limits
15) State Text: Designation of the “on” and “off” state values for discrete points.
16) Output Type

F. Control / Network Panel Drawings Submittal
   1. Provide a complete list of all panels to be supplied.
   2. Provide a complete hardware list or Bill of Materials (BOM) including all hardware to be supplied by the PCSI. For each hardware component, submit a cover page that lists, at a minimum, date, specification number, product name, manufacturer, model number, location(s), and power required.
   3. Catalog cuts for supplied Programmable Logic Controller (PLC), process

controller equipment, remote telemetry units (RTU), including central processing units, redundancy units, memory, input modules, output modules, modems, network interface modules, mounting racks, and power supplies. Submit descriptive literature for each hardware component that fully describes the units being provided.

4. Panel drawing submittals shall be complete, fully demonstrating compliance with all specification requirements and features. Panel drawings shall include, but not be limited to, the following for each panel supplied:
   a. Panel Layout and Bill of Materials (with quantity)
   b. Panel Power Wiring Schematics
   c. Panel Input/Output Wiring Diagrams
5. Drawings shall be furnished for all panels, consoles, and equipment enclosures specified in related PCSI/ASP sections. Panel assembly and elevation drawings shall be drawn to scale and detail all equipment in or on the panel. Panel drawings shall be at least 11x17 (inch) print size. As a minimum, the panel drawings shall include the following:
   a. Interior and exterior panel elevation drawings to scale
   b. Nameplate schedule
   c. Conduit access locations
   d. Panel construction details
   e. Cabinet assembly and layout drawings to scale. The assembly drawing shall include a bill of material on the drawing with each panel component clearly defined. The bill of material shall be cross-referenced to the assembly drawing so that a non-technical person can readily identify any component of the assembly by manufacturer and model number.
   f. Fabrication and painting specifications including color (or color samples).
   g. Panel control schematics and interconnection diagrams detailing the electrical connections of all equipment in and on the panel. Diagrams shall include power and signal connections, UPS and normal power sources, all panel ancillary equipment, protective devices, wiring and wire numbers, and terminal blocks and numbering.
   h. Point to point I/O wiring diagrams depicting wiring within the panel as well as connections to external devices. The diagram shall identify all device terminal points that the system connects to, including terminal points of equipment not supplied by the PCSI, Wiring labeling used on the drawings shall match that shown on the Contract Documents or as developed by the ASP and approved by the Owner/Engineer. Field device wiring shall include the device ISA-tag and a unique numeric

identifier. PLC I/O wiring shall be numbered with rack number, slot number, and point number. Two-wire and four-wire equipment shall be clearly identified, and power sources noted. Submit final wire numbering scheme for approval by the Owner/Engineer. Point-to-Point drawings shall be 11x17 (inch) minimum in size.

i. Submit construction details, NEMA ratings, intrinsically safe barrier information, gas sealing recommendations, purging system details, etc. for panels located in hazardous locations or interfacing to equipment located in hazardous areas.

j. Heating and cooling calculations for each panel supplied indicating conformance with cooling requirements of the supplied equipment and environmental conditions. Calculations shall include the recommended type of equipment required for both heating and cooling.

k. Submit evidence that all control panels shall be constructed in conformance with UL 508 and bear the UL seal confirming the construction. Specify if UL compliance and seal application shall be accomplished at the fabrication location or by field inspection by UL inspectors. All costs associated with obtaining the UL seal and any inspections shall be borne by the Contractor and included in the contract.

l. Submit seismic calculations and anchoring requirements in conformance with Division 01.

m. Process Controller Memory Sizing Calculation:

1) Submit memory sizing calculations for controller program memory including additional memory beyond the memory available for process control applications. This includes scratch pad or “housekeeping” programs, additional overhead for programming formats, redundancy, etc.; and shall be included in the total memory sizing calculation. Submit calculations verifying that the total memory provided will be adequate for the specified requirements.

n. Power Supply Sizing Calculations

1) Submit calculations to show compliance with specified power supply sizing requirements of the Specifications.

G. Detailed Control Narratives Submittal:

1. This submittal shall cover all of the application programs developed to implement the control functions specified herein and in the contract documents.

2. The process control schemes shall be developed based on information from the specifications. This submittal shall include the following, as a minimum:

a. A brief scope of the control function.

b. List of all scanned inputs to the control function.

c. A short narrative of the control strategy.

d. Any assumptions made in developing the program.

e. I/O database list showing all inputs and outputs (i.e., AI, DI, AO, DO), calculated points and pseudo points associated with the control function.

f. PLC communication and hardware monitoring.

g. List of all operator inputs/outputs to and from the control function. A description of the operation of any panels shall be described as it relates to the control function.

h. All anticipated failure contingencies shall be described in detail.

i. All applications programs shall be developed in a structured manner and shall follow an intuitive arrangement. Programs shall utilize standard program templates or subroutines for repetitive logic such as equipment control, flow total calculations, and equipment runtime calculations. All applications programs shall be submitted in 8.5-inch x 11-inch format. All programs shall be fully annotated throughout to facilitate diagnosis by instrumentation technicians with basic programming knowledge.

j. This submittal shall also include copies of the PLC I/O configuration tables and I/O reference usage table. In addition, any special switch settings or hardware configuration requirements, such as communications port configurations, shall be described in detail and submitted.

H. Process Graphics Submittal:

1. Submit all proposed graphic displays, trends, and logs to support the control strategy narratives.

2. Submitted graphic displays and trends shall be no less than 8.5-inch x 11-inch full-color prints.

3. For the existing graphic screens, the modified graphics shall include a description of all the changes.

4. The quantity of graphic displays to be provided shall be as required to depict all monitoring and control requirements defined herein and in the contract documents. All processes and equipment shown on the drawings shall be shown in a similar manner. The graphic displays shall represent all process flow paths and all associated equipment units, pumps, meters, valves, gates, feed systems, and auxiliary systems whether monitored or not.

5. Predefined trend displays shall be developed for easy recall using index

display or standard display recall buttons. Predefined trends shall be developed for all analog inputs. Grouping of analog inputs shall be as defined by the Owner/Engineer. A maximum of eight points shall be assigned to a trend.

6. For graphics that will be duplicated several times for similar equipment or purposes, submit a typical display for only the first equipment.
7. Each HMI process operation function, such as operation button and alarm acknowledgement functions, shall be configured with the proper security privileges to prevent unauthorized operation.
8. ASP shall configure the security areas and functions to points and displays.

I. Controller Program Submittal:

1. Submit software logic and documentation for function block language used for the application engineering effort.
2. Program documentation shall include individual rung, network, and/or command descriptions with abundant comments to clearly identify function and intent of each code segment. Link between “coil” and “contact” shall be clearly presented, the function of each timer described, the purpose of each subroutine call labeled and defined, etc. Program documentation shall be sufficiently clear to allow determination of compliance with the process control requirements included in the Process Control Loop Descriptions.
3. The submittal shall demonstrate that all logic provided under this project follows the same structure and format and reflects a common programming approach. Any custom subroutines or function blocks shall be described in detail and include all inputs with allowable ranges, outputs, and internal logic of the block.
4. Submit details of control system communication. Submit hardware and software configuration information in sufficient detail to verify performance of the communication system as detailed herein and on the drawings. Include descriptions of drivers and the impact of drivers on controller memory configuration. Any specific communication block memory addresses shall be defined.
5. Submit a memory usage report for the controller. This report shall indicate both used and unused memory addresses. Include constant and variable memory assignment records that tabulate area, location, number, and description of each numeric constant or variable stored in memory.
6. Submit method and logic for special housekeeping programs and routines including redundancy, clock synchronization, value scaling, alarm handling, archiving, etc. Submit information for all digital systems including controllers and HMI equipment.

7. Submit cross reference index of I/O allocation, controller memory address, HMI graphic systems address, and HMI graphic screen where the I/O point will appear. Every physical I/O point as well as calculated or virtual I/O required for the implementation of the process scheme shall be included.
8. Make additional changes to the software configuration, beyond those identified in the initial draft submittal, based on comments during the factory and field tests and during the commissioning process as required.

J. Historical Data:
   1. ASP shall provide a Historical Data submittal including the following:
      a. List of existing equipment tags to be modified by this project shall be submitted.
      b. List of all signals to be historically collected and stored, including sampling rate and duration for which data will be immediately accessible through the system.

K. Testing Plan Submittal:
   1. Testing Plan submittal shall include all the testing requirements in Section 13320 - Process Control System Testing, for both the PCSI and ASP.
   2. This submittal will outline the approach to testing the various components of the system to validate the HMI and PLC programming meets the requirements. In addition, sample test forms and procedures shall be included to allow the Owner/Engineer an opportunity to comment on format and content prior to the ASP developing the detailed test procedures. Additional components of this submittal shall include test approval and punch list procedures.
   3. Test Procedure Submittals: Submit the procedures proposed to be followed for each test. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests. Include sign-off forms for each testing phase or loop with sign-off areas for the ASP, PCSI, Engineer, and Owner. Submit separate procedures for each test phase.
   4. Test Documentation: Upon completion of each required test, document the test by submitting a copy of the signed-off test results. Testing shall not be considered complete until the signed-off test results have been submitted and favorably reviewed. Submittal of other test documentation, including “highlighted” wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.
   5. Each loop shall have a Loop Status sign-off form to organize and track its inspection, adjustment, and calibration. These forms shall include the following information and check-off items:

a. Project Name.
b. Loop Number.
c. Detailed test procedure indicating exactly how the loop will be tested including all required test equipment, necessary terminal block numbers, and simulation techniques required.
d. Tag Number for each component.
e. Check-offs/sign-offs for each component.
    1) Tag/identification.
    2) Installation.
    3) Termination – wiring.
    4) Termination – tubing.
    5) Calibration/adjustment.
f. Check-offs/sign-offs for the loop.
    1) Panel interface terminations.
    2) I/O interface terminations.
    3) I/O signal operation.
    4) Inputs/outputs operational: received/sent, processed, adjusted.
    5) Total loop operation.
    6) Space for comments.
    7) Sign-off and date fields for the Contractor, the Owner/Engineer, and the PCSI/ASP.

6. Each active analog subsystem element shall have a Component Calibration form. These forms shall have the following information including space for data entry:
    a. Project Name.
    b. Loop Number.
    c. ISA Tag Number and I/O Module Address.
    d. Manufacturer.
    e. Model Number/Serial Number.
    f. Summary of Functional Requirements. For example:
        1) For Indicators: Scale ranges.
        2) For Transmitters/Converters: Scale and chart ranges.
        3) For Computing Elements: Function.
        4) For Controllers: Action (direct/reverse) control modes (PID).

5) For Switching Elements: Unit range, differential (FIXED/ADJUSTABLE), reset (AUTO/MANUAL).

6) For I/O Modules: Input or output.

g. Calibrations; for example:

1) For Analog Devices: Required and actual inputs and outputs at 0, 50, and 100 percent of span.

2) For Discrete Devices: Required and actual trip points and reset points.

3) For Controllers: Mode settings (PID).

4) For I/O Modules: Required and actual inputs or outputs for 0, 50, and 100 percent of span.

h. Space for comments.

i. Sign-off and date fields for the Contractor, the Owner/Engineer, and the PCSI.

L. Training Plan Submittal

1. Training Plan submittal shall include all the training requirements in Section 13330 - Process Control System Training, for both the PCSI and ASP.

2. This submittal shall provide an overview of the proposed PCSI/ASP training for the Owner’s operations and maintenance staff. The training program shall be coordinated with the Owner’s staff so that the schedule and content meet their needs. The approved submittal shall be used as the basis for development of training manuals that will be provided to all attendees.

3. Upon receipt of the Engineer's comments on the preliminary training plan, submit the specific proposed training plan. The training plan shall include:

a. Definitions, objectives, and target audience of each course.

b. Schedule of training courses including proposed dates, duration, and locations of each class.

c. Submit outlines of the specific training, resumes of trainers, prerequisite requirements for each class, and general samples of handouts for review.

d. Complete copy of all proposed handouts and training materials. Training information shall be bound and logically arranged with all materials reduced to a maximum size 11x17 (inch), then folded to 8.5x11 (inch) for inclusion into the binder.

M. Spares, Expendables, and Test Equipment Lists Submittal:

1. This submittal shall include for each Subsystem:

a. A list of, and descriptive literature for, spares, expendables, and test equipment as specified in Division 13.

b. A list of, and descriptive literature for, additional spares, expendables, and test equipment recommended by the manufacturer. PCSI shall furnish all standard recommended spare parts as indicated in the Manufacturer's instruction manuals, for each component in the process control system.

c. Unit and total costs for the additional spare items specified or recommended for each subsystem.

N. Process Control System Operations and Maintenance (O&M) Manuals:

1. Submit in accordance with Section 01730 – Operation and Maintenance Data. O&Ms shall be provided in both hardcopy and electronic copy.

2. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment and software furnished. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features.

3. The O&M manuals shall, at a minimum, contain the following information:

a. Table of Contents shall be provided for the entire manual with the specific contents of each volume clearly listed. The complete Table of Contents shall appear in each volume.

b. Instrument and Equipment Lists

1) The instrument and equipment lists shall be developed in Microsoft Excel format and provided as a hardcopy in the O&M and electronically as part of the final PDF.

2) Instrument list for all devices supplied including tag number, description, specification section and paragraph number, manufacturer, model number, serial number, range, span, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.

3) An equipment list for all non-instrument devices supplied listing description, specification section and paragraph number, manufacturer, model number, serial number, location, manufacturer phone number, local supplier name, local supplier phone number, completion year replacement cost, and any other pertinent data.

4) Certified calibration data for all flow metering devices.

5) Submit Factory calibration result for the instruments.

4. Equipment O&M Information:

a. Data sheets shall be provided for all field and non-field instrumentation devices. Provide a cover page for each device, piece of equipment, and OEM software that lists date, specification number, product name, manufacturer, model number, location(s), and power required. Preferred format for the cover page is ISA-TR20.00.01-2001(updated in 2004-2006), general data sheet; however, other formats will be acceptable provided they contain all required information.

b. Vendor O&M documentation for each device, piece of equipment, or OEM software shall be either new documentation written specifically for this project or modified standard vendor documentation. All standard vendor documentation furnished shall have all portions that apply clearly, indicated with arrows, circles or highlighted. All portions that do not apply shall be neatly lined out or crossed out. Groups of pages that do not apply at all to the specific model supplied shall be removed.

c. Any component requiring custom software configuration or dip switch settings, that information shall be included along with the corresponding data sheets and O&M information.

d. Provide the record documentation of the system audit as specified in Section 13320 - Process Control System Testing.

e. Include the calibration forms developed as specified in Section 13320 - Process Control System Testing.

f. Include reports detailing cable acceptance testing specified in Section 13430 - Network and Communication Equipment. Test reports shall include the following information for each Ethernet cabling element tested:

   1) Results of each testing criteria listed in Section 13430 - Network and Communication Equipment Specification.

   2) Circuit ID number (Cable Tag ID).

   3) Overall pass/fail indication.

   4) Date and time of test.

   5) Contractor signature certifying that the test results are accurate and complete.

g. Include reports detailing network device configurations. Include all connections, addresses, and port assignments for each configured network device.

h. Include OTDR trace plots for all fiber optic cables.

5. Software O&M Information:

   a. All operations and maintenance procedures for the applications software and system configuration shall be furnished.

b. All software applications, programs, and configuration files shall be provided on electronic media disks independent of computer hard disk files. Files shall be provided on machine-loadable media capable of being used by a technician to restore the installed software using the existing hardware and software programs.

c. The manuals shall contain operating and maintenance data written specifically for this project.

d. At a minimum, the following information shall be provided in the manuals.

1) A comprehensive index.

2) All documentation from previous submittals updated to reflect the as-built system.

3) Detailed service, maintenance, and operation instructions for each item supplied, including procedures for backing up files and archiving historical data.

4) List of personnel to be contacted for warranty and emergency services, including name, address, telephone number, pager or cell phone number, fax number, and email address.

5) Printouts of every graphic display with all dynamic points referenced.

6) Printouts of all configuration files.

7) Printouts of all documented PLC programs.

8) Electronic media disks containing all HMI, PLC, and other custom-configured files used on the Project.

9) Final PID Loop Tuning Parameters for all associated control loops.

6. As-Built Drawings

a. As-built drawings shall be complete and including all drawings and diagrams specified in this section. Drawings shall include all wiring, fabrication, and interconnection drawings for all equipment the PCS is connected to including terminal points of equipment not supplied by the PCSI.

b. As built documentation shall include information from submittals, as described in this Specification and the other process control system specifications and be updated to reflect the as-built system. Errors in or modifications to the system resulting from the Factory and/or Functional Demonstration Tests shall be incorporated in this documentation.

7. Original Licensed Software

a. Submit original software provided under this Contract. Submit original paper based and electronic documentation for all software provided.

b. Submit license agreement information including serial numbers, license agreements, User Registration Numbers and related information.

c. Provide media in software sleeves within O&M manual.

8. Control Panel Operations Narrative Manual:

   a. Record documentation shall have a Control Panel Operations Narrative manual for every PLC control panel. Provide a hardcopy of each manual to be placed in its respective enclosure. The information to be included in this manual:

      1) Describe the purpose of PLC.

      2) Control Descriptions.

      3) PLC Tag Info: A brief explanation of each tag and its function.

      4) PLC Input/Output List.

      5) Control Panel layout.

      6) Control Panel Wiring Diagrams (including all the communications between the PLC modules and the terminal blocks).

      7) Printout of the PLC Function Block codes of the PLC program.

      8) Soft copies of the PLC code and configuration information.

9. Electronic O&M Information:

   a. Provide an electronic version of all equipment manuals and data sheets, along with any software back-up of configuration files. Electronic documents shall be supplied in PDF format.

   b. Provide electronic files for all custom-developed manuals including training manuals. Text shall be supplied in both Microsoft Office format and PDF format.

   c. Provide electronic files for all drawings produced. Drawings shall be in AutoCAD ".dwg" format and in PDF format. Drawings shall be provided using the AutoCAD eTransmit feature to bind external references, pen/line styles, fonts, and the drawing file into individual zip files.

   d. Each computer system hardware device shall be backed up onto DVD after Substantial Completion and shall be turned over to the Owner.

   e. If specified in the training section, provide digital copies of all training videos. Videos shall be in a format that is readable by standard DVD players and by standard PC DVD drives. Format shall be a minimum of 1920 by 1080 pixels and shall include sound.

END OF SECTION

SECTION 13320

PROCESS CONTROL SYSTEMS TESTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the testing requirements for all process equipment, instruments, and devices that are monitored, controlled, or otherwise part of the process control system (PCS) and is detailed in the contract drawings and those specified in 13300, Process Control System General Provisions.

B. Testing of vendor supplied equipment connecting to the PCS shall adhere to the same testing requirements herein. The PCSI/ASP shall coordinate with the vendor(s) for integration and testing of their equipment into the PCS.

C. PCSI/ASP shall coordinate all testing activities with the Owner, Engineer, Contractor, all affected subcontractors, equipment suppliers, and vendors.

D. PCSI/ASP shall provide all labor, materials, equipment, and incidentals required to complete all testing listed herein.

E. PCSI/ASP shall perform all test listed per testing requirements as specified herein.

1. Factory Testing
    a. Unwitnessed Factory Test (UFT)
    b. Witnessed Factory Acceptance Test (WFAT)
2. Testing of Existing System
    a. Pre-Functional Demonstration Tests (PFDT)
3. Field Testing
    a. Unwitnessed Operational Readiness Test (UORT)
    b. Witnessed Operational Readiness Test (WORT)
    c. Functional Demonstration Test (FDT)
    d. Site Acceptance Test (SAT)

F. PCSI/ASP shall provide to the Engineer certified calibration / recalibration (for existing Instruments) reports for field instruments and devices specified or shown on the drawings immediately upon completion of calibration.

1. Receipt of any calibration / recalibration certificates shall in no way imply acceptance of any work or of instruments supplied.
2. Each calibration / recalibration certificate shall be signed and dated by an authorized representative of the PCSI/ASP. Completed certificates shall

be submitted to the Engineer through the submittal process.

3. A typical instrument calibration certificate form is included at the end of this Section.

1.02 TEST – GENERAL

A. The PCSI/ASP shall test all PCS equipment at the factory prior to shipping to site. To the extent possible all PCS equipment shall be tested as a single fully integrated system at the factory.

B. Each test shall be performed in the cause-and-effect format. The person administering the test shall initiate an input (cause) and, in which the system's or subsystem's produce the correct result (effect).

C. Whether explicitly stated on the test procedures, the Engineer reserves the right to test or retest all specified functions to determine compliance with the functional requirements. Additional testing by Engineer to determine compliance with the specified requirements shall be performed at no additional cost to the Owner. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

D. Test using actual process variables, equipment, and data when possible. If it is not practical to test with actual process variables, equipment, and data, variables, equipment, and data shall be simulated.

E. PCSI/ASP shall prepare and submit testing procedures to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications.

F. PCSI/ASP shall notify Engineer and Owner in writing at least 14 days before the proposed testing date.

G. If any test is concluded unsuccessfully, the test shall be repeated.

H. Equipment shall not be shipped to the project site until the Engineer and/or Owner has received all Factory Acceptance testing submittals and approved the system ready to ship in writing.

I. Correction of Deficiencies

1. Deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet such requirements at no additional cost to Owner.

2. Testing shall be repeated after correction of deficiencies are made until the test is deemed successful. This work shall be performed at no additional cost to Owner.

1.03 RELATED WORK

A. Refer to Section 13300 – Process Control System General Provisions.

B. Refer to Section 13310 – Application Engineering Services.

1.04 SUBMITTALS

A. PCSI/ASP shall submit all testing documents in one submittal. Testing documents shall include the following:

1. Testing Procedures

a. Detailed procedures proposed to be followed for each tests specified herein. The test procedures shall serve as the basis for the execution of the required tests to demonstrate that the PCS meets, and functions as specified.

b. Sample test forms and procedures to be included to allow the Owner/Engineer an opportunity to comment on format and content prior to the PCSI/ASP developing the detailed test procedures.

c. Structure procedures in an orderly and easy to follow manner to facilitate an efficient and comprehensive test. Test shall be in a cause-and-effect format.

d. Procedures shall include test descriptions, forms, and checklists to be used to control and document the required tests.

e. The PCSI/ASP shall include punch list forms with the test procedures to document issues that arise during the testing. Punchlist forms, at a minimum, shall include a specification cross reference; an issues description field; a resolution description field; and a sign-off area for the PCSI/ASP, Owner, and Engineer.

f. Indicate all pre-testing setup requirements, all required test equipment, and simulation techniques to be used.

g. Include the demonstration and validation under normal operating conditions and under various failure scenarios as specified in Contract Documents.

2. Testing Status signoff forms

a. Develop project specific I/O Status and Automatic Control Strategy signoff forms to be used during factory and field testing to organize and track each loop's inspection, adjustment, calibration, configuration, and testing status and sign off. Include sign-off forms for each testing phase showing all loops with sign-off areas for the PCSI/ASP and Owner/Engineer.

b. Separate forms for factory and field testing can be used, or they can be combined, at the discretion of the PCSI/ASP.

c. Testing Status signoff forms shall provide space to note any deficiencies and whether the test passed or failed.

d. Example forms are shown in the Appendices.

3. Testing Documentation

a. After completion of each required test, the signed Testing Status signoff forms shall be submitted to the Owner/Engineer within 10 days of completion of each test.

b. Testing shall not be considered complete until the signed-off forms have been submitted and approved.

c. Submittal of other test documentation, including "highlighted" wiring diagrams with field technician notes, are not acceptable substitutes for the formal test documentation.

B. Testing may not start until all Testing Submittals have been approved.

1.05 COST OF TRAVEL

A. Scheduled tests will only be attended once by Owner and/or Engineer. If test is not successful, all subsequent tests will be performed at PCSI/ASP's expense.

B. PCSI/ASP shall reimburse Owner and Engineer for all labor and expenses incurred in connection with attending repeated test necessitated by system failure or inadequate preparation.

C. Reimbursement will go through the Owner with Engineer invoicing Owner for all expenditures associated with retesting.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. The PCSI/ASP shall conduct factory test prior to equipment shipping to the project site.

B. The PCSI/ASP shall conduct field test once all equipment and devices that makeup the PCS has been installed.

C. All tests shall be specifically addressed in Test Procedure submittal.

D. All tests shall be recorded on the approved Test Status Signoff forms.

3.02 FACTORY TESTS

A. Unwitnessed Factory Acceptance Test (UFAT)

1. Purpose of UFT is for PCSI/ASP to verify the functionality, performance,

and stability of the system prior to Engineer and/or Owner attending Witnessed Factory Acceptance Testing (WFAT).

2. Temporary network connections will be required to confirm the network configuration. Temporary wiring of primary elements, final control elements, and field-mounted transmitters is not required.
3. All panels, consoles, and assemblies shall be inspected and tested to verify their conformance with related submittals, Specifications, and Drawings.
    a. All panels and enclosures being provided shall undergo a thorough inspection to verify integrity of cabinet enclosures, frame structures, paint work, and finish, etc. Review panel drawings to ensure they accurately reflect panel layout and wiring.
    b. Perform a system audit to verify all components have been staged for test and have been documented properly with correct model numbers, serial numbers, etc. The following audit documentation shall be provided at WFAT and submitted as part of O&M Manual Documentation:
        1) For each workstation and server, list of all software installed (including the operating system), with software revision number, software improvement modules or patches installed, license number and owner registration information, warranty period, vendor and local distributor names and contacts.
        2) For each microprocessor-based component connected to control communication backbone in system (PLCs, managed switches, protocol converters, communication cards on final field devices, radios, etc.), list firmware revision, vendor and local distributor information, and system, warranty information, configuration parameters (e.g., communication settings, fail position settings, etc.)
    c. The PCSI/ASP shall load, configure, and test any specialized Virtual software on the Computers, Switches, and other equipment.
    d. Application software shall be loaded on the PLCs and HMI computers and the entire system shall be tested. The test shall be conducted to verify readiness for the WFAT.
    e. Panel wire pull tests shall be performed to ensure all wiring has been secured with appropriate torque to prevent wires from coming loose.
    f. UPS shall be tested to verify that the UPS switches power correctly while keeping all UPS powered loads online. Testing of UPS to determine if they have been sized correctly to maintain specified run time shall be performed during field testing.
    g. A complete I/O point checkout shall be performed on all I/O to verify proper operation of input/output points from panel terminations to HMI

and OIT nodes. All I/O includes all wired spare points. I/O checkout shall be recorded on Test Status Signoff form.

1) Discrete Inputs – Points shall be jumpered at field terminal blocks in PLC panels to verify proper status in HMI and OIT nodes.

2) Analog Inputs – Points shall be connected to a signal generator at field terminal blocks in PLC panels to verify proper status in HMI and OIT nodes. Signals shall be verified at zero percent, 25 percent, 50 percent, 75 percent, and 100 percent of full scale.

3) Discrete Outputs – Points shall be tested by manipulating the output from HMI and OIT nodes. Signal shall be verified by connecting a digital multimeter to measure continuity at field terminal blocks.

4) Analog Output – Points shall be tested by manipulating the analog output value at the HMI and OIT. Signal shall be verified by utilizing a digital multimeter to measure current or voltage generated at field terminal blocks. Signals shall be verified at zero percent, 25 percent, 50 percent, 75 percent, and 100 percent of full scale.

h. All control strategies shall be verified using simulation or other means to verify that all logic performs as expected. Verify faults and logical failure conditions for control strategies such instrument failures, equipment failures, loss of communication between HMI Server and PLC, loss of peer-to-peer communication, out of range testing (over and under scale) for analog inputs, and all other strategies specified in Section 13350 – Process Control Descriptions.

i. For each subpanel, inspection shall include but not be limited to, I/O subsystem physical layout, power supply sizing and mounting, cable routing, wire runs across hinges properly installed, fans and blowers unobstructed and mounted to maximize air flow, power conditioning correctly installed, and overall layout and installation of components meets manufacturer's recommendations and standard industry accepted practices.

4. Upon successful completion of UFAT, PCSI/ASP shall submit a record copy of the UFAT Status Signoff form. Once the form is submitted, PCSI/ASP shall notify Engineer and Owner in writing that system is ready for WFAT. No other notice of FAT will be accepted. Engineer and/or Owner shall schedule a test date within 30 days of receipt of this submittal.

B. Witnessed Factory Acceptance Test (WFAT)

1. Purpose of WFAT is for PCSI/ASP to demonstrate to the Engineer and/or Owner the PCS’s functionality, performance, and stability as a complete integrated system. Successful completion of the WFAT warrants the PCS

equipment to be shipped to the project site.

2. The WFAT shall be conducted at the PCSI/ASP's facilities.
3. As part of the WFAT the PCS system shall run for a minimum of 48 hours without any failures. Any unanticipated failures may result in an overall unsuccessful WFAT.
4. PCSI/ASP shall provide the following documents during the WFAT for reference and signoff.
    a. A set of Contract drawings and specification including addenda and change orders.
    b. A copy of all approved equipment submittals relevant to the test.
    c. Fresh set of approved panel drawings and wiring diagrams.
    d. Master copy of the PCSI/ASP developed factory testing signoff forms and testing procedures.
5. Daily schedule during these tests shall be as follows:
    a. Morning meeting to review the day's test schedule.
    b. Scheduled tests and signoffs.
    c. End of day meeting to review day's test results and to review or revise next day's test schedule.
    d. Unstructured testing period by Engineer and/or Owner.
6. Test to be performed during the WFAT shall include but not be limited to the following:
    a. Perform a system audit to verify all components have been staged for test and have been documented properly with correct model numbers, serial numbers, etc.
        1) For each workstation and server, list of all software installed (including the operating system), with software revision number, software improvement modules or patches installed, license number and owner registration information, warranty period, vendor and local distributor names and contacts.
        2) For each microprocessor-based component connected to control communication backbone in system (PLCs, managed switches, protocol converters, communication cards on final field devices, radios, etc.), list firmware revision, vendor and local distributor information, and system, warranty information, configuration parameters (e.g., communication settings, fail position settings, etc.)
        3) All panels and enclosures being provided shall undergo a thorough inspection to verify integrity of cabinet enclosures, frame structures,

paint work, and finish, etc. Review panel drawings to ensure they accurately reflect panel layout and wiring.

b. Demonstrate operability of the Virtual Servers and workstation.
    1) The ability to share data between operator workstations and servers.
    2) The ability of each workstation to print reports on all network printers.
    3) The operability of all mass storage equipment.
    4) Demonstrate the ability of each workstation to print alarm/events on the local printer.
c. Demonstrate procedure for backing up the computer system (including PC and PLC); reload using a backup; and completely restoring a PC and/or PLC from a backup.
d. Demonstrate operability of the control data communication network under anticipated full load conditions, communication failure, and automatic recovery.
e. For each sub-panel, inspection shall include, but not be limited to, I/O subsystem physical layout, power supply sizing and mounting, cable routing, wire runs across hinges properly installed, fans and blowers (if required) unobstructed and mounted to maximize air flow, power conditioning correctly installed, and overall layout and installation of components meets manufacturer's recommendations and standard industry accepted practices.
f. Panel wire pull tests shall be performed to ensure all wiring has been secured with appropriate torque to prevent wires from coming loose.
g. UPS shall be tested to verify that the UPS switches power correctly while keeping all UPS powered loads online. Testing of UPS to determine if they have been sized correctly to maintain specified run time shall be performed during field testing.
h. A complete I/O point checkout shall be performed on all I/O to verify proper operation of input/output points from panel terminations to HMI and OIT nodes. All I/O includes all wired spare points. I/O checkout shall be recorded on Test Status Signoff form.
    1) Discrete Inputs – Points shall be jumpered at field terminal blocks in PLC panels to verify proper status in HMI and OIT nodes.
    2) Analog Inputs – Points shall be connected to a signal generator at field terminal blocks in PLC panels to verify proper status in HMI and OIT nodes. Signals shall be verified at zero percent, 25 percent, 50 percent, 75 percent, and 100 percent of full scale.

3) Discrete Outputs – Points shall be tested by manipulating the output from HMI and OIT nodes. Signal shall be verified by connecting a digital multimeter to measure continuity at field terminal blocks.

4) Analog Output – Points shall be tested by manipulating the analog output value at the HMI and OIT. Signal shall be verified by utilizing a digital multimeter to measure current or voltage generated at field terminal blocks. Signals shall be verified at zero percent, 25 percent, 50 percent, 75 percent, and 100 percent of full scale.

i. All control strategies shall be verified using simulation or other means to verify that all logic performs as expected. Verify faults and logical failure conditions for control strategies such instrument failures, equipment failures, loss of communication between HMI Server and PLC, loss of peer-to-peer communication, out of range testing (over and under scale) for analog inputs, and all other strategies specified in control strategy document.

7. All deficiencies identified during these tests shall be corrected and re-tested prior to completing WFT or shipment of panels to jobsite as determined by Engineer and/or Owner.

8. Upon successful completion of WFAT, PCSI/ASP shall submit a record copy of the WFAT Status Signoff form.

3.03 TESTING OF EXISTING SYSTEM

A. Pre-Functional Demonstration Test (PFDT)

1. Purpose of PFDT is for PCSI/ASP to verify the functionality, performance, and stability of the existing system to document the existing conditions prior to installation of the replacement process control system.

2. At the beginning of project and prior to installation of the process control system components and prior to performing the electrical or PLC replacement work, the existing system shall be tested (inspect and document terminations, calibrations, field wire routing to the end device, functionality of connected equipment and instruments, circuit power type and source, loop functionality, field equipment functionality, and controls functionality) as installed to document conditions prior to construction activities.

3. The PFDT shall be performed by PCSI/ASP, and Owner. The PCSI/ASP shall facilitate testing under the direction of Owner personnel and provide sufficient staff to cover onsite PLC and HMI inspections, and documentation.

4. Loop/Component Inspections and Tests: The entire system shall be checked on a loop-by-loop and component-by-component basis.

a. The Loop/Component Inspections and Tests shall be implemented using Owner/Engineer approved forms and checklists. PCSI/ASP shall submit testing forms for approval as part of the testing plan and prior to testing.

1) Each loop shall have a Loop Status Report to organize and track its inspection. These reports shall include the following information and check-off items with spaces for sign-off by the Contractor and Owner:

a) Project Name, test date, PCSI/ASP name, and lead PCSI/ASP technician name.

b) PLC name, PLC loop tags (arranged by input/output channel or type), PLC loop description, PLC loop range, PLC loop HI/LO state, setpoint, etc.

c) Check-offs/sign-offs for the loop: Panel interface terminations; I/O interface terminations; I/O signal operation; inputs/outputs operational (received/sent, processed, adjusted); total loop operation; process controller scaling and adjustment; and space for comments.

d) Total loop operation: Provide space for comments.

e) Equipment status: Provide space for comments.

b. Computer-Manual (i.e., Remote-Manual) start/stop, open/close commands of all devices controlled by the SCADA system shall be verified by the PCSI/ASP during the PFDT.

c. Upon completion of the PFDT, the PCSI/ASP shall submit a record copy of the test results to the Owner/Engineer and request the scheduling of Operational Readiness Test.

3.04 FIELD TESTS

A. Unwitnessed Operational Readiness Test (UORT)

1. Purpose of UORT is to check that process equipment, instrument installation, instrument calibration, instrument configuration, field wiring, control panels, and all other related system components are ready to monitor and control the processes. This test will determine if equipment is ready for operation.

2. This test shall take place after the installation of all PCS components and prior to FDT and startup. Prior to starting this test, relevant process equipment shall be installed and mechanically tested, instruments installed, control panels installed, and field wiring complete.

3. Unwitnessed ORT (UORT) shall be performed prior to the Witnessed ORT (WORT).

4. ORT shall be conducted by the PCSI/ASP, Contractor, subcontractors,

equipment vendors, and any others that are responsible for process equipment being monitored or controlled by and through the PCS.

5. All deficiencies found shall be corrected and retested by PCSI/ASP prior to commencement of the FDT.
6. Required Documents for Test
    a. Master copy of the PCSI/ASP developed field Testing Signoff forms
    b. Testing Procedures
    c. Calibration forms
7. PCSI/ASP shall maintain Sign-off forms and Calibration forms at job site and make them available to Engineer/Owner at any time.
8. The following tests shall be performed as part of ORT
    a. Instrument calibration, configuration, and set-up.
    b. Input/Output (I/O) Testing from field device to PLC and to HMI/OITs.
    c. Testing of individual process control strategies.
9. Instrument calibration, configuration, and set-up
    a. Calibrate, configure, and set-up all components and instruments to perform specified functions. This included tuning all process equipment PID loops.
    b. Calibration form
        1) PCSI/ASP shall maintain a calibration form in field to document any component or instrument requiring dip switch settings, calibration, or custom configuration. These forms shall provide a summary of the actual settings used in the field to allow an Instrument technician to replace the device entirely and configure it to function as it did before.
        2) Calibration information shall be added to Instrument data sheet, shall be added to a copy of manufacturer's standard "Configuration Sheet", or a separate form shall be created.
            a) If a separate form is used, the form shall list Project Name, Loop Number, ISA Tag Number, I/O Module Address, Manufacturer, Model Number/Serial Number, Output Range and Calibrated Value.
        3) Required information shall include but not be limited to:

a) Discrete Devices: Actual trip points and reset points.

b) Instruments: Any configuration or calibration settings entered into the instrument

c) Controllers: Mode settings (PID).

d) I/O Modules: Dip switch settings, module configuration (if not documented in native programming documentation).

4) Any device that allows configuration files to be backup of to a laptop, the PCSI/ASP shall make configuration files to be available to Engineer and/or Owner for inspection. Submit backup files as part of Final System Documentation.

10. I/O Testing

a. PCSI/ASP in conjunction with Contractor shall test all signals under process conditions. Each I/O shall be tested from the field device to the PLC terminal block and from PLC to HMI/OIT. Simulation of I/O, such as jumpering inputs, will not be accepted unless authorized by Engineer.

b. The following I/O tests shall be performed:

1) Discrete Input – At device or instrument, change signal condition from inactive to active state. Observe results on all indicators within loop such as HMI screens, OIT screens, pilot lights, horns, beacons, etc.

2) Analog Input – Test analog signal over entire engineering range at various intervals including 0, 25%, 50%, 75%, and 100% as well as on increasing and decreasing range. Observe results on all indicators within loop such as HMI screens, OIT screens, recorders, digital indicators, etc.

3) Discrete Output – Signals shall be tested by switching equipment to manual control at the HMI and OIT nodes and turning output on or using other means to turn output on, then verify equipment responds accordingly.

4) Analog Output – Test analog signal over entire engineering range at various intervals including 0, 25%, 50%, 75%, and 100% as well as on increasing and decreasing range by switching equipment to manual control at HMI and OIT nodes and manipulating the variable output, then verify equipment responds accordingly.

11. Testing of Automatic Control Strategies

a. All automatic control strategies shall be verified using actual process equipment and instruments, or other means, to verify logic performs as expected. Verify faults and logical failure scenarios for control strategies such as instrument failures, equipment failures, loss of communication between HMI Server and PLC, loss of peer-to-peer

communication, out of range testing for analog inputs, loss of power, and all other strategies specified in control strategy document.

b. Repeat all systems tests specified under factory testing.

c. UPS shall be tested to verify UPS switch power correctly while keeping all UPS powered loads online. Test UPS capacity by switching offline power to UPS and verify if they maintain specified run time.

d. Panels modified by this Contract shall test the internal control panel temperature under full running conditions to ensure proper cooling/ventilation is being provided.

e. Upon successful completion of UORT, PCSI/ASP shall submit a record copy of test results and request scheduling of WORT.

B. Witnessed Operational Readiness Test (WORT)

1. Purpose of WORT is to check that process equipment, instrument installation, instrument calibration, instrument configuration, field wiring, control panels, and all other related system components are ready to monitor and control the processes. This test will determine if equipment is ready for operation.

2. Before scheduling the WORT, the PCSI/ASP shall determine through his own UORT and through their internal quality assurance program that the process control system is ready for the witnessed operational readiness testing by the Owner and Engineer.

3. The WORT shall follow all requirements listed for the UORT.

4. PCSI/ASP shall submit to the Engineer the complete and signed Testing Status forms indicating that all test have been completed and is ready for the Functional Demonstration Test.

C. Functional Demonstration Test (FDT)

1. Purpose of the FDT is to certify that the entire PCS is ready for operation by demonstrating each specified function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis. FDT is to be witnessed by the Engineer and/or Owner.

2. FDT shall be performed after successful completion of the ORT and individual process startup, and prior startup and the SAT. The FDT shall be completed in a single testing period. The testing period may span over several days.

3. Failure of five (5) percent of I/O tested or more than one (1) hour of troubleshooting during the FDT will deem test as unsuccessful and the FDT shall be rescheduled once the system is ready for retesting.

4. All test shall be the same as specified under ORT, except that the entire installed system shall be tested and all functions demonstrated using live field-based data to the greatest extent possible.

5. Required Documents for Test:
    a. Set of panel drawings and wiring diagrams from WFAT and ORT with corrections noted.
    b. A set of Contract drawings and specification including addenda and change orders.
    c. Signed-off master copy of the PCSI/ASP developed field testing signoff forms.
    d. Testing procedures.
    e. Copy of completed calibration forms.
    f. One copy of all O&M Manuals for PCSI/ASP supplied equipment.
6. Daily schedule during FDT shall be as follows:
    a. Morning meeting to review the day's test schedule.
    b. Scheduled tests and signoffs.
    c. End of day meeting to review day's test results and to review or revise next day's test schedule.
    d. Unstructured testing period by Engineer and/or Owner.
7. The system shall operate for 96 continuous hours without failure before this test shall be considered successful. The start of the continuous hours will commence after all testing has been completed.
8. Punch list items and resolutions noted during the test shall be documented on the Punch list/Resolution form. In the event of rejection of any part or function test procedure, the PCSI/ASP shall perform repairs, replacement, and/or retest within 10 days.
9. Upon successful completion of the FDT, PCSI/ASP shall submit a record copy of test results to the Engineer and/or Owner as specified and request the scheduling of the SAT.

D. Site Acceptance Test (SAT)
1. Purpose of the SAT is to verify that the PCS capable of functioning as specified and intended for an extended period and without major malfunctions.
2. The SAT duration shall be 30 consecutive days under full plant process operations. SAT will be deemed successful if there are no major non-field-repairable malfunctions.
    a. Any malfunction which cannot be corrected within 24 hours of occurrence by PCSI/ASP personnel, or more than two similar failures of any duration, will be considered a non-field-repairable malfunction.
    b. Any malfunction during the SAT shall be analyzed and corrected by the PCSI/ASP. The Engineer and/or Owner will determine whether any

such malfunctions are sufficiently serious to warrant a repeat of this test.

c. In the event of any part or function of the SAT being rejected, the PCSI/ASP shall perform repairs or replacement within 5 days of the event. Upon completion of repairs by the PCSI/ASP, the SAT will be re-started from the date which the PCSI/ASP successfully corrected the malfunction(s) and the Engineer and/or Owner have accepted and signed off on the repairs.

d. Malfunctions shall include any logic sequencing that is not operating per the specifications.

3. During the SAT plant operations and PCSI/ASP shall be present and available to address any potential issues that may impact the overall system process.

   a. The PCSI/ASP shall provide personnel who has intimate knowledge of the system, its functionality, hardware, and software.

   b. When PCSI/ASP personnel is not onsite, they shall be available by phone, with their phone number given to the Owner for immediate assistance. The PCSI/ASP personnel shall be able to be onsite within 4-hours of a notification by the Owner.

4. While this test is proceeding, Engineer and Owner shall have full use of system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes. Plant operations shall remain responsibility of Owner and decision of plant operators regarding plant operations shall be final.

5. During the SAT no software or hardware modifications shall be made to the system without prior approval from Owner or Engineer.

6. Upon successful completion of the SAT and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete and the one-year warranty period shall commence.

E. CERTIFICATE OF INSTALLATION

1. Following successful completion of the SAT, PCSI/ASP shall submit a Certification of Installation to the Owner and Engineer. Certification shall state that the process control system installation has been completed in conformance with plans and specifications. Certification shall be on PCSI/ASP corporate letterhead and signed by an officer of the company.

END OF SECTION

CALIBRATION CERTIFICATE							
Instrument Name & Service							
Tag Number/Loop Number							
Instrument Location							
Manufacturer							
Model Number							
Adjustable Range							
Calibrated Range							
Remarks							
Installation Per Manufacturer's Requirements?				Yes		No	
Installation Per Contract Documents?				Yes		No	
If "No", explain							
Calibration Test:							
	Input (Units)			Output (Units)		Accuracy	
0%							
25%							
50%							
75%							
100%							
Switch Test	Switch Point Upscale			Switch Point Downscale		Setting Deadband	
Setpoint 1							
Setpoint 2							
Setpoint 3							
I hereby certify that the above information is correct and accurate, to the best of my knowledge, and that the instrument indicated above has been supplied, installed, calibrated, and tested in accordance with the manufacturer's recommendations and the Contract Documents, unless otherwise noted. Receipt of this Calibration Certification shall in no way imply acceptance of any work or instrument supplied as a part of this Contract.							
PCSI/ASP’s Signature:				Date:			

SECTION 13330

PROCESS CONTROL SYSTEMS TRAINING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the training requirements for process equipment, instruments, and devices that are monitored, controlled, or otherwise part of the process control system (PCS) and is detailed in the contract drawings and those specified in 13300 – Process Control System General Provisions.

B. PCSI shall coordinate all training activities with the Owner, Engineer, Contractor, all affected subcontractors, equipment suppliers, and vendors.

C. PCSI shall include training for equipment items not manufactured by the PCSI. This training shall be provided by authorized manufacturer's representative as set forth within this section and related sections of the specifications.

D. The training and instruction shall be directly related to the system being supplied.

E. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.

F. PCSI shall conduct training courses for Owner personnel. Training shall be provided for the following, and as outlined under this specification section:

1. Instruments
2. Process Control System Hardware
3. Process Control System Software
4. SCADA Network System

G. Unused specified training courses/sessions shall be returned as a credit to the contract.

1.02 TRAINING – GENERAL

A. Training Summary

1. The following training courses listed in the summary table shall, as a minimum, be provided:

Training Course Description	Minimum Course Duration (hours)	Maximum Number of Trainees per Course	Number of Times Course to be Given	Intended Audience
Manufacturer's Training				
Instrument Manufacturer Training – Flow, Level, Pressure, Temperature	1	2	1	Maintenance
PCSI and ASP's Onsite Training				
SCADA System Training - Prior to/at Witnessed Operational Readiness test (WORT) (PCSI/ASP)	1	4	1	Operations
SCADA System Training - After Functional Demonstration Test (FDT) (PCSI/ASP)	1	4	1	Operations
PLC Hardware and Software Training (PCSI/ASP)	1	2	1	Maintenance
Instruments PCSI Training (PCSI)	1	2	1	Maintenance
Instruments Training - Operator familiarity (PCSI)	1	4	1	Operations
Network System Training (PCSI/ASP)	1	4	1	Maintenance, Administrator

2. Definitions of audience roles
   a. Administrator - personnel responsible for maintaining the HMI / SCADA system.
   b. Maintenance - personnel responsible for maintaining the field controller hardware and instrumentation system.
   c. Operations - personnel responsible for daily plant operations.
   d. Management - non-daily operations personnel

B. Owner shall select Technicians, Operators, Engineers, and Managers of the facility to be trained on new processes and equipment included within the project scope. The training courses shall address operation, maintenance, and troubleshooting of the system provided. The courses shall be designed specifically for the type of personnel attending, such as operators, engineers, etc.

C. PCSI standard training courses may be used to meet the training objectives specified. Where standard courses do not meet these objectives, additional coursework shall be developed.

1. Clock hour requirements for each level of training shall be as listed herein. A "clock hour" is defined as one hour of instruction or supervised training exercise.
2. Training hour requirements are the number of hours of training to be provided for each student. Additional training time shall be provided if considered necessary to meet the training objectives.

D. Training Instructors

1. All onsite training shall be conducted by experienced instructors who are intimately familiar with the operation and control of the Owner's facilities and with the specific system supplied.

E. Training Material

1. Provide detailed training manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project. The manuals shall be provided in hardcopy for each student. Provide electronic copy of each training manual in PDF format for Owner's future use.
2. The trainer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, all training materials shall be delivered to Owner.

F. Training Costs

1. All costs associated with the manufacturer’s training sessions, including travel and lodging for the Engineer and/or Owner, shall be the responsibility of the PCSI/ASP and shall be included in the contract price. Travel for the Engineer and/or Owner shall be via non-stop flight, originating and terminating at William P. Hobby Airport. PCSI shall provide transportation from the airport to lodging and the training site for the Engineer and/or Owner personnel.

G. Training Schedules

1. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner’s working schedule.

H. Lessons

1. Training lesson plans and other information shall be submitted at least 30 days prior to the start of training.

I. Video Recording

1. The Owner reserves the right to videotape all custom training sessions. All training tapes shall become the sole property of the Owner.

1.03 RELATED WORK

A. Refer to Section 13300 - Process Control System General Provisions.

1.04 SUBMITTALS

A. Training Plan Submittal
   1. PCSI shall provide proposed lesson plans or outlines for all training courses specified herein. Training submittals shall include:
      a. Course objectives and target audience
      b. Proposed schedule including proposed dates, duration, and location
      c. Resumes of trainers including instructors' qualifications and experience
      d. Prerequisite requirements for each class
      e. Samples of handouts for review.
   2. Complete copies of all proposed handouts and training materials. Training information shall be bound and logically arranged with all materials reduced to a maximum size of 11 inch by 17 inch, then Z-folded to 8.5 inch by 11 inch for inclusion into the binder.
   3. Refer to Section 13300 - Process Control System General Provisions for the submittal order.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 MANUFACTURER'S TRAINING

A. PLC Hardware and Software
   1. Provide manufacturer's standard training courses for the Owner's personnel in the operation, configuration, programming, installation, and maintenance of the PLC hardware and software supplied. Conduct this course in separate beginner and advanced training sessions.
   2. The training shall be conducted no more than two months before the WFT.
   3. The following hardware training shall be provided as a minimum:
      a. Hardware maintenance for the PLC equipment provided.
      b. Test, adjustment, and calibration procedures.
      c. Troubleshooting and diagnosis.

d. Component removal and replacement.

e. Periodic maintenance.

4. The following software training shall be provided as a minimum:

a. System configuration.

b. Application specific program development/programming.

c. Uploading/downloading programs.

d. Documenting program/configuration.

e. System backups and reload procedures.

f. TCP/IP addressing procedures.

g. Network communications configuration.

B. Instrument Manufacturer Training

1. Manufacturer instrument training shall be provided for those instruments where specifically indicated in the Training Summary table. This shall be on-site training provided by an authorized representative of the manufacturer. This work shall not be done by the PCSI/ASP or the Contractor. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.

3.02 ONSITE TRAINING

A. Training personnel shall be intimately familiar with the control system equipment, its manipulation, and configuration. Training personnel shall command knowledge of system debugging, program modification, troubleshooting, maintenance procedure, system operation, and programming, and shall be capable of transferring this knowledge in an orderly fashion to technically oriented personnel.

B. SCADA System Training

1. SCADA system training classes shall cover plant operation with the control system and use of the HMI display screens, including at a minimum all the following items:

a. Basics of HMI control, settings, and navigation

b. Alarming, events, and interlocks

c. Auto functionality of automated processes and HMI control

d. Failure modes of SCADA equipment and operator responses

2. Conduct this training in separate training sessions as follows:

a. Prior to or at the WORT

b. After FDT

3. Training personnel shall be intimately familiar with both the control system and the plant process. The ASP shall provide trainers that are familiar with the designed operations of the plant and how the control system executes the operation.
4. The training shall be structured specifically for operations type personnel. Training personnel shall be prepared to show the operators how to operate the plant from the control panel level in the event of control room equipment failure.
5. The ASP shall, at a minimum, have the following teaching aids available for distribution during SCADA system training sessions:
    1) Preliminary Operation and Maintenance Manuals (prior to or at the WORT); Final O&M Manuals (after FDT)
    2) Process, and Instrumentation Diagrams as presented in the Contract documents
    3) Training Session Agenda
6. Fifty percent of all SCADA system training shall be "hands on" utilizing the installed control system to the fullest extent possible. The ASP shall ascertain the operability of the control system before commencing training. Training performed using a non-functioning control system shall be rejected and repeated.

C. Installed Process Control System Training
    1. Provide training for the Owner's personnel in the functionality, maintenance, and troubleshooting of the installed Control System. The training shall be held before the WORT, but not more than two months before.
    2. Training and instruction shall be specific to the system that is being supplied.
    3. Training shall consist of classroom instructions and hands-on instruction utilizing the Owner's system.
    4. Detailed training shall be provided on the actual configuration and implementation for this Contract. Training shall cover all aspects of the system that will allow the Owner's personnel to maintain, modify, troubleshoot, and develop future additions/deletions to the system. The training shall cover the following subjects, as a minimum:
        a. System overview.
        b. System hardware components and specific equipment arrangements.
        c. Periodic maintenance.
        d. Troubleshooting and diagnosis.
        e. Network configuration, communications, and operation.

f. TCP/IP addressing procedures for all Ethernet devices.

D. PLC Hardware and Software

1. Provide training for the Owner's personnel in the operation, maintenance, troubleshooting, etc. with the PLC hardware and software system. The training shall be held before the WORT, but not more than two months before.
2. Training and instruction shall be specific to the system that is being supplied.
3. Training shall consist of classroom instructions and hands-on instruction utilizing the Owner's system.
4. Detailed training shall be provided on the actual configuration and implementation for this Contract. Training shall cover all aspects of the PLC system that will allow the Owner's personnel to maintain, modify, troubleshoot, and develop future additions/deletions to the PLC system. The training shall cover the following subjects, as a minimum:
   a. PLC system overview.
   b. PLC system architecture.
   c. PLC system hardware components and specific equipment arrangements.
   d. PLC system startup, shut down, load, backup, and PLC failure recovery.
   e. Periodic maintenance.
   f. Troubleshooting and diagnosis down to the I/O card level.
   g. PLC configuration, communications, and operation.

E. Instrument PCSI Training

1. Provide instruction on the maintenance of the field and panel instrumentation for the Owner's instrumentation technicians. This training shall be conducted before the WORT, but no more than 1 month before and at a time suitable to the Owner. This training shall take place at the Owner's facility. As a minimum the following shall be included:
   a. Training in standard hardware maintenance for the instruments provided.
   b. Specific training for the actual instrumentation configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and set up for this Contract.
   c. Test, adjustment, and calibration procedures.
   d. Troubleshooting and diagnosis.

e. Periodic maintenance.

F. Instruments - Operator familiarity

1. Provide operator level instruction on the use of the field and panel instrumentation for the Owner's operations staff. This training shall be conducted before the 30-day site acceptance test, but no more than 1 month before and at a time suitable to the Owner. This training shall take place at the Owner's facility. Include hands on demonstration of the information each transmitter indicates, and the method used to retrieve any operator information from the transmitter, including use of pushbuttons and interpretation of international graphic symbols used on the instruments.

G. Network System Training

1. Provide instruction on the maintenance and administration of the network system for the plant personnel including Owner's network technicians. This training shall be conducted before the WORT, but no more than 1 month before and at a time suitable to the Owner. This training shall take place at the Owner's facility. As a minimum the following shall be included:
   a. Network Setup and Configuration
      1) Hardware system types, architecture layout, physical connections, locations
      2) General switch and router configurations
      3) IP Addressing
      4) Security configurations
      5) Routing, VLAN, and other configurations
   b. Network Maintenance and Administration
      1) Routine maintenance
         a) System backups
         b) System restoration
         c) Firmware and patch updates
      2) Network Administration
         a) Software and hardware tools
         b) Addition or removal of network connections
         c) Troubleshooting
      3) Repair and replacement of equipment

END OF SECTION

SECTION 13340

PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the Process Control System Input/Output (PCS I/O) List for the controller. The list is intended to reflect the signals that serve as the basis of the application to be programmed by the ASP (Applications Services Provider) who is furnishing the process monitoring and control functionality specified within this Division or as indicated on the drawings.

B. Equipment and services provided under this section shall be subject to all Associated Sections listed below.

C. This section shall be used and referenced only in conjunction with the Process Control System sections.

D. This section supplements the Process Control System section. Input/Output data are indicated on the drawings or the Input/Output List.

1.02 ASSOCIATED SECTIONS

This section encompasses the equipment and services specified in the following sections:

SECTION	SPEC TITLE
13300-1	Process Control System General Provisions
13306-1	Application Engineering Services
13350-1	Process Control Descriptions
13350-10	Booster Pump Station

1.03 SUBMITTALS

A. Submittals shall be per the Process Control System General Provisions and Applications Engineering Services sections.

1.04 CONTROLLER INPUT/OUTPUT TAGS

A. For consistency between the field and PLC/HMI tag names, same tag naming convention used for instrument or equipment tag including sequence loop numbers shall be used for the PLC/HMI tag numbering.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. The PCS I/O List is based on the contract documents and included within the tables attached to this Section. The ASP shall follow standards to complete the I/O list submittal as described in the Process Control System General Provisions and Applications Engineering Services sections.

3.02 INPUT/OUTPUT LIST

A. Input/Output List is included to provide further details and requirements for the PLC/HMI programming. The PCS I/O List:
   1. Summarizes the minimum physical signal requirements of the control loops represented in the Contract Documents. Provide additional soft signals as required to fully implement the functionality described in these contract documents.
   2. Does not show all hardware and software necessary to perform all control functions specified herein and as shown on the drawings. PCSI to provide all hardware and software necessary to provide a complete and working system.
   3. Is not intended to be an inclusive listing of all elements and appurtenances required to execute the loop functions. It is intended to supplement and complement the drawings and other specification sections. The design I/O List shall not be considered equal to the exact field wired I/O.

B. I/O list includes the following information:
   1. Item: An arbitrary sequential number that is for reference only.
   2. Controller ID.: Controller identification is a sequential number for a given type within a specific controller (PLC or RTU).
   3. IO Type: The identifier of the type of I/O signal, including:
      a. AI: Analog Input
      b. AO: Analog Output
      c. DI: Discrete Input
      d. DO: Discrete Output
      e. PI: Pulse Input or accumulator Type Input
      f. EAI: Ethernet Analog Input
      g. EDI: Ethernet Discrete Input
   4. Field Device: Tag number of the instrument or equipment identifier

associated with the I/O point.

5. Loop No.: Numeric (or alphanumeric) loop designation for the instrument or equipment.
6. I/O Tagging Suffix: Multi-letter designation to uniquely identify the PLC/HMI tags. Suffixes will be per the ISA Standards and the Owner's guidelines.
7. I/O Tag No.: The identifier assigned to the instrument or equipment that performs a function in the control system. Tag naming shall follow the ISA tag numbering and the Owner's guidelines.
8. Service Description: A description of the function of an instrument or equipment that includes signal source and control function (i.e. Filter No. 1 Loss-of-Head).
9. IO Range: Engineering Range or State; the range in engineering units corresponding to an analog signal or scalable variable (LO/HI), or the text description corresponding to each state of a discrete point (ON/OFF).
10. Engineering Unit (EU): Engineering Range associated with the analog I/O or scalable variable.
11. Alarm Information: This column includes alarm limits to be verified by the programmer during startup and commissioning. This includes the following information:
    a. Alarm/Event (designation of the data point as an Alarm or an Event)
    b. HI HI: High-High Alarm Limit (If applicable).
    c. HI: High Alarm Limit (If applicable).
    d. LO LO: Low-Low Alarm Limit (If applicable).
    e. LO: Low Alarm Limit (If applicable).
12. Historical Information: Points to be placed into Historian.
    a. Update Rate (sec): Rate that a collected data point to be collected by the Historian. These rates shall be finalized by the Owner during the project construction phase.
    b. Historical Logging: This column indicates whether a data point is to be historized.
13. Analog Data:
    a. Signal Type: This will typically be 4-20mA, but could also be 1-5Vdc, RTD, or Network Protocols (i.e. Ethernet/IP, Modbus TCP, Modbus RTU, FLD-BUS, Profibus DP or PA, serial, HART, or similar) to indicate the signal type of the associated input or output.
    b. Power: This will typically be '2-wire' for devices that are loop powered from the PLC enclosure, '3-wire' for combination loop-powered and

externally powered devices, or '4-wire' for devices that are powered from external power supplies, unless noted otherwise.

14. Discrete Data:
    a. Signal Type: This will be 120VAC, 24VDC, or similar to indicate the signal type of the associated input or output.
    b. Closed State: This will indicate the state of the input or output when it is considered to be closed or energized (normal, alarm, running, failed, etc.).
    c. Power Source: This will indicate the location of the power source for the wetting voltage on the contacts, as follows: Field (External field power source, may require interposing relays or isolated I/O module type.), or Local (Power originates from within the PLC or I/O enclosure).
    d. Interposing Relay: This will be either 'Yes' or 'No' to indicate whether the input or output requires an interposing relay. Relays are typically required to isolate external voltage sources. See specifications for additional details.
15. Drawing/P&ID No.: This is the drawing number of the drawing or Process and Instrumentation Diagram where the device is shown.
16. Remarks: This column may include a cross reference to another specification section where applicable, or to a note which provides additional information.

END OF SECTION

Item	Controller ID	IO Type	Field Device	Loop Number	I/O TAGGING SUFFIX	I/O TAG No.	Service Description	I/O Range		Engineering Unit	ALARM INFORMATION					Historical Information		Analog		Discrete				Drawing/P&ID No.	Remarks
								HI / ON	LO / OFF		ALARM / EVENT	HI HI	HI	LO	LO LO	Update Rate (sec)	Historical Logging	Signal Type	Power Type	Signal Type	Close State	Power Source	Interposing Relay		
1	BOOSTER PUMP RTU	AI	LIT	101	LI	LIT-101-LI	STORAGE TANK 01-GST-1 LEVEL INDICATOR	100	0	FEET	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-1.00	New signal added
2	BOOSTER PUMP RTU	DI	LSH	102	LAH	LSH-102-LAH	STORAGE TANK 01-GST-1 HIGH LEVEL FLOAT	HI LEVEL	NORMAL	FEET	ALARM	N/A	Y	N/A	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-1.00	New signal added
3	BOOSTER PUMP RTU	DI	LSL	102	LAL	LSL-102-LAL	STORAGE TANK 01-GST-1 LOW LEVEL FLOAT	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-1.00	New signal added
4	BOOSTER PUMP RTU	DI	VFD	210	YI	VFD-210-YI	HIGH SERVICE PUMP VFD 210 RUNNING	RUNNING	STOPPED	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-2.00	New signal added
5	BOOSTER PUMP RTU	DI	VFD	210	YIR	VFD-210-YIR	HIGH SERVICE PUMP VFD 210 IN REMOTE	IN REMOTE	MANUAL	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	IN AUTO	PLC	N/A	I-2.00	New signal added
6	BOOSTER PUMP RTU	DI	VFD	210	UA	VFD-210-UA	HIGH SERVICE PUMP VFD 210 FAULT	FAULT	NORMAL	N/A	ALARM	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	FAULT	PLC	N/A	I-2.00	New signal added
7	BOOSTER PUMP RTU	DO	VFD	210	UCS	VFD-210-UCS	HIGH SERVICE PUMP VFD 210 START/STOP	START	STOP	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	START	PLC	N/A	I-2.00	New signal added
8	BOOSTER PUMP RTU	AI	VFD	210	SI	VFD-210-SI	HIGH SERVICE PUMP VFD 210 SPEED FEEDBACK	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
9	BOOSTER PUMP RTU	AO	VFD	210A	LI	VFD-210A-LI	HIGH SERVICE PUMP VFD 210 STORAGE TANK LEVEL	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
10	BOOSTER PUMP RTU	AO	VFD	210B	LC	VFD-210B-LC	HIGH SERVICE PUMP VFD 210 DESIRED TANK LEVEL	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
11	BOOSTER PUMP RTU	DI	VFD	220	YI	VFD-220-YI	HIGH SERVICE PUMP VFD 220 RUNNING	RUNNING	STOPPED	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-2.00	New signal added
12	BOOSTER PUMP RTU	DI	VFD	220	YIR	VFD-220-YIR	HIGH SERVICE PUMP VFD 220 IN REMOTE	IN REMOTE	MANUAL	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	IN AUTO	PLC	N/A	I-2.00	New signal added
13	BOOSTER PUMP RTU	DI	VFD	220	UA	VFD-220-UA	HIGH SERVICE PUMP VFD 220 FAULT	FAULT	NORMAL	N/A	ALARM	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	FAULT	PLC	N/A	I-2.00	New signal added
14	BOOSTER PUMP RTU	DO	VFD	220	UCS	VFD-220-UCS	HIGH SERVICE PUMP VFD 220 START/STOP	START	STOP	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	START	PLC	N/A	I-2.00	New signal added
15	BOOSTER PUMP RTU	AI	VFD	220	SI	VFD-220-SI	HIGH SERVICE PUMP VFD 220 SPEED FEEDBACK	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
16	BOOSTER PUMP RTU	AO	VFD	220A	LI	VFD-220A-LI	HIGH SERVICE PUMP VFD 220 STORAGE TANK LEVEL	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
17	BOOSTER PUMP RTU	AO	VFD	220B	LC	VFD-220B-LC	HIGH SERVICE PUMP VFD 220 DESIRED TANK LEVEL	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
18	BOOSTER PUMP RTU	DI	VFD	230	YI	VFD-230-YI	HIGH SERVICE PUMP VFD 230 RUNNING	RUNNING	STOPPED	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-2.00	New signal added
19	BOOSTER PUMP RTU	DI	VFD	230	YIR	VFD-230-YIR	HIGH SERVICE PUMP VFD 230 IN REMOTE	IN REMOTE	MANUAL	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	IN AUTO	PLC	N/A	I-2.00	New signal added
20	BOOSTER PUMP RTU	DI	VFD	230	UA	VFD-230-UA	HIGH SERVICE PUMP VFD 230 FAULT	FAULT	NORMAL	N/A	ALARM	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	FAULT	PLC	N/A	I-2.00	New signal added
21	BOOSTER PUMP RTU	DO	VFD	230	UCS	VFD-230-UCS	HIGH SERVICE PUMP VFD 230 START/STOP	START	STOP	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	START	PLC	N/A	I-2.00	New signal added
22	BOOSTER PUMP RTU	AI	VFD	230	SI	VFD-230-SI	HIGH SERVICE PUMP VFD 230 SPEED FEEDBACK	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
23	BOOSTER PUMP RTU	AO	VFD	230A	LI	VFD-230A-LI	HIGH SERVICE PUMP VFD 230 STORAGE TANK LEVEL	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
24	BOOSTER PUMP RTU	AO	VFD	230B	LC	VFD-230B-LC	HIGH SERVICE PUMP VFD 230 DESIRED TANK LEVEL	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
25	BOOSTER PUMP RTU	AI	PIT	240	PI	PIT-240-PI	BOOSTER PUMP STATION 240 PRESSURE INDICATOR	TBD	0	PSIG	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
26	BOOSTER PUMP RTU	AI	FIT	250	FI	FIT-250-FI	BOOSTER PUMP STATION 250 FLOW INDICATOR	100	0	FEET	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-2.00	New signal added
27	PLC A	DI	CP	410	UCS	CP-410-UCS	CHEMICAL FEED PUMP 410 START/STOP	START	STOP	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	START	PLC	N/A	I-4.00	EXSISTING
28	PLC A	DI	LI	411	LS	LI-411-LS	HYPOCHLORITE 411 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
29	PLC A	DI	TI	411	TS	TI-411-TS	HYPOCHLORITE 411 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
30	PLC A	DI	LI	412	LS	LI-412-LS	HYPOCHLORITE 412 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
31	PLC A	DI	TI	412	TS	TI-412-TS	HYPOCHLORITE 412 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
32	PLC A	DI	LI	413	LS	LI-413-LS	HYPOCHLORITE 413 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
33	PLC A	DI	TI	413	TS	TI-413-TS	HYPOCHLORITE 413 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
34	PLC A	DI	LI	414	LS	LI-414-LS	HYPOCHLORITE 414 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
35	PLC A	DI	TI	414	TS	TI-414-TS	HYPOCHLORITE 414 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
36	PLC A	DI	LI	415	LS	LI-415-LS	HYPOCHLORITE 415 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
37	PLC A	DI	TI	415	TS	TI-415-TS	HYPOCHLORITE 415 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	EXSISTING
38	PLC A	DI	RT	416	UCS	RT-416-UCS	RECTIFIER 416 START/STOP	START	STOP	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	START	PLC	N/A	I-4.00	EXSISTING
39	PLC A	DI	RT	416	UA	RT-416-UA	RECTIFIER 416 IN REMOTE	IN REMOTE	MANUAL	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	IN AUTO	PLC	N/A	I-4.00	EXSISTING
40	PLC A	DI	RT	416	YI	RT-416-YI	RECTIFIER 416 FAULT	FAULT	NORMAL	N/A	ALARM	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	FAULT	PLC	N/A	I-4.00	EXSISTING
41	PLC A	AI	RT	416	SI	RT-416-SI	RECTIFIER 416 FEEDBACK	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-4.00	EXSISTING
42	PLC A	DI	CP	420	UCS	CP-420-UCS	CHEMICAL FEED PUMP 420 START/STOP	START	STOP	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	START	PLC	N/A	I-4.00	New signal added
43	PLC A	DI	LI	421	LS	LI-421-LS	HYPOCHLORITE 421 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
44	PLC A	DI	TI	421	TS	TI-421-TS	HYPOCHLORITE 421 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
45	PLC A	DI	LI	422	LS	LI-422-LS	HYPOCHLORITE 422 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
46	PLC A	DI	TI	422	TS	TI-422-TS	HYPOCHLORITE 422 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
47	PLC A	DI	LI	423	LS	LI-423-LS	HYPOCHLORITE 423 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
48	PLC A	DI	TI	423	TS	TI-423-TS	HYPOCHLORITE 423 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
49	PLC A	DI	LI	424	LS	LI-424-LS	HYPOCHLORITE 424 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
50	PLC A	DI	TI	424	TS	TI-424-TS	HYPOCHLORITE 424 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
51	PLC A	DI	LI	425	LS	LI-425-LS	HYPOCHLORITE 425 LEVEL SWITCH	LOW LEVEL	NORMAL	FEET	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
52	PLC A	DI	TI	425	TS	TI-425-TS	HYPOCHLORITE 425 TEMPERATURE SWITCH	HIGH TEMP	NORMAL	DEG F	ALARM	N/A	N/A	Y	N/A	N/A	Y	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-4.00	New signal added
53	PLC A	DI	RT	426	UCS	RT-426-UCS	RECTIFIER 426 START/STOP	START	STOP	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	START	PLC	N/A	I-4.00	New signal added
54	PLC A	DI	RT	426	UA	RT-426-UA	RECTIFIER 426 IN REMOTE	IN REMOTE	MANUAL	N/A	EVENT	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	IN AUTO	PLC	N/A	I-4.00	New signal added
55	PLC A	DI	RT	426	YI	RT-426-YI	RECTIFIER 426 FAULT	FAULT	NORMAL	N/A	ALARM	N/A	N/A	N/A	N/A	N/A	Y	N/A	N/A	120VAC	FAULT	PLC	N/A	I-4.00	New signal added
56	PLC A	AI	RT	426	SI	RT-426-SI	RECTIFIER 426 FEEDBACK	100	0	%	EVENT	N/A	N/A	N/A	N/A	1	Y	4-20mA	2-WIRE	N/A	N/A	N/A	N/A	I-4.00	New signal added

SECTION 13350

PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Specification section provides general control loop requirements for the programming of the Process Control System by the Applications System Programmer (ASP).

B. These descriptions are intended to provide an overview of the operating concept of the plant process equipment rather than describing in detail every operating feature or interlock.

C. All Process Control System PLC controller programming and Operator Interface Terminal (OIT) or Operator Workstation Station (OWS) graphics and programming shall be performed as defined herein.

1.02 ASSOCIATED SECTIONS

A. This section encompasses the equipment and services specified in the following sections:

SECTION	SPEC TITLE
13300	Process Control System General Provisions
13315	Process Control System Submittals
13306	Application Engineering Services
13340	Process Control System Input/Output List

1.03 SUBMITTALS

A. Refer to Section 01300 – Submittal Procedures for general submittal requirements.

B. Refer to Section 13315 – Process Control System Submittals for the specific submittal requirements.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. Control descriptions are provided for each process area and are attached at the end of this section. The following is a list of attached Sections that have detailed control descriptions for each process area. The list shows the specification attachment number, process area with accompanying process number.

Spec No.	Area Name	Area Number
13350.10	Booster Pump Station	200

B. The control descriptions are organized in the following format:
   1. General
      a. Process Area
      b. Process Overview
      c. Associated Equipment
      d. Associated Instruments
      e. Associated PLC
      f. Associated Control Panels
      g. Associated P&ID(s)
   2. Controller Programming
      a. Control Modes
      b. Software Permissives
      c. Hardwired Interlocks
      d. Calculated Alarms and Variables
      e. Power Failure
   3. System Configuration
      a. Status
      b. Setpoints
      c. Trending
      d. Alarms
      e. HMI Requirements
   4. Alarm Management

3.02 GENERAL CONTROL CRITERIA

A. General configuration and programming tasks are required for system PLCs. Each PLC may have several occurrences of each of these tasks or may not

have any occurrences of some or all of these tasks.

B. The input/output lists in Section 13340 Input/Output List and detailed equipment control descriptions included in the attachments of this section shall be referenced to determine the requirements for each PLC.

C. All alarm and control setpoints shall be adjustable by the Operator at the HMI unless specifically stated otherwise, even if not shown on the Drawings.

D. HMI computers shall function as a monitoring system, not as a controller, for the process equipment. The computer shall download set points and other information to the PLCs, and the PLCs shall perform all control algorithms, so a temporary failure of any HMI computer will not disrupt plant control.

E. Rack and module definitions for each PLC, as well as the PLC communications configuration shall be completely configured to allow proper addressing of all field connected I/O points. This shall include configuration of any remote input/output (RIO) racks.

F. The PLC database will include both field I/O points and internally generated points required for programming. All field I/O points and internal programming points shall be fully defined according to database naming conventions approved by Owner. As a minimum, each database point shall be provided with a tag name, engineering unit, alarm parameters, and description.

G. All PLC-generated process alarms, equipment statuses, and process variable values shall be available at any operator workstation.

H. Failure of a PLC shall result in safe shutdown of associated process equipment. Interposing relays shall be provided where required to assure that equipment will revert to its fail-safe condition. Failure of any PLC or its communication shall be alarmed on the HMI computer.

3.03 EQUIPMENT CONTROL AND CONTROL MODE OVERVIEW

A. The control descriptions correspond to the P&ID control hierarchical layers shown as process area, field panels, PLC, and SCADA.

B. The control descriptions consist of four control modes. There may be one or more modes per loop depending on the process and associated equipment. Control modes consists of the following:

1. Local Manual Control – This is the lowest layer of control and is typically located either in the process area located near the equipment or in the field panels at an equipment’s control panel or MCC.
2. Local Auto Control – This layer of control is typically located in the field panels at the equipment’s control panel or MCC, either by hardwired relay

logic or process specific PLCs. This control is most commonly used in batch processes or vendor supplied systems.

3. Remote Manual Control – This layer of control is typically provided at the OIT/HMI. This control allows operators to manipulate process equipment remotely. Commands issued at the OIT/HMI are sent to the PLC where signals are generated to process equipment for control and monitoring.
4. Remote Auto Control – The highest layer of control is done by the process control system PLC. In remote auto, operators typically enter a control setpoint at an OIT/HMI. Process instrumentation provides feedback signals to the PLC. The PLC is programmed to take the setpoints and feedback signals and to manipulate process equipment according to a specific algorithm. Any functions done in the operator workstations also take place at all the SCADA OITs.

C. Descriptions for local control are included in the detailed equipment control descriptions. They are provided primarily for documentation purposes and for information. These controls are provided by the equipment vendors and require no programming effort with the exception of process interfacing such as setpoint adjustments, etc.

D. Descriptions for remote control are included in the detailed equipment control descriptions and are to be used by the PCSI to program algorithms for process equipment control.

3.04 PLC PROGRAMMING FUNCTIONAL REQUIREMENTS

A. The following covers functional requirements of the software, which are generic and may or may not be related to any specific control loop.

B. Analog Scaling

1. Each analog input and output will be appropriately scaled for use in internal PLC programming, monitoring by the HMI computers, or transmission to other PLCs.
2. Requirements for raw count values shall be coordinated with the operator interface software to ensure compatibility.

C. Flow Values

a. Flow values shall be integrated, totalized, and stored in the PLC registers so the values displayed on the HMI computers and on the field processor will be identical.

D. Flow Totalization:

1. Every reading that monitors the flow of the main water flow needs to be totalized daily.

a. Only values with a good value status are totalized.

b. All flow totals will be maintained in millions of gallons (MG) for MGD rates.

c. Flow rates and flow totals shall be indicated and recorded at the HMI.

2. Running Total

a. The running total starts at the beginning of the day and totalizes the volume throughout the day.

b. At the end of the day, it resets that total and starts over.

c. Before the total is reset, it is stored for examination throughout the next day. Therefore, the flow total consists of two values: previous day's total, and the total for this day since midnight.

1) For example: The total reading is calculated by integrating the minutely average of the MGD readings every minute. The minutely average need to be scaled to millions of gallons per minute before it is totalized. While MGD units is used in this example, flow totalization may be for other volumetric flow units such as gallons per minute (gpm), standard cubic feet per minute (scfm), etc.

d. ASP shall provide flow totalization in the base units of the flow signal being totalized, unless stated as otherwise in the specifications.

e. Flow shall not be totalized:

1) When a valve is closed or a pump is not running, the flow totalizer shall not accumulate values caused by noise or errors in calibration.

2) If the analog signal is outside the 4-20 mA range.

3) If the value of the flow input is less than 2% of the full range of the input.

$$MG_{Daily} = \sum_{1}^{1440} \frac{MGD_{MinAvg}}{60Min * 24Hours}$$

3. Each flow totalization shall come with a reset button on the HMI screen.

E. Equipment Runtimes and Starts

1. To support routine maintenance functions, all motorized equipment (pumps, motors, motorized gates, etc.) whose "run" status is monitored by a PLC, will have their runtime and number of starts accumulated by the respective PLC.

a. The runtime procedure will monitor the status of the equipment "run" contact and, when the equipment is running, increment a software timer that maintains equipment runtime to within a one-minute resolution.

b. The timer shall stop incrementing, but not reset, when the "run" contact indicates that the equipment is not running.

c. The timer value shall increment an hour counter that maintains an integer value representing the equipment run time in hours.

d. The counter value shall be available for display on the HMI computer.

2. Both the runtime and number of starts will continue to be collected until reset by an operator with permissions at the supervisor level and above. When reset, both values will be set to zero, and the date/time when it was reset will be noted. A manual reset of the runtime value shall be available at the HMI.

3. Two runtime parameters shall be provided for equipment:

a. Accumulated Runtime – Accumulates for the life of the equipment.

b. Resettable Runtime – Runtime with reset capabilities.

F. Equipment Availability

1. Remote Switch Monitoring

a. In general, equipment with PLC control has been provided with a local selector switch that transfers control to the PLC.

b. The PLC shall monitor the position of this switch to determine if the equipment is available for PLC control.

c. If the equipment is not available, the PLC program shall not attempt to implement remote manual or automatic status changes for the equipment.

d. The PLC program may, however, need to implement special routines if equipment unavailability affects a sequence (as described in the detailed equipment descriptions).

2. Equipment Out Of Service tag (OOS) Command

a. All controllable equipment is provided with the ability to have an operational tag applied to it.

b. Upon receiving an Out Of Service tag command from the Operator, the control logic will inhibit all remote controls of the equipment.

G. Power Faults and Maintained Outputs

1. The use of maintained control outputs to equipment should be evaluated to determine whether contacts need to be de-energized upon power loss, so equipment does not automatically energize upon restoration of power, and if any startup sequencing is needed. Utilize plant power monitoring systems to determine when utility power is lost and restored.

H. Control Mode Transition:

1. Equipment Failures
    a. Unless otherwise indicated in the equipment control descriptions, equipment in automatic mode shall be transitioned to manual mode (and stopped) if the equipment fails or becomes unavailable or if the PLC processor resets.
2. Manual/Auto Bumpless Transfer
    a. Programming at the PLC shall be such that switching between manual and automatic control modes results in a smooth (bumpless) transition without upsetting the process or inadvertently changing equipment states.
    b. Equipment running in local manual mode shall be tracked by the PLC code such that the PLC maintains the running status and speed setpoint when switching the equipment's Hand-Off-Auto (or Local-Remote) switch from Hand to Auto (or Local to Remote).
    c. When switching equipment directly into an Automatic PID or sequence type control function, the PLC shall use the tracking values (running status and speed) as initial values.
3. Equipment running or stopped in automatic mode shall remain running or stopped when manual mode is selected.
4. Peer-to-Peer Communications
5. If equipment tracking is via peer-to-peer communications (rather than hardwired interface) and communications link goes down, the PLC shall be programmed to re-verify equipment running and speed status before allowing the switch to remote control mode.
6. This is intended to prevent PLC code from inadvertently shutting down equipment when communications are restored.

I. PID Tuning Parameters:
    1. All tuning parameters for each PLC software PID controller are entered at the HMI.
    2. Tuning trends are provided to tune and monitor each PID operation.
    3. Tuning parameters settings are password protected.

3.05 ALARM CRITERIA

A. Preclusion logic shall be added to all applicable alarms. This logic will prevent secondary alarms that are a direct result of a primary alarm from being annunciated. For example, station power failure should not cause a circuit breaker-tripped alarm to be annunciated.

B. All software adjustable alarm setpoints accessible from the HMI shall have adjustable deadbands unless specifically noted otherwise.

C. Plant personnel must acknowledge all alarms before they can be cleared. No alarm shall clear automatically until it has been acknowledged.

D. Command Fault (Discrepancy) and Failure Alarms:

1. For all controlled devices such as pumps, valves, etc., if the device is commanded to Start or Stop (or Open or Close) by the PLC and the device feedback state does not match the commanded state within a pre-set time, a Command Fault Alarm is generated by the PLC for display and alarming at the HMI (valves shall remain in the last state).
2. If a duty pump, or system, is commanded to start and does not start within the pre-set time, an alarm shall be generated by the PLC for display and alarming at the HMI and the standby pump shall start without operator intervention.
3. If a device feedback state does not match the commanded state at any time, excluding the change of state described above, an Uncommand Change of State Alarm is generated by the PLC for display and alarming at the HMI (valves shall remain in the last state).
4. After a Command Fault Alarm occurs, the device cannot be started again until the Operator at the HMI has issued a Reset. All controlled devices with feedback shall generate Failure alarms at the PLC for display and alarming at the associated process graphic displays, even if not shown on the Drawings.
5. All motors shall be programmed so that if a motor stops for any reason, it shall not be re-started automatically once the problem with the motor has been resolved.
    a. The start command on the HMI shall not be a maintained contact but a momentary command to the PLC. The run confirms of all motors shall seal in the control output to the motor once the momentary start command drops out.
    b. The run confirms shall be on a five second timer delay in that if the run confirm is not present after five seconds, the contact output to the motor from the PLC shall drop out. Thus, the only way a motor can be restarted after five seconds by the SCADA system is if the operator reinitiates the start command for that motor on the HMI or when that motor control at the HMI is placed in complete automatic mode and the SCADA OWS, through logic/interlocks, requests the motor to run.

E. Analog Alarms:

1. All analog alarms shall be generated at the HMI level as follows, with the exceptions of bad value processing and deviation alarms.
    a. If the analog point’s value exceeds or drops below the alarm limit value and set time delay has been passed, then an alarm shall be generated at the HMI for display and alarming.

   b. To eliminate excessive alarm reporting, the analog point shall remain in alarm until the analog point's value returns beyond the limit set by the analog limit deadband.

2. All process analog inputs are displayed, historically collected, and trended. Low-low, low, high, and high-high alarms shall be calculated at the HMI for display and alarming.
   a. Nuisance alarms, such as low turbidity, shall be inhibited.
   b. When a valve is closed or a pump is not running, the analog flow signal associated with that valve or pump shall not generate a low flow alarm, and it shall be forced to a zero value.
3. When an analog signal goes outside the 4-20 mA range due to a failure at the instrument or PLC card, the following SCADA programming shall take place:
   a. Alarm the signal at any local OITs and in the HMI system.
   b. If the analog signal is associated with a control loop or ratio control loop that loop shall go into manual.
   c. If the analog signal is used in a calculation, that calculation shall use the last good analog signal. The computer shall place the control loop in manual if using the calculation.
4. Manual Override:
   a. This capability is implemented within the PLC controller. Since scaling is processed at the controller, the manual override value (operator entered at the HMI) will be in engineering units, not raw counts. When a point is placed in manual override mode, the point's associated data quality is forced to be "Good" as well. Providing this capability in the controller allows the rest of the logic to operate in the manual override mode.
5. Data Quality
   a. A key attribute of every analog input is its associated data quality. This is a simple Boolean value that indicates whether the analog reading can be trusted. The value is reset when the value is good, and it is set when it is bad. There are several checks done on the value before it is declared as "Good."
6. Bad Value Processing:
   a. If the value is not in Manual Override, then the raw value needs to be processed further before it is converted into its engineering units.
   b. Check to ensure the raw reading is within the limits of the instrument. These limits are specified on an individual point basis.

1) Normally the limits need to check over or under-range (open-loop) values, such as the raw count readings for 3-21mA on a 4-20mA instrument.
2) Depending upon the process being monitored, it may require the range to be narrowed further. For example, a temperature instrument may have a range from 0 degrees F to 200 degrees F. If the process being measured is water temperature, then the readings should never get outside 40 degrees F to 100 degrees F.
3) By specifying this set of limits, any reading outside this range would indicate an instrument problem.
4) If the raw reading is outside these limits, the point's data quality would be set to "Bad.".
5) The controller will not maintain the last good reading; values will be presented as processed by the controller.

7. Deviation Alarms:
   a. For all variable speed pumps, if the pump is commanded to run at a specific speed and the speed feedback signal deviates from the commanded speed by a pre-set dead band (initially set for 5%) for a pre-set time period (initially set for 30-seconds), a Speed Deviation alarm is generated by the PLC for display and alarming at the HMI.
   b. For all modulating valves, if the valve is commanded to a specific position, and the position feedback signal deviates from the requested position by a pre-set dead band (initially set for 5%) for a pre-set time period (initially set for 30-seconds), a Position Deviation alarm is generated by the PLC for display and alarming at the HMI.
   c. For all controlled setpoints (i.e., level, flow, etc.), if a process is requested to a specific setpoint, and the control variable feedback signal deviates from the requested setpoint by a pre-set dead band (initially set for 5%) for a pre-set time period (initially set for 30-seconds), a Setpoint Deviation alarm is generated by the PLC for display and alarming at the HMI.

F. Communication Alarms:
   1. Provide specific communication status(es) for all Peer-to-Peer data communications. Upon a Peer-to-Peer communication failure, a communication failure alarm shall be generated at each PLC for display and alarming at the HMI. This communication failure alarm shall also be utilized for the associated control strategy.

END OF SECTION

SECTION 13350

BOOSTER PUMP STATION PROCESS CONTROL SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Specification section provides detailed control loop descriptions for the programming of the Process Control System by the Applications System Programmer (ASP).

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 GENERAL

A. Booster Pump Station, Area 200

B. Process Overview

1. The level of processed water stored in the new ground storage tank (01-GST-1) located on the suction side of the booster pumps shall be maintained by the new booster pumps through the use of Variable Frequency Drives (VFDs) and a new booster station RTU.

C. Associated Equipment

	Equipment Service Description	Equipment Tag Number
1.	Ground Storage Tank	01-GST-1
2.	Booster Pump Station Pump 1	02-BP-210
3.	Booster Pump Station Pump 2	02-BP-220
4.	Booster Pump Station Pump 3	02-BP-230
5.	GAC Vessel 1	03-PV-1-1
6.	GAC Vessel 2	03-PV-1-2
7.	GAC Vessel 3	03-PV-2-1
8.	GAC Vessel 4	03-PV-2-2

D. Associated Instruments

	Instrument Service Description	Instrument Tag Number
1.	Ground Storage Tank Level Transducer	LE/LIT-205
2.	Ground Storage Tank Low Level Float	LSL-101

3. Ground Storage Tank High Level Float LSH-101
4. Booster Pump Station Flow Meter FIT-250

E. Associated PLC
   1. Booster Pump PLC (located in the RTU)

F. Associated Control Panels
   1. Booster Pump RTU

G. Associated P&ID(s)
   1. I-1.00
   2. I-2.00

3.02 CONTROLLER PROGRAMMING

A. Local Manual Control Mode
   1. Booster Pumps
      a. The pumps shall be started and stopped when their associated VFD Human Module Interface (HMI) Hand-Off-Auto (or Local-Off-Remote) buttons are pressed to place them in Hand (or Local).
      b. The speed of each VFD shall be modulated directly through the VFD's HMI.
      c. All manufacturer required interlocks shall be hardwired into the starting circuit to properly protect the pump.

B. Local (Backup) Automatic Control Mode
   1. Booster Pumps
      a. The storage tank shall contain a set of backup floats to be used in the event of a level transducer or PLC failure. Relay logic in the RTU shall be utilized in conjunction with the float switches to command the booster pump VFDs to run whenever the high level float is tripped. The pumps shall run at a preset speed until the low-level float hangs.
      b. The individual float switch status as well as indication of whenever the station is in backup mode shall be wired to the RTU's PLC and relayed to the plant control system to alert plant personnel.
      c. If/when the PLC and/or transducer returns to normal functionality, the RTU shall reclaim functionality once the float mode is disengaged either through the reset push button on the RTU or whenever the last float cycle has been completed.
      d. The floats shall be positioned in the storage tank so that they don't interfere with the typical operating range utilized by the transducer.

C. Remote Manual Control Mode

1. None.

D. Remote Automatic Control Mode

1. Booster Pumps

a. The RTU shall monitor the storage tank level in conjunction with operator adjustable setpoints and stage pumps on, off, and adjust the VFD speed to maintain an operator adjustable desired tank level setpoint.

1) Control system setpoints shall be provided for the lead pump start, lead pump stop, lag pump start, lag pump stop, and desired tank level. All setpoints shall be in feet with two decimal places of resolution.

2) Control system time delay setpoints shall be implemented and utilized in conjunction with the lead and lag start and stop setpoints to prevent inadvertent starting and stopping of the pumps. Initially, each shall be set for 5 seconds, but the values shall be operator adjustable.

3) The VFDs shall modulate the speed of the pumps (through a PID controller) based upon the level in the storage tank in comparison to the operator adjustable desired tank level setpoint.

4) The minimum and maximum allowable speeds for the VFDs shall be set within each VFD so that the booster pumps are able to overcome the head pressure of the system and GAC filtration system.

b. The RTU shall give the pumps assignments (lead, 1st lag, 2nd lag) based on the availability of the pumps. A pump shall be available for assignment when it is in ‘Auto’, no faults exist, and none of the manufacturer required interlocks are energized.

1) In the event that a failure occurs, or a pump is taken out of auto, the RTU shall automatically alternate to the next available pump.

2) In the event that a pump draws the tank level down to the lead off level and stops, the pump assignments shall be rotated (from Lead to 2nd Lag, 1st Lag to Lead, and 2nd Lag to 1st Lag).

3) An operator adjustable setpoint for lead pump maximum continuous runtime shall be utilized to automatically alternate the pump assignments (from Lead to 2nd Lag, 1st Lag to Lead, and 2nd Lag to 1st Lag) once the continuous run duration has elapsed. Initially the setpoint shall be set for 8 hours. Units shall be in whole hour increments.

4) In the event of a power failure (or other event) that could potentially cause all of the pumps to start simultaneously, the control system shall stagger starting of the pumps.

E. Software Permissive

a. None.

F. Calculated Alarms and Variables

1. Ground storage tank level low, low low, high, and high high (via ground storage tank transducer)
2. High and low flow (via booster pump discharge flow meter). The alarms shall only be triggered whenever the booster pumps are running.
3. High and low pressure (via booster pump discharge pressure transducer). The alarms shall only be triggered whenever the booster pumps are running.

G. Power Failure

1. Control shall resume with the control mode established prior to the power failure.

3.03 SYSTEM CONFIGURATION

A. Status

1. The HMI shall indicate the following statuses at a minimum:
   a. Ground storage tank high- and low-level floats
   b. Current ground storage tank level
   c. Booster pump running (typical of 3)
   d. Booster pump fault (typical of 3)
   e. Booster pump in remote (typical of 3)
   f. Booster pump speed (typical of 3)
   g. Booster pumps running in backup mode
   h. Booster pump discharge pressure
   i. Booster pump discharge flow

B. Setpoints

1. The HMI shall include the following setpoints at a minimum:
   a. Desired ground storage tank level (in feet)
   b. Lead pump start level (in feet)
   c. Lead pump stop level (in feet)

d. Lag pump start level (in feet)
e. Lag pump stop level (in feet)
f. Time delays associated with each start and stop level (in seconds)
g. Lead pump maximum continuous runtime (in hours)

C. Trending
1. Ground storage tank level
2. Booster pump running status (typical of 3)
3. Booster pump speed (typical of 3)
4. Booster pump discharge flow

D. Alarms
1. The HMI shall indicate the following alarms at a minimum:
a. Ground storage tank low, low low, high, and high high (via transducer)
b. Ground storage tank low level alarm (low float)
c. Ground storage tank high level alarm (high float)
d. Booster pump fault (typical of 3)
e. Booster pump failed to run (typical of 3)
f. Booster pumps running in float backup (potential transducer failure)
g. High and low (when running) booster pump discharge pressure
h. High and low (when running) booster pump discharge flow

E. HMI Requirements
1. Equipment and instrumentation shall be depicted on the HMI screen. Displays shall be per the Owner’s current HMI Standards and Conventions.

END OF SECTION

SECTION 13420

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes Programmable Logic Controllers (PLCs) and Operator Interface Terminals (OITs) for control of process equipment, process-oriented machinery, and process systems.

B. The attached schedule provides details for the replacement PLC systems at each project location. The quantities shown are to be provided at a minimum but understanding that additional hardware may be required and deviations from the hardware quantities listed may be required because of space restrictions or other unforeseen installation constraints.

1.02 ASSOCIATED SECTIONS

A. This section encompasses the equipment and services specified in the following sections:

SECTION	SPEC TITLE
13300	Process Control System General Provisions
13306	Application Engineering Services

1.03 SUBMITTALS

A. Submittals shall be per 13300 – Process Control System General Provisions and 13315 – Process Control System Submittals.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. A qualified manufacturer shall be capable of providing training, parts, and coordination of emergency maintenance and repairs.
2. The manufacturer shall have a local office within one hundred (100) miles of the jobsite or have technicians available on-site within four hours of emergency notification.

3. The manufacturer shall have a local full-time staff of employees that have developed and commissioned a minimum of three (3) new Automation Direct/Alan Bradley based systems within the past 12 months. The manufacturer must have a minimum of five (5) years' experience designing, installing, and commissioning SCADA systems.
4. The manufacturer shall have a minimum of three (3) full-time employees qualified to perform the SCADA system work.

B. The manufacturer of this equipment shall have produced similar equipment for a minimum of five (5) years. When requested by the OWNER/ENGINEER, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

C. The programmable controller and all the corresponding components within the family of controller products shall be manufactured by a company who regularly manufactures and services this type of equipment.

D. The manufacturer shall comply with ISO 9001 standards for "Quality Systems – Model for Quality Assurance in Design/Development, Production, Installation, and Servicing".

E. The manufacturer shall provide complete technical support for all the products. This shall include factory or on-site training, regional application centers, local or factory technical assistance, and a 24/7/365 technical support phone service.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver PLC components in packaging designed to prevent damage from static electricity and physical damage.

B. Store PLC equipment according to manufacturer requirements. At a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect PLCs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the PLC from all forms of electrical and magnetic energy that could reasonably cause damage.

1.06 NOMENCLATURE AND IDENTIFICATION DEFINITIONS

A. AI: Analog Input.

B. AO: Analog Output.

C. Fixed I/O: A PLC style consisting of a fixed number of I/O, a processor, and a power supply all in one enclosure. Some fixed PLCs have limited expansion ability.

D. CPU: Central Processing Unit.

E. DI: Discrete Input.

F. Distributed I/O: Hardware specially designed to function as Remote I/O.

G. DO: Discrete Output.

H. HMI: Human-Machine Interface.

I. I/O: Input and/or Output.

J. Master/Slave: Communication between devices in which one device, the master, controls all communications. The other devices, the slaves, respond only when queried by the master. Typically used in a Remote I/O application.

K. Modular I/O: A PLC style consisting of cards that are assembled to comprise a complete unit. All I/O, CPU, and Power Supply are dedicated cards. Typically, these cards are inserted into a chassis.

L. Peer-to-Peer: Communication between two or more devices, typically PLCs, in which each device can control the communication exchange.

M. PID: Control action, proportional plus integral plus derivative.

N. PLC: Programmable Logic Controller.

O. Remote I/O: I/O that is located remotely from the processor. Remote I/O can communicate over a variety of communication protocols and can use standard rack based I/O, or special Remote I/O hardware referred to as Distributed I/O.

P. SCADA: Supervisory Control and Data Acquisition.

1.07 WARRANTY

A. Provide warranty per Section 01760 – Warranties and as specified herein.

B. The manufacturer shall warrant the equipment to be free from defects in material and workmanship for two years from the date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty, the manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the CONTRACTOR at no expense to the OWNER.

1.08 SPARE PARTS

A. Refer to Section 13300 Process Control System General Provisions.

B. All spare parts shall be packaged to prevent damage during long-term storage. Identify all packages with indelible markings on the exterior describing contents.

C. Provide complete ordering information including manufacturer, part number, part name, hardware and software revision levels, and equipment for which the part is to be used.

D. The following PLC spare parts shall be furnished at a minimum:

1. I/O Cards: Provide spares for each unique I/O module type installed. Provide two spares, or 10% of installed quantity, whichever is greater.
2. Miscellaneous Components (including cables): Provide spares for each unique component installed.

1.09 SPARE I/O AND SLOTS

A. Refer to Section 13340 Input/Output List for summaries of I/O type quantities for each PLC.

B. Each panel containing PLC I/O shall include at least 20 percent (minimum of four) spare points of each type (AI, AO, DI, and DO) for future use, regardless of whether any of those point types are used in that panel or not. The spares shall be the same type of I/O modules supplied.

C. For chassis-based PLC systems, provide at least two spare slots for the addition of future I/O in each chassis provided. For non-chassis-based PLC systems, provide adequate space to the right of the last I/O card in each row of I/O cards for at least two future I/O cards (width should be based on the widest I/O card provided in the panel).

D. Spare output points that require the use of an external relay shall be supplied with the external relay.

E. All installed unused points on all I/O modules shall be wired to terminal blocks in the order that they occur on the I/O modules. Unwired spares shall not be acceptable.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable.

1. Programmable Logic Controller
    a. Automation Direct PLC.
    b. Allen Bradley
    c. Engineer Approved Equal

2.02 GENERAL

A. Provide PLC equipment with the required memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.

B. PLC systems shall include processors, memory cards, power supplies, input/output modules, communication modules, redundancy modules, and remote interface modules as required to satisfy project requirements.

1. Provide memory cards for all PLC CPUs provided on this project.

C. Furnish products listed and classified by Underwriters Laboratories (UL), Canadian Standards Association (CSA), or Factory Mutual (FM) approval as suitable for the purpose specified and indicated.

D. All equipment and devices furnished hereunder shall be designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production.

E. The PLCs shall communicate between the HMI Server and field-mounted transducers, switches, controllers, and process actuators. Communications

protocol shall be completely transparent to process operators at the HMI.

F. All equipment furnished shall be designed and constructed so that in the event of power interruption the systems shall go through an orderly shutdown with no loss of memory and resume normal operation without manually resetting when power is restored.

G. The PLC shall be capable of stand-alone operation in the event of failure of the communication link to the HMI subsystem.

H. Remote Input/Output Units shall include input/output modules, interface modules, communication modules, and power supply to meet system input and output requirements.

I. Agency and Environmental Specifications

1. Electrical supply voltage to the PLC shall be 120 VAC, ±15 percent, 48-63Hz. PLC system power supplies shall be fused for overload protection.
2. Vibration: 3.5 mm Peak-to-Peak, 5-9Hz: 1.0G, 9-150\Hz. The method of testing is to be based upon IEC 68-2-6 and JIS C 0911 standards for vibration. The system is to be operational during and after testing. Vibration Rating of 2.0G maximum peak acceleration for 10 to 500Hz in accordance with at least one of the following:
    a. Installed Rating
        1) DIN rail mounted PLC: 10-57 Hz, amplitude 0.075 mm, acceleration 25-100 Hz.
        2) Panel- or plate-mounted PLC: 2-25 Hz, amplitude 1.6 mm, acceleration 25-200 Hz.
    b. In compliance with IEC 60068 and IEC 61131.
3. Shock: 15G, 11msec. The method of testing is to be based upon IEC 68-2-27 and JIS C 0912 standards for shock. The system is to be operational during and after testing.
4. Temperature: All PLC hardware shall operate at an ambient temperature of 0° to 55°C (32° to 140°F) with a storage ambient temperature rating of -25° to 70°C (-40° to 185°F).
5. Relative Humidity: The Programmable Controller hardware shall function continuously in the relative humidity range of 30 to 95 percent non-condensing.

6. Noise Immunity: The Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.
7. Altitude
    a. Operation: 0-6,500 feet.
    b. Storage: 0-9,800 feet.
8. Degree of protection: NEMA 1 (IP20).
9. All products shall have corrosion protection.

J. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings indicating:
    1. Modules product type such as analog or digital.
    2. Modules catalog number.
    3. Modules major revision number.
    4. Modules minor revision number.
    5. Modules manufacturer vendor.
    6. Modules serial number.

K. All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer's recommendations.

2.03 POWER SUPPLIES

A. The PLC shall have chassis-mounted power supplies to power the chassis backplane and provide power for the processor and applicable modules.

B. Power supplies shall have a clearly visible LED to indicate that the incoming power is acceptable, and the output voltage is present.

C. Power supplies shall feature over-current and over-voltage protection and should be designed to operate in most industrial environments without the need for isolation transformers.

D. Power supplies shall be sized to accommodate the anticipated load plus 30%.

E. DC power supplies shall be capable of handling ripple up to 2.4V peak-to-peak.

F. AC Line Voltage rating of 85 to 265 VAC, 47-63Hz.

G. The power supplies shall allow for brown outs of at least ½ of a cycle, a harmonic rate of 10%, and will sustain continuous operation through momentary interruptions of AC line voltage of 10ms or less.

H. Automatically shut down the Programmable Controller system whenever its output power is detected as exceeding 125% of its rated power.

I. Provide surge protection, isolation, and outage carry-over up to two cycles of the AC line.

J. Redundant Power Supplies

1. The PLC shall be supplied with redundant power supplies if specified and/or shown in the drawings. Redundant power supplies will comply with all the requirements of non-redundant power supplies in addition to the features stated below.
2. The redundant power supplies shall be designed to share the current required by the chassis. In the event of a failure of one redundant power supply, the remaining supply will accommodate the entire load of the chassis without disruption to the chassis activity.
3. Provide a failsafe fuse that is not accessible by the customer.
4. Provide a solid-state relay connection to allow for failure annunciation when wired to an input module.
5. Diagnostic LED status indicators for power and redundancy.

2.04 PLC/RIO CHASSIS

A. All system and signal power to the CPU and support modules shall be distributed on the backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable.

B. All system modules, main, and expansion chassis shall be designed to provide free air flow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.

C. All system modules including the processor shall be removable from the

chassis or inserted into the chassis while power is being supplied to the chassis without faulting the processor or damaging the modules.

D. Modules shall be designed to plug into a chassis and to be keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying shall perform an electronic check to ensure that the physical module is consistent with what was configured.

2.05 DISCRETE I/O MODULES

A. General

1. For existing system replacements, selection of discrete input and output module types shall be based on maintaining functionality and connection to existing PLC/RIO signals. For new systems, selection of discrete input and output module types shall be per OWNER/ENGINEER requirements included in this specification section.
2. Digital input and output modules shall provide ON/OFF detection and actuation.
3. The I/O count and type shall be as required to implement the functions specified plus an allowance for active spares.
4. Modules shall be designed to be hot-swappable, or installed or removed while chassis power is applied and the PLC continues to execute.
5. Modules shall have indicators to display the status of communication, module health, and input/output devices.
6. Each module shall have the following status indicators:
   a. The On/Off state of the field device.
   b. The module's communication status.
7. I/O modules shall contain a maximum of 16 points per module.
8. Discrete output modules shall be configurable to hold last value, turn on, or turn off upon failure or fault state.

B. Discrete Module Specifications

	24VDC DI/DO Cards

Channel Qty.	16
Type	Isolated, Current Sink
Channel Voltage	24VDC
1 Voltage (Min)	79V
1 Current (Min)	2.5mA
0 Voltage (Max)	20V
0 Current (Max)	1mA
Switching Delay	0.2(min)-12.8ms (max)
Protection Type	ext. fuse
Network Frequency	n/a
IP Protection	IP20
Operating Temperature	-20-60 degC
Relative Humidity	95%

2.06 ANALOG I/O MODULES

A. General

1. For existing system replacements, selection of analog input and output module types shall be based on maintaining functionality and connection to existing PLC/RIO signals. For new systems, selection of analog input and output module types shall be per OWNER/ENGINEER requirements included in this specification section.
2. Analog input modules shall convert an analog signal that is connected to the module's screw terminals into a digital value. The digital value representing the magnitude of the analog signal shall be transmitted on the backplane. Analog output modules shall convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals.
3. The I/O count and type shall be as required to implement the functions specified plus an allowance for active spares.
4. Modules shall be designed to be hot-swappable, or installed or removed while chassis power is applied, and the PLC continues to execute.
5. Modules shall have indicators to display the status of communication, module health, and input/output devices. Each analog module shall

provide both hardware and software indication when a module fault has occurred. Each module shall have an LED fault indicator and the programming software shall display the fault information.

6. Analog modules shall be software configurable through the I/O configuration portion of the programming software.
7. The following status shall be capable of being examined in programming logic:
   a. Module Fault Word: provides fault summary reporting.
   b. Channel Fault Word: provides under-range, over-range, and communications fault reporting.
   c. Channel Status Words: provides individual channel under-range and over-range fault reporting for process alarm, rate alarms, and calibration faults.
8. The 24 VDC power for analog instrument loops shall be provided as a part of the system. The 24 VDC power supply shall be derived from the 120 VAC input power circuit to the PLC. The field side of the 24 VDC power source(s) shall have individual or grouped (of logically associated circuits) fusing and be provided with a readily visible, labeled blown fuse indicator.

B. Analog Module Specifications

	24VDC AI/AO Cards
Channel Qty.	4
Type	Isolated, Current Sink
Channel Voltage	24VDC
Input Voltage	35V
Input Current	40mA
Resolution	12 bit
IP Protection	IP20
Operating Temperature	-20-60 degC
Relative Humidity	95%

2.07 COMMUNICATION INTERFACES

A. The PLC shall be capable of the following communication protocols as shown on the drawings:

1. 10BASE-T/100BASE-TX Ethernet communication.
2. Ethernet IP.
3. Modbus (RTU and ASCII) for up to 247 slaves.

B. Ports

1. 100MB/1G Ethernet

C. When required, provide a Communications Interface Module mounted in the chassis or the equivalent port directly on the CPU.

2.08 PLC SOFTWARE

A. The PCSI shall provide a PLC configuration and application development software package complete with documentation and disks. The PLC software package and associated licensing and/or activation shall be installed on the computers shown on the Drawings.

B. The software package shall allow on-line/off-line program development, annotation, monitoring, debugging, uploading, and downloading of programs to the PLCs.

C. All required hardware (including cables, cable adapters, etc.) for connection to PLCs shall be furnished.

D. All software licenses required to achieve the functionality described in the Specifications shall be provided and shall be licensed to the OWNER.

E. All software shall be of the latest available revision.

F. The software package shall include a software license agreement allowing the OWNER the right to use the software as required for any current or future modification, documentation, or development of the PLCs furnished for this project.

G. The software provided shall be capable of the following IEC 61131-3 functions:

1. Ladder logic.
2. Function block.

3. Sequential function chart.
4. Structure text.

H. In addition to the above editors, an add-on instruction editor shall work with any of the above-mentioned editors to create custom reusable function blocks. This software shall allow any of the derived function blocks to be modified online.

I. The software shall be Microsoft Windows-based and run on the supplied computers.

J. The software shall include a security feature to prevent unauthorized personnel from modifying and downloading the programs.

K. Provide an I/O simulator that allows the PLC application load program to be tested on a PC with simulated analog and digital inputs and outputs, allowing I/O testing and debugging to be performed in a safe, isolated environment without the need for running the PLC CPU and process I/O boards.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Maintain area free of dirt and dust during and after installation of programmable controller products.

B. Anchor PLCs within enclosures as recommended by the PLC manufacturer.

C. Ventilation slots shall not be blocked or obstructed by any means.

D. Examine areas, surface, and substrates to receive PLCs for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Install in accordance with manufacturer's instructions.

F. Unload, unpack, and transport equipment to prevent damage or loss.

G. Replace damaged components as directed by ENGINEER.

3.02 PANEL LAYOUT

A. Coordinate size and configuration of enclosure to meet project requirements. Drawings indicate maximum dimensions for PLCs and minimum clearances between PLCs, adjacent surfaces, and other items.

B. Comply with indicated maximum dimensions and clearances, or with PLC vendors required distances if they are greater than the distances indicated.

1. Provide spacing around the PLC as required by the PLC manufacturer to ensure adequate cooling. Ensure that the air surrounding the PLC has been conditioned to maintain the required temperature and humidity range.
2. Wires entering and exiting PLC components shall be sized to comply with the PLC manufacturer's requirements. Doors on all components shall be able to be fully closed when all the wires are installed.
3. For chassis-mounted PLCs, no wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack.
4. PLC lights, keys, communication ports, and memory card slots shall be accessible at all times. Lights shall be visible at all times when the enclosure door is opened.
5. The control panel designer shall provide independent line fuses or circuit breakers, per the PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements.
6. The control panel designer shall ensure that communication signals, 4-20 mA signals (including those with embedded HART), are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics.
7. Where multiple mechanical components are provided for process redundancy, arrange their field connections to I/O modules such that the failure of a single module will not disable all mechanical components associated with the process (e.g., inputs and outputs for redundancy device 1 shall reside on different modules than the inputs and outputs for redundancy device 2, etc.), irrespective of the number of used points resulting from this configuration. This applies to all I/O types. The acceptability of the I/O arrangement shall be at the discretion of the ENGINEER.
8. Provide all required cables, cords, and connective devices for interface

with other control system components.

END SECTION

SECTION 13500
INSTRUMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the furnishing, installation, and services for all instruments and accessories required for the Process Control System as specified herein or as indicated on the drawings.

B. Equipment and services provided under this section shall be subject to all Associated Sections listed below.

C. This section shall be used and referenced only in conjunction with the Process Control System sections.

D. This section supplements the Process Control System section. Instrument data, special requirements, and options are indicated on the drawings or the Instrument Device Schedule.

E. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.02 ASSOCIATED SECTIONS

A. This section encompasses the equipment and services specified in the following sections:

SECTION	SPEC TITLE
13300	Process Control System General Provisions
13510	Flow Measurement
13530	Level Measurement
13550	Pressure Measurement

1.03 DESIGN CRITERIA.

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

D. Instrument Calibrations

1. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Drawings or in the Instrument Device Schedule. Flowmeters shall be wet flow calibrated.
2. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type.
3. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1.04 SUBMITTALS

A. Submittals shall be per the 13300 - Process Control System General Provisions section.

1.05 INSTRUMENT TAGS

A. All supplied instrument transmitters and instrument transmitter elements shall have a 316 stainless steel identification tag attached to each transmitter and element prior to shipment.

B. Tag shall be attached via stainless steel chain or stainless-steel wire (24 gauge minimum) to a non-removable part of the device.

C. The tag size shall be a minimum of 1.5 square inches.

D. Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings.

E. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-inch high alphanumeric characters.

PART 2 - PRODUCTS

2.01 GENERAL

A. The Associated Sections listed above provide minimum device requirements. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

2.02 INTERCONNECTING CABLE

A. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided.

B. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter.

C. The cable shall be provided in the length necessary for installation. Splices shall not be allowed in the installed cable.

D. The cable's minimum length shall be a minimum of three meters or as indicated on the Drawings or in the 13500A – Attachment A - Instrument Device Schedule.

2.03 PROGRAMMING DEVICE

A. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility.

B. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup.

C. The programming device shall include appropriate operation manuals and shall be included in the training requirements.

D. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

2.04 CONFIGURATION SOFTWARE/SERIAL INTERFACE

A. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link.

B. As a minimum, an appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer.

C. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section).

D. Software shall be capable of running under the Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

PART 3 - EXECUTION

3.01 GENERAL

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

3.02 MANUFACTURERS' FIELD SERVICES

A. If indicated in the individual instrumentation sections, the instrument manufacturer or manufacturer's certified service representative shall provide start-up and training services. This work shall not be done by the PCSI contractor.

B. The field services shall be to calibrate, oversee the installations of the sensor, and start-up the sensor/transmitter to provide reliable measurement at the instrument and to a remote system. The vendor shall work with the PCSI and ASP to verify the transmitter sends correct information to the remote system (i.e., that the scaling and units are the same at the instrument and on the remote operator interface).

3.03 INSTRUMENT SHIPPING

A. The PCSI shall be responsible for coordinating the installation schedule with the Installation Contractor.

B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation.

C. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

3.04 INSTRUMENT INSTALLATION

A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions.

B. Instrumentation and control equipment and device locations shown on the drawings are approximate. Exact locations shall be relatively close to the indicated location.

C. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated.

D. Installation details for some instruments are indicated on the Drawings. Where specific installation details are not shown, the American Petroleum Institute (API) recommended practice 550 shall be followed.

E. In case of any interference with other work, proceed as directed by the Engineer.

F. All equipment used in classified areas shall be designed for the Class, Group, and Division as required for the locations as shown on the Drawings and specified in Division 16. All work shall be in strict accordance with codes and local rulings.

G. Provide brackets and hangers required for mounting of equipment.

H. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face North or as required to minimize the impact of glare and ultraviolet exposure on digital readouts.

3.05 TRAINING

A. Training shall be in accordance with Section 13330 – Process Control System Training.

B. While the instrument manufacturer or manufacturer’s certified service representative is starting up the instrumentation, training shall be provided to the Owner's instrumentation technicians.

C. The training shall be in how to calibrate, install, troubleshoot, read the diagnostics, and maintain the sensor and transmitter.

3.06 INSTRUMENT DEVICE SCHEDULE

A. 13500A – Attachment A - Instrument Device Schedule is included to provide further details and requirements for the instruments.

B. Instrument Device Schedule contains only major plant instrumentation devices. Devices such as switches and indicating lights located on MCCs or local panels and gate/valve actuators are not included.

C. Instrument Device Schedule includes the following information:

1. Item: An arbitrary sequential number that is for reference only.
2. System Code: The system code, which denotes the associated process.
3. Loop No.: The numeric (or alphanumeric) loop designation for the

instrument.

4. Tag No.: The ISA alpha tag representing the function of the instrument.
5. Service Description: The description of the instrument service (Example: Fine Screen Level High).
6. Device Type: The instrument device type that should match the description as listed in the specification.
7. Component Options: The instrument component options and indicates specific features and requirements, such as integral/remote mounted installations, valve manifolds, diaphragm seal, etc.
8. Size: The instrument device size (such as the diameter of flowmeters).
9. Output Type: Output signal type, ‘4-20mA’ or ‘Dry Contact”. It could also be a serial output for smart devices (such as HART or FLD-BUS) but only if the serial output is the primary I/O interface.
10. Output Range/Setpoint: The calibrated range for the analog devices or the trip point(s) for the discrete devices.
11. Power: The instrument power requirements such as '2-wire' for loop powered devices, or '4-wire' for 120-volt powered devices.
12. Installation Details No.: The drawing number of the Installation Details Drawing where the device mounting instruction is provided.
13. Location Drawing No.: The drawing number of the process/mechanical drawing where the device location is shown.
14. Drawing/P&ID No.: The drawing number of the drawing or Process and Instrumentation Diagram where the device is shown.
15. Specification Section No.: The section in the specifications where the device is specified.
16. Remarks: A cross-reference to another specification section where applicable, or to a note which provides additional information.

END OF SECTION

Item	System Code	Loop No.	Tag No.	Service Description	Device Type	Component Options	Size	Output Type	Output Range/Setpoint	Power	Installation Details No.	Location Drawing No.	Drawing/P&ID No.	Specification Section No.	Remarks
1		101	LI-101	STORAGE TANK 101 LEVEL INDICATOR	LEVEL TRANDUCER	WEIGHT MOUNTED	N/A	4-20mA	TBD	N/A	ID-01	I-1.00	I-1.00	13531	
2		102	LAH-102	STORAGE TANK 102 HIGH LEVEL FLOAT	LEVEL SWITCH	STEEL CABLE MOUNTED	N/A	DRY CONTACT	HIGH	N/A	ID-01	I-1.00	I-1.00	13542	
3		102	LAL-102	STORAGE TANK 102 LOW LEVEL FLOAT	LEVEL SWITCH	STEEL CABLE MOUNTED	N/A	DRY CONTACT	LOW	N/A	ID-01	I-1.00	I-1.00	13542	
4		250	FI-250	BOOSTER PUMP STATION 250 FLOW INDICATOR	MAGNETIC FLOWMETER	MOUNTED ON BPS DISCHARGE IN A VAULT	16"	4-20mA	TBD	4-WIRE	ID-01	I-2.00	I-2.00	13511	THE RANGE FOR THE GAC IS AROUND 5000 GPM.

SECTION 13510

FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Flow Measurement Section covers the furnishing of flow instruments and accessories required for the Process Control System (PCS) as specified herein or as indicated on the Drawings.

B. Refer to section 13500 - Instruments for general requirements.

PART 2 - PRODUCTS

2.01 ASSOCIATED FLOWMETER SECTIONS

SECTION	SPEC TITLE
13511-1	Magnetic Flow Meters
13515-1	Variable Area Flow Meters

PART 3 - EXECUTION

3.01 GENERAL

A. See section 13500 - Instruments.

END OF SECTION

SECTION 13511

MAGNETIC FLOW METER

PART 1 - GENERAL

1.01 SCOPE.

A. The Flow Measurement Section covers the furnishing of flow instruments and accessories required for the Process Control System (PCS) as specified herein or as indicated on the Drawings.

B. Refer to section 13510 – Flow Measurement.

PART 2 - PRODUCTS

2.01 MAGNETIC FLOW METER

A. Flow Element
   1. Type
      a. Pulsed DC type
   2. Function/Performance
      a. Operating Temperature:
         1) Process liquid temperature: of 21 to 122 °F or greater dependent upon liner
         2) Ambient temperature: -4 to 130 °F.
      b. Radio Frequency Interference (RFI) protection: RFI protection shall be provided as recommended by the manufacturer.
      c. Pressure rating: Equal to piping system where meter is installed.
      d. Inlet and outlet conditions: Minimum 5 pipe diameters upstream and 3 pipe diameters downstream.
      e. Additional: Meter shall be capable of running empty indefinitely without damage to any component.
   3. Physical
      a. Metering Tube:
         1) Type 304 stainless steel
         2) Carbon steel
         3) Or equivalent. Metering tube material to be compatible with process fluid as indicated on the Drawings.
      b. Flanges:

1) ANSI 150 lb. or DIN PN 16 carbon steel, as required by the piping system, unless otherwise indicated.
2) ANSI 150 lb. or DIN PN 16 stainless steel flanges shall be used on all SS process pipes.

c. Liner:
1) Polyurethane, polypropylene, composite elastomer, hard rubber, neoprene, EPDM, or PTFE unless otherwise indicated on the Drawings or in the Instrument Device Schedule.

d. Electrodes:
1) Type 316 stainless steel standard minimum requirements.
2) All electrodes to be compatible with process fluid as indicated on the Drawings or electrodes to be supplied as listed in the Instrument Device Schedule.

e. For sludge, polymer, or any slurry application where the electrodes will be coated, a self-cleaning or a removable electrode option must be provided with that meter.

f. Housing:
1) For meters with remote mounted transmitters, meters below grade shall be suitable for submergence for up to 48 hours to a depth of 30 ft. (9m).
2) Meters above grade shall be NEMA 6P (IP68). Where hazardous areas are indicated on the Drawings, the equipment shall be rated for that area.

g. Finish: All external surfaces shall have a chemical and corrosion resistant finish.

4. Power Requirements
a. Meter shall be 24 VDC powered instrument, receiving its power from transmitter.

5. Accessories/Documentation Required
a. Factory calibration: All meters shall be factory calibrated. A copy of the calibration report shall be included in the O&M manual.

b. Grounding:
1) Meter shall be grounded in accordance with the manufacturer's recommendation.
2) Provide ground ring, ground wires, gaskets, etc., as required.
3) All materials shall be suitable for the liquid being measured and must be compatible with process fluid and with the process pipe.

c. For meters with remote-mounted transmitters, signal cable for installation between the flow tube and the transmitter. Length shall be as required by installation as indicated on the Drawings.

B. Flow Converter/Transmitter

1. Type

a. Microprocessor-based, intelligent transmitter compatible with flow tube provided.

b. Integral mount or mounted remote from the flow tube as shown on the drawings or as required by the physical location.

2. Functional/Performance

a. Accuracy (including flow tube): Plus/minus 0.5 percent of flow rate or better.

b. Operating Temperature: –4 to 122 °F.

c. Output: Isolated 4-20 mA with HART protocol. Current output adjustable over the full range of the instrument. Provide a dry contact to indicate reverse flow.

d. Diagnostics: Self diagnostics with on screen display of faults.

e. Display: Digital indicator displaying flow in engineering units indicated in the Instrument Device Schedule.

f. Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.

g. Empty Tube Zero: The transmitter shall include a feature that will lock the output at zero when no flow is detected. The empty tube zero feature shall be enabled automatically when the transmitter detects no flow or manually through a contact input.

h. Provide electrode cleaning unit to match flow element requirements.

3. Physical

a. Transmitter shall be suitable for surface or pipe stand mounting.

b. Enclosure shall be NEMA 4X (IP66).

4. Power Requirements

a. The transmitter shall be 120 VAC powered instrument.

5. Accessories/Required

a. Keypad where required for transmitter configuration.

C. Manufacturer

1. Rosemount Series 8750 Meter and 8712 Transmitter for remote mounted transmitter, or 8732E meter/transmitter for integral mounted.

2. Endress & Hauser W400
3. Or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. See section 13500 - Instruments.

END OF SECTION

SECTION 13515

VARIABLE AREA FLOW METERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Refer to section 13510 – Flow Measurement.

PART 2 - PRODUCTS

2.01 VARIABLE AREA FLOW METER

A. Manufacturer:
   1. King.
   2. ABB.
   3. Dwyer.
   4. Or Approved Equal.
   5. Construction:
      a. Metering Tube:316L SS
      b. Internal Components: 316L SS
      c. Fitting Material: 316L SS
      d. O-Ring Standard: Viton®
      e. Inlet/Outlet Fittings: 316L SS NPT or flange, vertical
      f. Indicator type: Vertical or 4 inches dial.
      g. Indicator Housing: Die-cast aluminum / powder coated with chemfilm base (RoHS compliant), Rated IP66.
   6. Performance:
      a. Capacities: Liquid 0 GPH to 15 GPH
      b. Scale: 120 mm direct reading, detachable.
      c. Accuracy: ± 3% of full-scale flow.
      d. Turndown: 10:1
      e. Repeatability: 1 %
      f. Maximum Temperature:

O-Ring Material	Max Temperature
Viton®	350° F (177° C)

      g. Maximum Pressure: NPT fittings 1,500 psi
      h. Ambient Temperature: -40° F to 125° F (-40° C to 52° C)

7. Specifications:
    a. SP.GR (g/ml): 0.8980 (for ammonia system)
    b. Float material: 316L SS
    c. Connection type: FNPT
    d. Connection size: ½" (as minimum). Refer P&ID drawings.

PART 3 - EXECUTION

3.01 GENERAL

A. See section 13510 – Flow Instruments.

3.02 INSTALLATION REQUIREMENTS:

A. Install at specified locations indicated on drawings and conform to the installation details.

B. Install in the vertical position.

C. Thread sealer suitable for use with the associated process to be used in assembly of threaded connections.

D. Connections shall be leak free. Lines shall be purged at flow gauge locations before installation.

E. Conforms to mounting requirements in Drawings or Instrument Device Schedule.

F. Unless specified otherwise, mounting and installation hardware to be Type 316L stainless steel.

END OF SECTION

SECTION 13530

LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 SCOPE

A. The Level Measurement Section covers the furnishing of level instruments and accessories required for the Process Control System (PCS) as specified herein or as indicated on the Drawings.

B. Refer to section 13500 - Instruments for general requirements.

PART 2 - PRODUCTS

2.01 ASSOCIATED LEVEL INSTRUMENT SECTIONS

SECTION	SPEC TITLE
13531	Ultrasonic Level Meters (Continuous and Point-Type)
13542	Level Switches

PART 3 - EXECUTION

3.01 GENERAL

A. See section 13500 - Instruments.

END OF SECTION

SECTION 13531

ULTRASONIC LEVEL METER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Level Measurement Section covers the furnishing of level instruments and accessories required for the Process Control System (PCS) as specified herein or as indicated on the Drawings.

B. Refer to section 13500 - Instruments for general requirements.

PART 2 - PRODUCTS

2.01 ULTRASONIC LEVEL/DIFFERENTIAL LEVEL METER

A. Transducer

1. Type
    a. Non-contact, ultrasonic level transducer.
2. Function/Performance
    a. Measuring Range: Transducer range shall be suitable for the installation indicated on the Drawings, up to 50 ft. (15m).
    b. Temperature Range: –20 to 60 degrees C.
    c. Relative Humidity: Zero to 100 percent.
    d. Temperature Compensation: Transducers shall be provided with integral temperature sensors for temperature compensation at above temperature ranges.
3. Physical
    a. Transducers shall be potted/encapsulated in a Kynar or other chemical and corrosion resistant housing. Where indicated on the Drawings, transducers shall be approved for installation in Class I, Division 1, Groups C and D (Zone 0) environments.
    b. The surface of transducers shall be Teflon-coated where mounted on chemical tanks and exposed to vapors in the tanks that are not compatible with the transducer material.
    c. Transducers shall be capable of being completely submerged without damage.
    d. Transducers shall be suitable for surface, pipe, or flange mounting as indicated on the Drawings or Instrument Device Schedule. Appropriate mounting hardwired shall be provided. Flanges shall be six inch (150 mm) and resistant to attack by the medium being metered or, where

required, shall be protected by corrosion- resistant coatings and facings.

4. Options/Accessories Required
    a. Transducers located in areas where freezing condensation may occur shall be provided with special heaters or other type of transducer protection designed to prevent sensor icing.
    b. Signal cable as recommended by the manufacturer, for installation between the transducer(s) and the transmitter. Length, up to 1000 feet (300 m), shall be as required by installation indicated on the Drawings.
5. Manufacturer(s)
    a. Siemens Echomax XPS
    b. Endress & Hauser Prosonic FDU92
    c. Or equal.

B. Transmitter/Converter
1. Type
    a. Microprocessor based compatible with the transducer(s) provided.
2. Functional/Performance
    a. Resolution (including transducer): Plus or minus 0.1 percent of range or 0.08 inches (2 mm), whichever is greater.
    b. Accuracy (including transducer): Plus or minus 0.25 percent of range or 0.24 inches (6 mm).
    c. Range: As required by the installation indicated on the Drawings.
    d. Temperature Range: -20 to 50 degrees C.
    e. Output: Minimum one isolated 4-20 mA output and minimum four alarm contacts (number of contacts above 4 required of each device to be determined by signals required as shown on the drawings adjustable to trip at any point in the instrument range. Output contacts shall be rated 5 A at 230 VAC.
    f. Temperature Compensation: Compensation over the temperature range of the sensor.
    g. Display: Digital indicator displaying level/differential level or volume in engineering units or percent as indicated on the Drawings or in the Instrument Device Schedule.
    h. Diagnostics: On-screen instructions and display of self-diagnostics.
    i. Loss of Signal: Transmitter shall ignore momentary loss-of-echo signals and shall indicate loss of echo on the transmitter unit.

j. Configuration Protection: Programmable parameters shall be protected using E2PROM. Battery backup protection is not acceptable.

3. Physical
   a. Transmitter shall be suitable for wall or panel mounting.
   b. Enclosure shall be NEMA 4X (IP65) or better.
   c. Power Requirements: 120 VAC.
4. Accessories Required
   a. Handheld programmer where required for configuration and calibration of the instrument.
5. Manufacturer(s)
   a. Siemens Model HydroRanger 200
   b. Endress & Hauser Prosonic FMU90
   c. Or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. See section 13500 - Instruments.

END OF SECTION

SECTION 13542

LEVEL SWITCHES

PART 1 - GENERAL

1.01 SCOPE.

A. Level Measurement Specification 13530 covers the furnishing of level instruments and accessories required for the Process Control System (PCS) as specified herein or as indicated on the Drawings.

B. Refer to section 13500 - Instruments for general requirements.

PART 2 - PRODUCTS

2.01 FIXED-MOUNT FLOAT TYPE LEVEL SWITCHES

A. Manufacturer(s)
   1. Evoqua Water Technologies Model 9G-EF.
   2. Siemens "9G-EF"
   3. Contegra “FS 90”
   4. Engineer Approved Equal

B. Type
   1. Mercury-free ball float.

C. Functionality
   1. Switch contacts shall be single pole single throw.
   2. Contacts shall be rated 1-amp at 120 VAC.

D. Construction
   1. Nominal 5-1/2 inch diameter.
   2. Coated stainless steel float ball containing sealed switch assembly.
   3. Synthetic rubber hinge hosing the lead wires from the switch.
   4. Lead wires shall be a waterproof cable with the required length to terminate in a junction box without splicing.

E. Installation
   1. The float shall be supported by a flexible synthetic rubber hinge fastened to an adjustable mounting bracket.
   2. Stainless steel mounting hardware and accessories shall be provided as required.

2.02 WEIGHTED FLOAT TYPE LEVEL SWITCHES

A. Manufacturer(s)
   1. Ametek B/W Controls "Series 7010"
   2. Siemens "LSC"
   3. ITT/Flygt "ENM 10"
   4. Gems Sensors & Controls/Warrick Controls "Series M"
   5. Engineer Approved Equal

B. Type
   1. Weighted

C. Functionality
   1. Switch shall be single pole double throw mercury switch.
   2. Contacts shall be rated 3-amp at 120 VAC.
   3. Temperature operating range 0° to 60°C.

D. Construction
   1. Switch shall be sealed and housed in a chemical-resistant polypropylene case.
   2. Switch assembly shall be weighted and suspended from a three-conductor, 19 AWG conductors, in a waterproof synthetic covered flexible cable.
   3. Lead wires shall be required length to terminate in a junction box without splicing.
   4. Suitable for use in sanitary wastewater wet wells.

E. Installation
   1. The float shall be supported by a flexible synthetic rubber hinge fastened to an adjustable mounting bracket.
   2. Adjustable mounting hardware shall be provided for supporting each level switch.

2.03 ULTRASONIC LEVEL SWITCHES.

A. Manufacturer(s)
   1. Magnetrol "Echotel 910"
   2. Siemens “Pointek ULS200”
   3. Or equal

B. Type

1. Level switches shall consist of a relay type switch.

C. Functionality

1. Ultrasonic level switch elements shall utilize ultrasonic sound waves across a gap in the transducer tip to determine the presence of liquid.
2. Actuated by the presence or absence of liquid at the element.
3. Switch contacts shall be:
    a. Double pole double throw.
    b. Rated 10-amp at 120 VAC.
4. The switch shall be provided with automatic self-test circuitry that verifies operation of the unit.
5. A single pole double throw relay for switch failure shall be provided.

D. Construction

1. Elements shall have AISI Type 316 stainless steel wetted parts, with a 1 inch [25 mm] NPT connection.
2. Elements shall be suitable for mounting in either the vertical or horizontal position.
3. Element length shall be as indicated on the Drawings or the Instrument Device Schedule.
4. The switch assembly shall be integrally mounted to the level element and shall be housed in a watertight, corrosion resistant enclosure.

E. Installation

1. Mounting and installation hardware shall be Type 316L stainless steel.

PART 3 - EXECUTION

3.01 GENERAL

A. See section 13500 - Instruments.

END OF SECTION

SECTION 13550

PRESSURE MEASUREMENT

PART 1 - GENERAL

1.01 SCOPE

A. The Pressure Measurement Section covers the furnishing of pressure instruments and accessories required for the Process Control System (PCS) as specified herein or as indicated on the Drawings.

B. Refer to section 13500 - Instruments for general requirements.

PART 2 - PRODUCTS

2.01 ASSOCIATED PRESSURE INSTRUMENT SECTIONS

SECTION	SPEC TITLE
13554	Gauge-Pressure Transmitters

PART 3 - EXECUTION

3.01 GENERAL

A. See section 13500 - Instruments.

END OF SECTION

SECTION 13554

GAUGE PRESSURE TRANSMITTERS

PART 1 - GENERAL

1.01 SCOPE

A. Refer to section 13550 – Pressure Measurement.

PART 2 - PRODUCTS

2.01 FIELD-MOUNT GAUGE PRESSURE

A. Type

1. Microprocessor-based, intelligent type.

B. Function/Performance

1. Range: As indicated in the instrument device schedule. Shall be the standard range of the manufacturer closest to the gauge pressure range to be metered.
2. Accuracy: 0.075 percent of span (linear output).
3. Operating Temperature: -20 to 80 degrees C.
4. Temperature Effect: Combined temperature effects shall be less than 0.2 percent of maximum span per 28 degrees C temperature change.
5. Static Pressure Effect: Effect on accuracy due to static pressure changes shall be negligible.
6. Output: 4-20 mA DC adjustable over the instrument range, with HART protocol. Output shall be linear for differential pressure applications. For flow metering applications, the output shall be proportional to the square root of the input differential pressure.
7. Stability: 0.05 percent of upper range limit for one year.
8. Display
    a. Digital indicator displaying gauge pressure in the engineering units indicated in the Instrument Device Schedule.
9. Diagnostics
    a. Self-diagnostics with transmitter failure driving output to above or below out of range limits.
    b. Simulation capability for inputs and loop outputs.
    c. Test terminals available to ease connection for test equipment without opening the loop.

d. Registers to record minimum and maximum pressure and temperatures transmitter has been exposed to, shall be available.

e. Over Range Protection: Provide positive over range protection to 150 percent of the maximum pressure of the system being monitored by the instrument.

C. Physical

1. Enclosure: NEMA 4X (IP65) for non-hazardous areas. For installation in hazardous areas, housing shall be explosion proof approved for Class 1, Division 1, Groups C and D (EEx d IIB).
2. Process Wetted Parts: Isolating diaphragm and other wetted metal parts shall be Type 316L stainless steel, unless otherwise indicated in the device schedule. Gaskets and O rings shall be Teflon.
3. Power Supply: 24 VDC loop power.
4. Sensor Fill Fluid: Silicone.

D. Accessories Required

1. Provide span and zero adjustment at the transmitter and through the handheld programming unit.
2. Configuration of the transmitter may be accomplished using the local display and pushbuttons without the use of an external programming device.
3. NOTE: Siemens, ABB and Foxboro have this capability.
4. For each transmitter, provide a valve manifold. The manifold shall be Type 316 stainless steel. Manifolds may be mounted directly to the instrument or separately mounted. Manifolds shall be by the instrument manufacturer or by D/A Manufacturing.

E. Manufacturer(s)

1. Rosemount 3051T
2. Endress Hauser Cerabar PMC 71
3. Or Approved Equal.

PART 3 - EXECUTION

3.01 GENERAL

A. See section 13550 – Pressure Instruments.

3.02 INSTALLATION REQUIREMENTS:

A. Install at specified locations indicated on drawings and conform to the

installation details.

B. Install in the vertical, upright positioning for gauges, snubbers, and diaphragm seals.

C. Thread sealer suitable for use with the associated process to be used in assembly of threaded connections.

D. Connections shall be leak free. Lines shall be purged at gauge locations before installation of diaphragm or gauge.

E. Each gauge supplied with necessary mounting hardware.

F. Conforms to mounting requirements in Drawings or Instrument Device Schedule.

G. Unless specified otherwise, mounting and installation hardware to be Type 316L stainless steel.

END OF SECTION

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SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Basic Electrical Requirements specifically applicable to Division 16 Sections, in addition to Division 1 - General Requirements.

1.02 SCOPE

A. This scope covers the furnishing, installation, testing, adjusting and placing in operation all electrical equipment, devices, facilities, materials, and auxiliary items necessary for the complete and successful operation of all electrical equipment as herein described, shown on the plans, or deemed necessary for the completion of the electrical portion of the project. It is the intent of DIVISION 16 to outline the electrical requirements of the contract in order to provide the information necessary for the construction of a fully operational system as shown on the plans and as herein described. A comprehensive electrical scope of work is as follows:

1. Power/Electrical system
2. Lighting system
3. Control system
4. Utility work
5. Connection of electrically powered mechanical equipment
6. Temporary construction power
7. All incidentals necessary for a complete and fully operational electrical system.

1.03 WORKING CLEARANCES

A. Working clearances around equipment requiring electrical services shall be verified by Contractor to comply with Code requirements. Should there be apparent violations of clearances; the Contractor shall notify the Engineer before proceeding with connection or placing of equipment.

B. In the case of panelboards, safety switches and other equipment requiring wire and cable terminations, the Contractor shall ascertain that lug sizes and wiring gutters or space allowed for proper accommodation and termination of the wires and cables are adequate.

1.04 WORKMANSHIP

A. Workmanship under this Division shall be accomplished by persons skilled in the performance of the required task. All work shall be done in keeping with conventions of the trade. Work of this Division shall be closely coordinated with work of other trades to avoid conflict and interference.

1.05 PROTECTION OF ELECTRICAL EQUIPMENT

A. Electrical equipment shall be protected by the weather, especially from water dripping or splashing upon it, at all times during shipment, storage and after installation. Should any apparatus be subjected to possible injury by water, it shall be thoroughly dried out and put through a dielectric test, at the expense of the contractor, to ascertain the suitability of this apparatus. The results of the test shall be submitted to the Engineer and if the apparatus is found to be unsuitable, the contractor shall replace it without additional cost to the Owner.

1.06 UTILITIES

A. The electrical contractor shall install a fully operational electrical service as described in the plans.

B. Arrange with the utility company for the services and install the services in accordance with their requirements, regulations, and recommendations.

1.07 GUARANTEE

A. Contractor shall guarantee all light bulbs. Fluorescent, HID, and LED lamps, starters, and ballasts shall be guaranteed for a period of one (1) year after the building is occupied. Incandescent bulbs shall be guaranteed for a period of 30 days after occupancy. Guarantee shall include material and labor for re-lamping.

B. The Contractor shall guarantee all other electrical systems, materials and workmanship to be free from defects for a period of one (1) year from the date of final acceptance. He shall correct all defects arising within this period upon notification by the Owner or Engineer, without additional compensation.

C. It is understood that the rights and benefits given the Owner by the guarantees found in the technical specifications are in addition to and not in derogation of any rights or benefits found in the special and general provisions of the contract.

1.08 TEMPORARY LIGHTS DURING CONSTRUCTION

A. It shall be the responsibility of the Contractor to provide and maintain adequate temporary lighting at all times during construction, so that the various other trades can accomplish their work in a flawless manner. Particular attention will be given to lighting for masonry, drywall, painting, tile work and any other finish work.

1.09 MATERIAL STANDARDS

A. Material shall be new and comply with standards of Underwriters' Laboratories, Inc., where standards have been established for the particular product and the various NEMA, ANSI, ASTM, IEEE, AEIC, IPCEA or other publications referenced.

1.10 TEST EQUIPMENT

A. The contractor shall provide all test equipment and supplies deemed necessary by the Engineer at no extra cost to the Owner. These supplies shall include but not be limited to the following: volt meters, amp meters, light meters, fuel, generator load banks, watt meters, harmonic distortion test equipment, thermal image camera, high pot test equipment, power quality analyzers, and oscilloscopes.

1.11 REFERENCES

A. ANSI/NFPA 70 – National Electrical Code.

B. ANSIC2 – National Electrical Safety Code.

C. NEMA – National Electrical Manufacturer's Assoc.

D. UL – Underwriters Laboratories

E. NFPA – National Fire Protection Assoc.

F. IEEE – The Institute of Electrical and Electronics Engineers

G. IESNA – The Illuminating Engineering Society of North America

H. NETA – International Electrical Testing Association

I. Recommended Standards for Water Works and Wastewater Facilities as published by Great Lakes – Upper Mississippi River Board of State Public Health and Environmental Managers.

1.12 SUBMITTAL

A. Submit under provisions of the General Provisions.

1. The Contractor installing all Electrical work shall review and approve all electrical shop drawings prior to submittal to the Engineer for review. As part of the review, the installer shall certify the following:

a. I hereby certify that the (equipment (material) (article) shown and marked in this submittal is in compliance with the contract drawing and specifications, can be installed in the allocated space, will be stored in

accordance with the manufacturers recommendation, will be installed per NEC, and is submitted for approval.

Certified by: _____

Date: _____

B. Submit shop drawings and product data grouped to include complete submittal of related systems, products, and accessories in a single submittal. No electrical work may be performed until shop drawings are approved. Submit Shop Drawings on the Following Systems as Grouped Below:

1. Power/Electrical System
    a. Conduit and Conduit Fittings
    b. Wire
    c. Pull Boxes
    d. Panelboards
    e. Panelboard Layouts
    f. Circuit Breakers
    g. Disconnects
    h. Fuses
    i. Conduit Support Systems
    j. Wiring Devices
    k. Switchboards
    l. Transformers
    m. Surge Protection Equipment
    n. Motor Control Centers (MCC)
    o. Breaker Coordination Study
    p. Variable Frequency Drives
    q. Control Panels
2. Generator Equipment
    a. Generator
    b. Fuel System
    c. Generator Enclosure
    d. Automatic Transfer Switch
3. Site Lighting
    a. All light fixtures

1) Computer printout of lighting layout
2) Sample fixtures
3) IES photometric files

4. Control System
   a. PLC
   b. I/O Racks
   c. Field Instruments
   d. HMI Software
5. Miscellaneous Electrical Equipment
   a. Miscellaneous Electrical Parts
6. Drawings
   a. Coordination drawing of All Electrical Rooms/Equipment Racks
   b. Conduit layout drawings
   c. Duct drawings
   d. As-Built Drawings

C. Mark dimensions and values in units to match those specified.

1.13 REGULATORY REQUIREMENTS

A. Conform to applicable sections of the Building Code and all local rules, regulations and ordinances.

B. Electrical: Conform to NFPA 70 & National Electric Safety Code

C. Obtain permits, and request inspections from authority having jurisdiction.

D. References listed in Paragraph 1.11, this section.

1.14 FINAL INSPECTION AND TESTING

A. After the electrical installation is complete, the Contractor shall deliver to the Engineer the following information with his request for final inspection.

1. One set of contract drawings marked to show all significant changes in equipment ratings and locations, alterations in locations of conduit runs, or of any data differing from the contract drawings. This shall include revised or changed panelboard, motor control center, and switchgear schedules.
2. Certificates of final inspection from local authority.
3. A tabulation of all motors listing their respective manufacturer, horsepower, nameplate voltage and current, actual running current after installation

and overload heater rating.

B. The electrical work shall be thoroughly tested to demonstrate that the entire system is in proper working order and in accordance with the plans and specifications. Each motor with its control shall be run as nearly as possible under operating conditions for a sufficient length of time to demonstrate correct alignment, wiring capacity, speed and satisfactory operation. All main switches and circuit breakers shall be operated, but not necessarily at full load. Contractor may be required during final inspection, at the request of the Engineer to furnish test instruments for use during the testing.

C. All wiring shall be given a megger test using a 1000 Volt megger. This test shall be performed after conductors are pulled, but before final connections are made. The Engineer shall be given two (2) days' written notice of the anticipated test date so that he may witness the test if so desired. In any event, the Contractor shall record the circuit designation and the megger reading on each phase. This written record shall be submitted to the Engineer. The cost of this test or any retest caused by insufficient megger readings shall be the responsibility of the Contractor (All tests shall be done in accordance with NETA Standards).

1.15 STAFFING

A. The electrical contractor shall provide a “Master Electrician” who has been deemed a “Master Electrician” by exam through the State associated with the project location, or any other County in the State Permitting Authority as the Electrical Superintendent for the project. The Electrical Superintendent shall be on the project site any time any electrical work is performed by the contractor.

B. In addition, the contractor shall provide one Journeyman electrician for every four electrical helpers used on the project site.

1.16 PROCESS EQUIPMENT

A. The electrical contractor is required and expected to read all other equipment specifications contained in these documents and provide all required power and control conductors required by said equipment to allow them to function as described.

B. All equipment for which power is not specifically indicated on the plans shall be provided with power per the NEC to the nearest panelboard, MCC, or switchboard with adequate capacity to serve said equipment as calculated by the NEC.

1.17 AS-BUILT DRAWINGS

A. The contractor shall provide detailed as-built drawings for the project indicat

ing all power wiring. (All Drawings shall be delivered to the Owner in an AutoCAD 2013 Format.)

B. The As-Built drawings shall include detailed drawings of all duct banks, underground conduit, above ground conduit, motor control centers, PLC control panels, control drawings. These drawings shall indicate exact location of all underground electrical wiring and fiber optic cable.

C. The Engineer shall provide electronic copies of all drawings in the bid plans set for use by the contractor.

END OF SECTION

SECTION 16055

OVERCURRENT PROTECTIVE DEVICE COORDINATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. All new overcurrent protection devices installed in the plant facility shall be selectively coordinated.

B. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.

1. Coordination of series-rated devices is permitted where indicated on Drawings.

1.03 SUBMITTALS

A. Qualification Data: For coordination-study specialist.

B. Submittals: Submittals shall be in paper and electronic forms.

1. Coordination-study input data, including completed computer program input data sheets.
2. Study and Equipment Evaluation Reports.
3. Coordination-Study Report (breaker curves in color).
4. Provide Electronic Study for Engineer Review.

1.04 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

C. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under

the direct supervision and control of engineer.

D. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

E. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.01 COMPUTER SOFTWARE

A. Product:

1. SKM Systems Analysis, Inc.
2. Easy Power
3. Engineer Approved Equal

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.02 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:

1. Product Data for overcurrent protective devices specified in other Division 16 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Impedance of utility service entrance.
3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
    a. Circuit-breaker and fuse-current ratings and types.
    b. Relays and associated power and current transformer ratings and ratios.

c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

d. Generator kilovolt amperes, size, voltage, and source impedance.

e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.

f. Busway ampacity and impedance.

g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.

b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal-damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.

f. Special overcurrent protective device settings or types stipulated by utility company.

g. Time-current-characteristic curves of devices indicated to be coordinated.

h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.03 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Motor-control center.

2. Distribution panelboard.
3. Branch circuit panelboard.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10.
      b. ANSI C57.12.22.
      c. ANSI C57.12.40.
      d. IEEE C57.12.00.
      e. IEEE C57.96.
   2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
   3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
   2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:
   1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.04 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141 and IEEE 242 recommendations for fault currents and time intervals. (Comply with NEC for selective coordination NFPA 70; 240.12, 700.27, 701.18)

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:
   a. Inrush current when first energized.
   b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
   c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
   a. Device tag.
   b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
   c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
   d. Fuse-current rating and type.

e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices bound in a 3 ring binder.

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1. Underground distribution grounding.
2. Common ground bonding with lightning protection system.

1.03 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:

1. Ground rods.
2. Ground rings.
3. Grounding arrangements and connections for separately derived systems.
4. Grounding for sensitive electronic equipment.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at ground rings grounding connections for separately derived systems based on NFPA 70.
    a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.

b. Include recommended testing intervals.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators.

2.02 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.03 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel, sectional type, 1 inch in diameter (length as

required to achieve resistance to ground as specified in 3.5, B).

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: All conductors shall be stranded.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.02 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.

3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
9. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Anti-frost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

G. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bus.
2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding

terminal.

H. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.03 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

E. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically by

pass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building area or item indicated.

1. Install copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.

2. Bury ground ring not less than 24 inches from building foundation.

3.04 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and

Less: 5 ohms.

2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm.
5. Substations and Pad-Mounted Equipment: 5 ohms.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 16073

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.03 DEFINITIONS

A. IMC: Intermediate metal conduit.

B. RMC: Rigid metal conduit.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer**.** Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.07 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Stainless Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper B-Line, Inc.; a division of Cooper Industries.
      b. Thomas & Betts Corporation.
      c. Unistrut; Tyco International, Ltd.

B. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper B-Line, Inc.; a division of Cooper Industries.
      b. Unistrut; Tyco International, Ltd.
   2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
   3. Fitting and Accessory Materials: Same as channels and angles, except metal items shall be stainless steel.
   4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. Conduit and Cable Support Devices: Stainless Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-stainless steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Hilti Inc.
        3) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        4) MKT Fastening, LLC.
3. Clamps for Attachment to Steel Structural Elements: Stainless Steel, type suitable for attached structural element.
4. Through Bolts: Stainless Steel Structural type, hex head, and high strength.
5. Hanger Rods: Threaded stainless steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-stainless steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for conduit per NFPA 70. Minimum rod size shall be $1/4$ inch in diameter.

C. Multiple Raceways or Cables **(All spaces except chemical feed areas)**: Install trapeze-type supports fabricated with stainless steel slotted system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps

D. Multiple Raceways or Cables **(All chemical feed areas)**: Install trapeze-type supports fabricated with slotted nonmetallic system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt nonmetallic conduit clamps

3.02 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To New Concrete: Expansion anchor fasteners.
2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

3. To Existing Concrete: Expansion anchor fasteners.
4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete”.

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

A. Touchup: Comply with requirements in Division 9 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.03 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.04 QUALITY ASSURANCE

A. Comply with ANSI A13.1, ANSI C2, and ANSI Z635.4.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.05 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wir

ing diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

E. Install all signs and labels horizontal (level) and consistent for similar equipment and panels.

PART 2 - PRODUCTS

2.01 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use

2.02 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Aluminum Wraparound Marker Labels: Cut from 0.014-inch- thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.

2.03 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.

2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

PART 3 - EXECUTION

3.01 APPLICATION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with snap-around label.

1. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands:

1. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
2. Fire Alarm System: Red.
3. Fire-Suppression Supervisory and Control System: Red and yellow.
4. Combined Fire Alarm and Security System: Red and blue.
5. Security System: Blue and yellow.
6. Mechanical and Electrical Supervisory System: Green and blue.
7. Telecommunication System: Green and yellow.
8. Control Wiring: Green and red.

C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

1. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use color-coding conductor tape. Identify each ungrounded conductor according to source and

circuit number.

1. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

1. Write-On Tags: Polyester tag, 0.015 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
4. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway. During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches above duct. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

1. Description:
   a. Permanent, bright-colored, continuous-printed, polyethylene tape.
   b. Not less than 6 inches wide by 4 mils thick.
   c. Compounded for permanent direct-burial service.
   d. Embedded continuous metallic strip or core.
   e. Printed legend shall indicate type of underground line.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background.

Apply to exterior of door, cover, or other access.

1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
   a. Power transfer switches.
   b. Controls with external control power connections.Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
2. Comply with NFPA 70 and 29 CFR 1910.145.
3. Self-Adhesive Warning Labels: Factory printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment, unless otherwise indicated.
4. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.
5. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
6. Warning label and sign shall include, but are not limited to, the following legends:
   a. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   b. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

I. Instruction Signs:

1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with ENGINEER/OWNER APPROVED instructions where needed for system or equipment operation. Instructions are needed for all equipment unless otherwise noted.
   a. Signs shall be engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
   b. The engraved legend shall be ½ “ White letters on Brown face, and punched or drilled for mechanical fasteners.
   c. The signs shall be installed with stainless hardware.

2. Emergency Operating Instructions: Install emergency operating instruction signs at equipment used for power transfer, safety shutdown, or any other locations requiring operation in an emergency.
    a. Signs shall be engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
    b. The engraved legend shall be ½ " White letters on Red face, and punched or drilled for mechanical fasteners.
    c. The signs shall be installed with stainless hardware.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
    1. Labeling Instructions:
        a. Indoor and Outdoor Equipment: Use engraved, laminated acrylic or melamine labels, punched or drilled for screw mounting Identification labels shall have white letters on a dark-gray background. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where 2 lines of text are required, use labels 2 inches high. Mount labels with stainless hardware.
        b. Elevated Components: Increase the size of the labels and letters to those appropriate for viewing from the floor.
    2. Equipment to Be Labeled:
        a. Identification labeling of some items listed below may be required by individual Sections or by NFPA 70.
        b. Panelboards, electrical cabinets, and enclosures.
        c. Access doors and panels for concealed electrical items.
        d. Electrical switchgear and switchboards.
        e. Transformers.
        f. Electrical substations.
        g. Emergency system boxes and enclosures.
        h. Motor-control centers.
        i. Disconnect switches.
        j. Enclosed circuit breakers.
        k. Motor starters.

l. Push-button stations.
m. Power transfer equipment.
n. Contactors.
o. Battery inverter units.
p. Battery racks.
q. Power-generating units.
r. Voice and data cable terminal equipment.
s. Television/audio components, racks, and controls.
t. Fire-alarm control panel and annunciators.
u. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
v. Monitoring and control equipment.
w. Uninterruptible power supply equipment.
x. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.
y. Control systems
z. Field mounted control devices
aa. Field mounted instruments

3.02 INSTALLATION PRACTICES

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

D. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
   1. Color shall be factory applied or, for sizes LARGER than No. 10 AWG if authorities having jurisdiction permit, field applied.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.

c. Phase C: Blue.

3. Colors for 480/277-V Circuits:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

E. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

F. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

END OF SECTION

SECTION 16120

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Wires and cables rated 600 V and less.
2. Connectors and terminations rated 600 V and less.
3. Sleeves and sleeve seals for cables.

B. Restrictions

1. All wire/cable runs of any type must be continuous. Splices are expressly prohibited.

1.03 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

1.06 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. Beldon CDT Inc.
4. General Cable Corporation.
5. Senator Wire & Cable Company.
6. Southwire Company.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types XHHW and SO.

E. Multiconductor Cable: Comply with NEMA WC 70 for metal-clad cable, Type MC and Type SO with ground wire.

2.02 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.03 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, gal

vanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.04 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
2. Pressure Plates: Stainless steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper, stranded.

B. Branch Circuits: Copper, stranded.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type XHHW-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type XHHW-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type XHHW-2, single conductors in raceway.

F. Feeders in Cable Tray: Type XHHW-2, single conductors in raceway.

G. Exposed Branch Circuits, Including in Crawlspaces: Type XHHW-2, single conductors in raceway.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type XHHW-2, single conductors in raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

J. Branch Circuits Installed below Raised Flooring: Metal-clad cable, Type MC.

K. Branch Circuits in Cable Tray: Type TC.

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

M. All control cables between the PLCs / MMCs and field instruments: 2 # 18 AWG, twisted shielded pair, UL Instrument Cable, XLPE conductor insulation, PVC outer jacket.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Identify and color-code conductors and cables according to Division 16 Sec

tion "Electrical Identification."

3.04 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and cable unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to local codes and the manufacturer’s written in

structions.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to local codes and the manufacturer's written instructions.

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.06 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal

3.07 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to local codes and the manufacturer's written instructions.

3.08 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors, and conductors feeding the following critical equipment and services for compliance with requirements.
    a. All Process Equipment.
    b. Panels/Switchboards/Transformers/Transfer Switches
    c. Pumps

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. All megger readings using a 1000 V dc megger shall be greater than 50 mega ohms.
4. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:
    1. Test procedures used.
    2. Test results that comply with requirements.
    3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 16130

RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following: 16135

1.03 DEFINITIONS

A. FMC: Flexible metal conduit.

B. IMC: Intermediate metal conduit.

C. LFNC: Liquidtight flexible nonmetallic conduit.

D. RNC: Rigid nonmetallic conduit.

1.04 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.

1. For handholes and boxes for underground wiring, including the following:
    a. Duct entry provisions, including locations and duct sizes.
    b. Frame and cover design.
    c. Grounding details.
    d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
    e. Joint details.

C. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input

from installers of the items involved:

1. Structural members in the paths of conduit groups with common supports.
2. HVAC and plumbing items and other features in the paths of conduit groups with common supports.

D. Source quality-control test reports.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

C. For each type of conduit, all fittings shall be of one manufacturer.

PART 2 - PRODUCTS

2.01 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube & Conduit; a Tyco International Ltd. Co.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. Electri-Flex Co.
6. Manhattan/CDT/Cole-Flex.
7. Maverick Tube Corporation.
8. O-Z Gedney; a unit of General Signal.
9. Wheatland Tube Company.

B. Aluminum Rigid Conduit: ANSI C80.5.

C. FMC: aluminum: NOT ALLOWED

D. EMT: NOT ALLOWED

E. Fittings for Conduit and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with

UL 886.

2.02 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Anamet Electrical, Inc.; Anaconda Metal Hose.
   3. Arnco Corporation.
   4. CANTEX Inc.
   5. CertainTeed Corp.; Pipe & Plastics Group.
   6. Condux International, Inc.
   7. ElecSYS, Inc.
   8. Electri-Flex Co.
   9. Lamson & Sessions; Carlon Electrical Products.
   10. Manhattan/CDT/Cole-Flex.
   11. RACO; a Hubbell Company.
   12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. LFNC: UL 1660.

D. Fittings for ENT and RNC: NEMA TC 3; match to conduit or tubing type and material.

E. Fittings for LFNC: UL 514B.

2.03 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Arnco Corporation.
   2. Endot Industries Inc.
   3. IPEX Inc.
   4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for general-use installation.

2.04 NONMETALLIC WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hoffman.
2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

D. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.05 SURFACE RACEWAYS

A. Surface Nonmetallic Raceways: Two-piece construction, manufactured of rigid PVC with texture and color selected by Engineer from manufacturer's standard colors.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Butler Manufacturing Company; Walker Division.
   b. Enduro Systems, Inc.; Composite Products Division.
   c. Hubbell Incorporated; Wiring Device-Kellems Division.
   d. Lamson & Sessions; Carlon Electrical Products.
   e. Panduit Corp.
   f. Walker Systems, Inc.; Wiremold Company (The).
   g. Wiremold Company (The); Electrical Sales Division.

2.06 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.

4. Hoffman.
5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
6. O-Z/Gedney; a unit of General Signal.
7. RACO; a Hubbell Company.
8. Robroy Industries, Inc.; Enclosure Division.
9. Scott Fetzer Co.; Adalet Division.
10. Spring City Electrical Manufacturing Company.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The).
13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, aluminum, Type FD, with gasketed cover.

C. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

D. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.

E. Cabinets:
1. NEMA 250, Type 1, stainless-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.07 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. Description: Comply with SCTE 77.
1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have open bottoms with 8” of gravel fill below the bottom of the box.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, as indicated for each service.

6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with the entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 24 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armorcast Products Company.
b. Carson Industries LLC.
c. CDR Systems Corporation.
d. Hubble Power Systems, Quazite

2.08 SLEEVES FOR RACEWAYS

A. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.

C. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.09 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
1. Pressure Plates: Stainless steel. Include two for each sealing element.
2. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit, Non-Hazardous areas: Rigid aluminum conduit.
2. Exposed Conduit, Hazardous locations: Stainless Steel
3. Concealed Conduit, Aboveground: Rigid aluminum conduit.
4. Underground Conduit: RNC, Type EPC-40-PVC, direct buried.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
6. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X.
7. Application of Handholes and Boxes for Underground Wiring:
    a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Chemical Feed Areas: EPC-40 PVC
2. Exposed: Rigid aluminum conduit.
3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC
4. Damp or Wet Locations: Rigid aluminum conduit.
5. Raceways for Optical Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical fiber/communications cable raceway.
6. Raceways for Optical Fiber or Communications Cable Risers in Vertical

Shafts: Riser-type, optical fiber/communications cable raceway.

7. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: Plenum-type, optical fiber/communications cable raceway.
8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Aluminum Conduit: Use threaded aluminum conduit fittings, unless otherwise indicated.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. All aluminum conduit installed in contact with concrete or earth shall be protected with two coats of 3M Scotchrap Pipe Primer and then wrapped with one layer of 3M “Scotchrap –All Weather Corrosion Protection Tape” per the manufacturers recommendations.

3.02 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

F. Conceal conduit within finished walls, ceilings, and floors, unless otherwise indicated.

G. Raceways Embedded in Slabs:

1. Run all conduits parallel or at right angles to main reinforcement. Where at

right angles to reinforcement, place conduit close to slab support.

2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from Type EPC-40-PVC to rigid aluminum conduit, 3” before rising above the floor.

H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

I. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

J. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

K. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size: Install raceways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

M. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet.
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.

c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F temperature change.

d. Attics: 135 deg Ftemperature change.

2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change.

3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

O. Use LFNC in damp or wet locations not subject to severe physical damage.

P. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

Q. Set metal floor boxes level and flush with finished floor surface.

R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

S. The use of LFNC to accomplish bends, turns, or otherwise ease of installation, and not detailed in Section 3.1.A.4, 3.1.B.5, or 3.2.N is expressly prohibited. Any exceptions will be at the sole discretion of the engineer and must be a written request with full justification.

T. All underground conduits shall be spaced three times the trade size diameter apart.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified in Division 2 Section "Earthwork."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with

expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."

4. Conduit shall be provided with premanufactured conduit spaces designed to provide 3” separation between conduits. Spaces shall be equal to Carlon Snap-Loc or approved equal.
5. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
    a. Couple conduits to ducts with adapters designed for this purpose.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

B. Concrete Encased Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 2 Section "Earthwork."
3. Concrete shall be 3000 PSI, Fiber Reinforced with Red Dye added.
4. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
5. Conduit shall be provided with pre manufactured conduit spaces designed to provide 3” separation between conduits. Spaces shall be equal to Carlon Snap-Loc or approved equal.
6. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
    a. Couple conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. For stub-ups at equipment mounted on outdoor concrete bases, extend conduit horizontally a minimum of 60 inches from edge of equip

ment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

3.05 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:

1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.06 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position the raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.07 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

3.08 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 16135

UNDERGROUND DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.
2. Handholes and boxes.
3. Manholes.

1.03 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.04 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes**,** and other utility structures.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Frame and cover design and manhole frame support rings.
4. Ladder/Step details.
5. Grounding details.

6. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
7. Joint details.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Cover design.
   3. Grounding details.
   4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
   2. Drawings shall be signed and sealed by a qualified professional engineer.

E. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

F. Qualification Data: For professional engineer and testing agency.

G. Source quality-control test reports.

H. Field quality-control test reports.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store non-metallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.07 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify the Engineer, Construction Manager, and Owner no fewer than 5 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the Engineer's written permission.

1.08 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Engineer.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators**,** and associated fasteners in quantities equal to 10% percent of quantity of each item installed.

PART 2 - PRODUCTS

2.01 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.02 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

C. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following, or approved equal:

1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

D. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

E. Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type DB-60-PVC and Type DB-80-PVC, ASTM F 512, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9.

F. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 16 Section "Electrical Identification."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches in size, manufactured from 6000-psi concrete.
    a. Color: Red dye added to concrete during batching.

b. Mark each plank with "ELECTRIC" in 2-inch- high, 3/8-inch- deep letters.

2.03 PRECAST CONCRETE HANDHOLES AND BOXES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Elmhurst-Chicago Stone Co.
4. Oldcastle Precast Group.
5. Riverton Concrete Products; a division of Cretex Companies, Inc.
6. Utility Concrete Products, LLC.
7. Utility Vault Co.
8. Wausau Tile, Inc.

C. Comply with ASTM C 858 for design and manufacturing processes.

D. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
3. Frame and Cover: Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.
4. Frame and Cover: Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
    a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    b. Cover Handle: Recessed.

5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRICAL." Or "CONTROL"
7. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
8. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
    a. Extension shall provide increased depth of 12 inches.
    b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
9. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
    a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.
10. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
    a. Type and size shall match fittings to duct or conduit to be terminated.
    b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.
11. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.04 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.
    1. Color: Gray.
    2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
    3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
    4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

5. Cover Legend: Molded lettering, "ELECTRICAL." Or "CONTROL."
6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following, or approved equal:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. CDR Systems Corporation.
      d. NewBasis.
      e. Quazite

C. Fiberglass Handholes and Boxes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following, or approved equal:
      a. Armorcast Products Company.
      b. Carson Industries LLC.
      c. Christy Concrete Products.

d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.

D. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of polymer concrete.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following, or approved equal:
   a. Carson Industries LLC.
   b. Christy Concrete Products.
   c. Nordic Fiberglass, Inc.

E. High-Density Plastic Boxes: Injection molded of high-density polyethylene or copolymer-polypropylene. Cover shall be plastic.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following, or approved equal:
   a. Carson Industries LLC.
   b. Nordic Fiberglass, Inc.
   c. PenCell Plastics.

2.05 PRECAST MANHOLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

1. Carder Concrete Products.
2. Christy Concrete Products.
3. Oldcastle Precast Group.
4. Riverton Concrete Products; a division of Cretex Companies, Inc.

5. Utility Vault Co.

C. Coordinate first paragraph below with Drawings.

D. Comply with ASTM C 858[**,** and with interlocking mating sections, complete with accessories, hardware, and features.

1. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

a. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.

b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.

c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

2. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.

b. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable.

E. Concrete Knockout Panels: 1-1/2 to 2 inches thick, for future conduit entrance and sleeve for ground rod.

F. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.06 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C 858 and with Division 3 Section "Cast-in Place Concrete."

C. Structural Design Loading: As specified in Part 3 "Underground Enclosure Application" Article.

2.07 UTILITY STRUCTURE ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufac

turers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following, or approved equal:

1. Bilco Company (The).
2. Campbell Foundry Company.
3. Carder Concrete Products.
4. Christy Concrete Products.
5. East Jordan Iron Works, Inc.
6. Elmhurst-Chicago Stone Co.
7. McKinley Iron Works, Inc.
8. Neenah Foundry Company.
9. NewBasis.
10. Oldcastle Precast Group.
11. Osburn Associates, Inc.
12. Pennsylvania Insert Corporation.
13. Riverton Concrete Products; a division of Cretex Companies, Inc..
14. Strongwell Corporation; Lenoir City Division.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.
    a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
2. Cover Legend: Cast in. Selected to suit system.
    a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.

b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.

c. Legend: "SIGNAL" for communications, data, and telephone duct systems.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

D. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

F. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.

G. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

H. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

J. Cable Rack Assembly: Steel, hot-dip galvanized, except insulators.

1. Stanchions: T-section or channel; 2-1/4-inch nominal size; punched with 14 holes on 1-1/2-inch centers for cable-arm attachment.

2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.

3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with minimum of 9 holes for arm attachment.

2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

L. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 degrees F. Capable of withstanding temperature of 300 degrees F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

M. Fixed Manhole Ladders: Arranged for attachment to wall, and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

N. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length shall be equal to distance from deepest manhole floor to grade plus 36 inches. One required.

O. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

2.08 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by a independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification

complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.01 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-80-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Feeders 600 V and Less: RNC**,** NEMA Type EPC-80-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

E. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

F. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC installed in direct-buried duct bank, unless otherwise indicated.

G. Underground Ducts Crossing Paved Paths, Walks, and Driveways, Roadways, and Railroads: RNC, NEMA Type EPC-40-PVC, encased in reinforced concrete.

3.02 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less**,** Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-20 structural load rating.
2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.
3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.03 EARTHWORK

A. Excavation and Backfill: Comply with Division 2 Section "Earthwork," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 2 Sections "Lawns and Grasses" and "Exterior Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 1 Section "Cutting and Patching."

3.04 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or hand

hole.

3. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Coordinate design of concrete-encased duct banks approaching building wall penetrations with building structural design to support ducts at wall, without reducing structural or watertight integrity of building. Do not use steel conduit in highly corrosive soils. Coordinate with Drawings.

F. Sleeves and sleeve seals for conduits penetrating building walls below grade are specified in Division 16 Section "Basic Electrical Materials and Methods."

G. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 16 Section "Basic Electrical Materials and Methods."

H. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

I. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.

J. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not

allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Tape: Bury warning tape approximately 12 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

K. Direct-Buried Duct Banks:
    1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
    2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators

to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.

3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 2 Section "Earthwork" for pipes less than 6 inches in nominal diameter.
4. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."
5. Delete subparagraph below if dimensioned duct sections are shown on Drawings.
6. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
7. Requirements in first subparagraph below exceed NFPA 70. Retain for conservative design.
8. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
9. Set elevation of bottom of duct bank below the frost line.
10. Direct-buried, PVC duct elbows in first subparagraph below are particularly vulnerable to damage by pulling lines when cable pulling tensions are high. Rigid steel conduit elbows are sometimes specified for these stub-ups to prevent such damage. However, concrete encasement of PVC duct elbows, together with reduced pulling tensions, is also used in these situations. Pulling tensions can be reduced by making duct runs from the closest manhole or handhole as short as possible and arranging duct banks so stub-up elbows have the longest possible radius. 5-inch (125-mm) duct elbows are available in standard radii of 24, 36, 48, and 60 inches (300, 900, 1200, and 1500 mm) and greater. Coordinate with Drawings and see Editing Instruction No. 3 in the Evaluations.
11. Retain one of first two subparagraphs and associated subparagraphs below to specify type of stub-ups for direct-buried ducts in Project.
12. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
13. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

14. Warning Planks: Bury warning planks approximately 12 inches above direct-buried ducts and duct banks, placing them 24 inches o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

3.05 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Windows for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Cast-in-place concrete, formwork, and reinforcement are specified in Division 3 Section "Cast-in-Place Concrete."

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below the frost line.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate

with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Dampproofing: Apply dampproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Dampproofing materials and installation are specified in Division 7 Section "Bituminous Dampproofing." After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Coordinate paragraph below with Drawings. Delete second option if nonmetallic cable racks are specified.

I. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators**,** as required for installation and support of cables and conductors and as indicated.

J. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

K. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

L. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.06 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required

for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below the frost line.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Division 3 Section "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.07 GROUNDING

A. Ground underground ducts and utility structures according to Division 16 Section "Grounding and Bonding."

3.08 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.

3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 16 Section "Grounding and Bonding."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.09 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Receptacles with integral surge suppression units.
4. Isolated-ground receptacles.

1.03 DEFINITIONS

A. Retain term and abbreviations that remain after this Section has been edited.

B. EMI: Electromagnetic interference.

C. GFCI: Ground-fault circuit interrupter.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-frequency interference.

F. UTP: Unshielded twisted pair.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Retain first paragraph below if products have critical features needing hands-on appraisal.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain all wiring devices and associated wall plates from a single manufacturer and one source. (No deviation without written permission from the owner and engineer.)

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.06 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Retain subparagraph below if cord and plug sets are specified in Part 2.
   2. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   3. Leviton Mfg. Company Inc. (Leviton).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.02 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 5351 (single), 5352 (duplex).
      b. Hubbell; HBL5351 (single), CR5352 (duplex).
      c. Leviton; 5891 (single), 5352 (duplex).

d. Pass & Seymour; 5381 (single), 5352 (duplex).

B. Isolated-Ground, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Hubbell; CR 5253IG.

b. Leviton; 5362-IG.

c. Pass & Seymour; IG6300.

2. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

2. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; TR8300.

b. Hubbell; HBL8300SG.

c. Leviton; 8300-SGG.

d. Pass & Seymour; 63H.

e. <Insert manufacturer's name; catalog number.>

3. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.03 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Products: Subject to compliance with requirements, provide one of the following:

1. Cooper; GF20.

2. Pass & Seymour; 2084.

2.04 TVSS RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 1449, with integral TVSS in line to ground, line to neutral, and neutral to ground.
   1. TVSS Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 volts and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
   2. Active TVSS Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex TVSS Convenience Receptacles:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; 5362BLS.
      b. Hubbell; HBL5362SA.
      c. Leviton; 5380.
   2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R.

C. Isolated-Ground, Duplex Convenience Receptacles:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; IG5362BLS.
      b. Hubbell; IG5362SA.
      c. Leviton; 5380-IG.
   2. Description: Straight blade, 125 V, 20 A; NEMA WD 6 configuration 5-20R. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.05 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Wiring Devices for Hazardous (Classified) Locations: Comply with NEMA FB 11 and UL 1010.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Cooper Crouse-Hinds.
      b. EGS/Appleton Electric.
      c. Killark; a division of Hubbell Inc.

2.06 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Cooper; L520R.
      b. Hubbell; HBL2310.
      c. Leviton; 2310.
      d. Pass & Seymour; L520-R.

B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
   2. Hubbell; IG2310.
      a. Leviton; 2310-IG.
   3. Description: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.07 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
   2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.08 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: As selected by Engineer, unless otherwise indicated or required by NFPA 70 or device listing.
   2. Wiring Devices Connected to Emergency Power System: Red.
   3. TVSS Devices: Blue.

4. Isolated-Ground Receptacles: As specified above, with orange triangle on face.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace all damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
   1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.

F. Recommendation in subparagraph below is made in IEEE 602.

G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

H. Coordinate two paragraphs below with Drawings.

I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

J. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.02 IDENTIFICATION

A. Comply with Division 16 Section "Electrical Identification."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with [black] [white] [red]-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.03 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 16289

TRANSIENT VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes SPDs for low-voltage power, control, and communication equipment.

B. Related Sections include the following:

1. Division 16 Section "Wiring Devices" for devices with integral SPDs.

1.03 DEFINITIONS

A. Retain abbreviations that remain after this Section has been edited.

B. ATS: Acceptance Testing Specifications.

C. SVR: Suppressed voltage rating.

D. SPD: Surge Protection Device.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, operating weights, operating characteristics, furnished specialties, and accessories.

B. Product Certificates: For transient voltage suppression devices, signed by product manufacturer certifying compliance with the following standards:

1. UL 1283.
2. UL 1449.

C. Coordinate paragraph below with qualification requirements in Division 1 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

D. Retain first paragraph and subparagraphs below if Contractor is responsible for field quality-control testing.

E. Field quality-control test reports, including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Failed test results and corrective action taken to achieve requirements.

F. Operation and Maintenance Data: For transient voltage suppression devices to include in emergency, operation, and maintenance manuals.

G. Warranties: Special warranties specified in this Section.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain suppression devices and accessories through one source from a single manufacturer.

B. Product Options: Drawings indicate size, dimensional requirements, and electrical performance of suppressors and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."

E. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices."

F. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Transient Voltage Surge Suppressors."

1.06 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify Engineer not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Engineer's written permission.

B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
2. Operating Temperature: 30 to 120 deg F.
3. Humidity: 0 to 85 percent, noncondensing.
4. Altitude: Less than 20,000 feet above sea level.

1.07 COORDINATION

A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

B. Coordinate surge protection devices with Division 16 Section "Electrical Power Monitoring and Control."

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

1.09 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products.

B. Retain above for nonproprietary or below for semiproprietary specification. Refer to Division 1 Section "Product Requirements."

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advanced Protection Technologies, Inc.
   2. Current Technology, Inc.
   3. Leviton Mfg. Company Inc.
   4. Liebert Corporation; a division of Emerson.
   5. Square D; Schneider Electric.

6. Surge Suppression Incorporated.
7. Cuttler-Hammer

2.02 SERVICE ENTRANCE SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
   1. LED indicator lights for power and protection status.
   2. Audible alarm, with silencing switch, to indicate when protection has failed.
   3. One set of dry contacts per phase rated at 5 A and 250-V ac, for remote monitoring of protection status. (Contacts shall connected in either series or parallel as required to provide a single input to the plant control system.)

B. Retain first option in first paragraph below for high exposure and cost, second option for medium exposure and cost, and third option for low exposure and cost.

C. Peak Single-Impulse Surge Current Rating: 300 kA per phase.

D. Connection Means: Permanently wired.

E. Retain one of four paragraphs and associated subparagraphs below. Adjust clamping voltages to comply with Project conditions and verify compatibility of peak surge current rating and clamping voltage. Reference to UL 1449 is to the Second Edition.

F. Protection modes and UL 1449 SVR for delta circuits with voltages of 480V, 3-phase, 3-wire circuits shall be as follows:
   1. Line to Line: 1500 V for 480V.
   2. Line to Ground: 1000 V for 480V.

2.03 PANELBOARD SUPPRESSORS

A. Surge Protection Device Description: Non-modular, sine-wave-tracking type with the following features and accessories:
   1. LED indicator lights for power and protection status.
   2. Audible alarm, with silencing switch, to indicate when protection has failed.
   3. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.

B. Retain first option in paragraph below for high exposure and cost, second option for medium exposure and cost, and third option for low exposure and cost.

C. Peak Single-Impulse Surge Current Rating: 50 kA per phase.

D. Retain one of four paragraphs and associated subparagraphs below. Adjust clamping voltages to comply with Project conditions and verify compatibility of peak surge current rating and clamping voltage. Reference to UL 1449 is to the Second Edition.

E. Protection modes and UL 1449 SVR for grounded wye circuits with voltages of 208Y/120, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 400 V for 208Y/120.
2. Line to Ground: 400 V for 208Y/120.
3. Neutral to Ground: 400 V for 208Y/120.

F. Protection modes and UL 1449 SVR for delta circuits with voltages of 480V, 3-phase, 3-wire circuits shall be as follows:

1. Line to Line: 1500 V for 480V.
2. Line to Ground: 800 V for 480V.

2.04 PLUG-IN SURGE SUPPRESSORS

A. Description: Non-modular, plug-in suppressors with at least four 15-A, 120-V ac, NEMA WD 6, Configuration 15-15R receptacles, suitable to plug into a NEMA WD 6, Configuration 15-15R receptacle; with the following features and accessories:

1. LED indicator lights for power and protection status.
2. LED indicator lights for reverse polarity and open outlet ground.
3. Circuit breaker and thermal fusing. When protection is lost, circuit opens and cannot be reset.

B. Peak Single-Impulse Surge Current Rating: 33 kA per phase.

C. Protection modes and UL 1449 SVR shall be as follows:

1. Line to Neutral: 475 V.
2. Line to Ground: 475 V.
3. Neutral to Ground: 475 V.

2.05 ENCLOSURES

A. Interior enclosures to be NEMA 1.

B. Exterior enclosures to be NEMA 4X, Stainless Steel.

PART 3 - EXECUTION

3.01 INSTALLATION OF SURGE PROTECTION DEVICES

A. Install devices at each service entrance on load side, with ground lead bonded to service entrance ground.

B. Install devices for each panelboard and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Comply with manufacturer's written recommendation for conductor and circuit-breaker size for connecting SPD devices to distribution system. Match circuit-breaker size to conductor size. Coordinate with Drawings.
2. Provide multipole, circuit breaker as a dedicated disconnect for suppressor, unless otherwise indicated.

3.02 PLACING SYSTEM INTO SERVICE

A. Do not energize or connect service entrance equipment, panelboards, control terminals, and data terminals to their sources until surge protection devices are installed and connected.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust equipment installation, including connections, and to assist in field testing. Report results in writing.

1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Testing: Perform the following field tests and inspections and prepare test reports:

1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

C. Remove and replace malfunctioning units and retest as specified above.

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's mainte

nance personnel to adjust, operate, and maintain transient voltage suppression devices. Refer to Division 1 for training requirements.

END OF SECTION

SECTION 16410

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Molded-case circuit breakers (MCCBs).
5. Enclosures.

1.03 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.04 SUBMITTALS

A. First two paragraphs below are defined in Division 1 Section "Submittal Procedures" as "Action Submittals."

B. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Retain first subparagraph below if using series rating of overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual

overcurrent protective devices, accessories, and auxiliary components.

6. Retain subparagraph below if final system short-circuit and coordination studies will be performed by the designer or will be assigned to an independent consultant. These curves are also beneficial to Owner for future additions or reevaluations of settings of overcurrent protective devices. Although some manufacturers no longer offer curves on translucent graph paper, curves can normally be downloaded from manufacturers' Web sites or be obtained, in electronic form, from various coordination software vendors as part of a subscription service. Retain option in subparagraph below only if manufacturers selected offer curves on graph paper.
7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

C. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

D. Remaining paragraphs are defined in Division 1 Section "Submittal Procedures" as "Informational Submittals."

E. Coordinate first paragraph below with qualification requirements in Division 1 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

F. Retain first paragraph below if retaining "Manufacturer's Field Service" Paragraph in "Field Quality Control" Article. Consider manufacturer's field services especially when retaining zone-selective interlocking because setting it to operate properly requires factory-trained expertise.

G. Manufacturer's field service report.

H. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.05 RETAIN OPTION IN SUBPARAGRAPH BELOW ONLY IF MANUFACTURERS SELECTED OFFER CURVES ON GRAPH PAPER.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product

category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.07 PROJECT CONDITIONS

A. Specify unusual environmental or service conditions in first paragraph below. For equipment installed outdoors, indicate maximum and minimum ambient temperature and expected humidity range. For additional ambient compensation requirements for fuses, see Editing Instruction No. 5 in the Evaluations.

B. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
2. Altitude: Not exceeding 6600 feet (2010 m).

C. Retain paragraph below if interruption of existing electric service is required.

D. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Engineer no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Engineer's written permission.
4. Comply with NFPA 70E.

1.08 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.09 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.01 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Siemens
2. Square D
3. Allen-Bradley
4. Cutler-Hammer

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
6. Hookstick Handle: Allows use of a hookstick to operate the handle.
7. Lugs: Mechanical type, suitable for number, size, and conductor material.
8. Service-Rated Switches: Labeled for use as service equipment.

2.02 NONFUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Siemens
   2. Square D
   3. Allen-Bradley
   4. Cutler-Hammer

B. Type GD, General Duty, Single Throw, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

E. Type HD, Heavy Duty, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

F. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   4. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), ar

ranged to activate before switch blades open.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 RETAIN SUBPARAGRAPH BELOW IF RETAINING "AUXILIARY CONTACT KIT" SUBPARAGRAPH ABOVE AND IF REMOTE-CONTROL POWER FOR REMOTE INDICATION IS NOT SPECIFIED IN OTHER SECTIONS. SEE "CONTROL POWER OPTIONS" ARTICLE IN THE EVALUATIONS FOR VARIOUS SOURCES AVAILABLE FOR CONTROL POWER. ALTHOUGH OTHER VOLTAGES ARE AVAILABLE, THE SECTION TEXT INCLUDES ONLY THOSE THAT ARE MOST FREQUENTLY ENCOUNTERED AND LISTED IN MANUFACTURERS' LITERATURE. INTEGRALLY MOUNTED CONTROL POWER IS NOT AVAILABLE IN SAFETY SWITCHES.

2.04 RECEPTACLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Hubble

B. Type 4, IP66 Rated, Twist lock, amp rated, combination safety switch and receptacle

C. Receptacle: Twist lock, three-phase, four-wire or five-wire receptacle (one wire connected to enclosure ground lug).

2.05 IF MORE THAN ONE TYPE OR RATING OF RECEPTACLE-SWITCH COMBINATION IS REQUIRED, CONSIDER SHOWING LOCATION OF EACH ON DRAWINGS AND DELETING SUBPARAGRAPH BELOW; OTHERWISE, INSERT REQUIRED INFORMATION.

2.06 MOLDED-CASE CIRCUIT BREAKERS.

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following (all switches to be manufactured by the same manufacturer as the motor control centers used on the project):
   1. Cutler-Hammer
   2. Square D
   3. Engineer approved equal

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjusta

ble magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor. (Provide only when shown on the single line, or required by code)
5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact. (Provide when indicated on drawing)
6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay. (Provide when indicated on drawings)
7. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts. (Provide when indicated on drawing)

8. Alarm Switch: One NO contact that operates only when circuit breaker has tripped. (Provide when indicated on drawing)
9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position. (Provide when indicated on drawing)

2.07 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 4X stainless steel.
   3. Corrosion Areas: NEMA 250, Type 4X fiberglass.
   4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4X stainless steel.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 4X stainless steel

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.03 IDENTIFICATION

A. Comply with requirements in Division 16 Section "Electrical Identification."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections..

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results.

Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges to provide selective coordination above 0.1 seconds.

END OF SECTION

SECTION 16442
PANELBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.
   3. Load centers.
   4. Electronic-grade panelboards.

1.03 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. TVSS: Transient voltage surge suppressor.

1.04 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
   6. Include wiring diagrams for power, signal, and control wiring.

7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device (on project with emergency generators upstream of the panelboard, provide selective coordination for all panelboard circuit breakers).

Remaining paragraphs are defined in Division 1 Section "Submittal Procedures" as "Informational Submittals."

Coordinate first paragraph below with qualification requirements in Division 1 Section "Quality Requirements" and as supplemented in "Quality Assurance" Article.

Retain first paragraph below if required by seismic criteria applicable to Project. Coordinate with Division 16 Section "Vibration and Seismic Controls for Electrical Systems." See SEI/ASCE 7 for certification requirements for equipment and components.

Retain first paragraph below if Contractor is responsible for field quality-control testing and inspecting.

C. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
   2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1.

E. Comply with NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.07 PROJECT CONDITIONS

A. Environmental Limitations (NEMA 1 and NEMA 12 Panelboards Only):

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    a. Ambient Temperature: Not exceeding minus 22 deg F (minus 30 deg C) 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
    b. Altitude: Not exceeding 6600 feet (2000 m).

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Engineer no fewer than two days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Engineer’s written permission.
3. Comply with NFPA 70E.

1.08 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace

clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Per general conditions of the contract.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.
   a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
   b. Outdoor Locations: NEMA 250, Type 4X stainless steel.
   c. Corrosion Areas: NEMA 250, Type 4X fiberglass.
   d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4 stainless steel.
   e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
2. Hinged Front Cover: Entire front trim hinged to box and with standard door

within hinged trim cover.

3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
5. Finishes:
    a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Galvanized for NEMA 1 and NEMA12. Stainless steel for NEMA 4X..
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
6. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads (see Drawings for requirements).
4. Split Bus: Vertical buses divided into individual vertical sections.

Include instructions in first paragraph below if special sizing or oversizing of lugs is required, if allowing optional use of aluminum for circuits sized for copper conductors, or when upsizing conductors for voltage drop.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device (see Drawings for requirements).

5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.02 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. Square D/Schneider Electric
3. Siemens
4. Engineer approved equal

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: See panelboard schedules on Drawings.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in or Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

G. Branch Overcurrent Protective Devices: Fused switches.
1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor

connection.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Square D/Schneider Electric
   3. Siemens
   4. Engineer approved equal

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: See panelboard schedules on Drawings.

D. Branch Overcurrent Protective Devices: Plug-in or Bolt-on circuit breakers, replaceable without disturbing adjacent units.
   1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.04 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. Square D/Schneider Electric
   3. Siemens
   4. Engineer approved equal

B. Coordinate two paragraphs below with Drawings. See the "Disconnecting and Overcurrent Protective Devices" Article in the Evaluations for guidance on making selections.

C. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
   1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.
4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    f. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
    g. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
    h. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

i. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.

j. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.

2.05 PANELBOARD SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Current Technology; a subsidiary of Danahar Corporation.
2. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
3. Liebert Corporation.
4. Engineer approved equal

B. Surge Protection Device: IEEE C62.41-compliant, integrally mounted, solid-state, parallel-connected, non-modular type, with sine-wave tracking suppression and filtering modules, UL 1449, second edition, short-circuit current rating matching or exceeding the panelboard short-circuit rating, and with the following features and accessories:

1. Accessories:
   a. LED indicator lights for power and protection status.
   b. Audible alarm, with silencing switch, to indicate when protection has failed.
   c. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status.
2. Peak Single-Impulse Surge Current Rating: 120 kA per mode/240 kA per phase.
3. Minimum single-impulse current ratings, using 8-by-20-mic.sec. waveform described in IEEE C62.41.2.
   a. Line to Neutral: 70,000.
   b. Line to Ground: 70,000.
   c. Neutral to Ground: 50,000.
4. Withstand Capabilities: 12,000 IEEE C62.41, Category C3 (10 kA), 8-by-20-mic.sec. surges with less than 5 percent change in clamping voltage.
5. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 and 208Y/120-V, three-phase, four-wire circuits shall be as follows:
   a. Line to Neutral: 800 V for 480Y/277 or 400 V for 208Y/120.

b. Line to Ground: 800 V for 480Y/277 or 400 V for 208Y/120.

c. Neutral to Ground: 800 V for 480Y/277 or 400 V for 208Y/120.

2.06 ACCESSORY COMPONENTS AND FEATURES

A. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 3 Section "Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

J. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 16 Section "Electrical Identification."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 16 Section "Electrical Identification."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
   b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
   c. Instruments and Equipment:
      1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 16 Section "Overcurrent Protective Device Coordination."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 16461

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.
2. Buck-boost transformers.

1.03 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

C. Qualification Data: For testing agency.

D. Source quality-control test reports.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. If an independent testing agency is required, see Division 1 Section "Quality Requirements" for general testing and inspecting agency qualification requirements. If additional control is needed, retain one of first two paragraphs below to specify 29 CFR 1910.7 or other more specific criteria (e.g., NETA).

29 CFR 1910.7 defines a nationally recognized testing laboratory as it applies to testing and inspecting for safety, and lists, labels, or accepts equipment and materials that meet certain OSHA criteria.

B. Retain first paragraph and subparagraph below if Contractor selects testing agency.

C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.05 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.06 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Products.
2. Square D; Schneider Electric.
3. Siemens

2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.
   2. Coil Material: Copper.

2.03 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Interior Noncorrosive Area Enclosures: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Exterior/Interior Corrosive Area Enclosures: Totally enclosed, nonventilated, NEMA 250, Type 4X, stainless steel.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

E. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: ANSI 49 gray.

F. Taps for Transformers Smaller Than 3 kVA: None.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with NEMA TP 1, Class 1 efficiency levels.
   2. Tested according to NEMA TP 2.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with

UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.
2. Indicate value of K-factor on transformer nameplate.

L. Wall Brackets: Manufacturer's standard brackets.

M. Fungus Proofing: Permanent fungicidal treatment for coil and core.

N. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.04 BUCK-BOOST TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1 and shall be listed and labeled as complying with UL 506 or UL 1561.

B. Enclosure: Ventilated, NEMA 250, Type 2.

1. Finish Color: ANSI 49 gray.

2.05 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 16 Section "Electrical Identification."

2.06 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 16

Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

3.03 CONNECTIONS

A. Ground equipment according to Division 16 Section "Grounding and Bonding."

B. Connect wiring according to Division 16 Section "Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform 2 follow-up infrared scans of transformers, one at 4 months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 16491

FUSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, panelboards, switchboards, enclosed controllers, and motor-control centers.
2. Spare-fuse cabinets.

1.03 SUBMITTALS

A. First paragraph below is defined in Division 1 Section "Submittal Procedures" as an "Action Submittal."

B. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
5. Coordination charts and tables and related data.
6. Fuse sizes for elevator feeders and elevator disconnect switches.

C. Paragraph below is defined in Division 1 Section "Submittal Procedures" as an "Informational Submittal."

D. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
4. Coordination charts and tables and related data.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Comply with UL 248-11 for plug fuses.

1.05 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.06 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.07 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cooper Bussmann, Inc.
2. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.02 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.03 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull. (Install in the Admin. Building as directed)

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable, from fuse manufacturer.
5. Include in the cabinet a complete list of fuses used in the facility. (include: size, type, model, rating, quantity, and location)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FUSE APPLICATIONS

A. Cartridge Fuses (provide fuse type indicated below unless otherwise shown on Drawings or required by breaker coordination study):

1. Service Entrance: Class T, fast acting.
2. Feeders: Class RK1, time delay.
3. Motor Branch Circuits: Class RK5, time delay.
4. Other Branch Circuits: Class RK5, time delay.
5. Control Circuits: Class CC, fast acting.

3.03 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.04 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 16 Section "Electrical Identification" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

SECTION 16622
STANDBY EMERGENCY GENERATOR

PART 1 - GENERAL

1.1 SCOPE

A. This is a performance specification for a Standby Emergency Generator Power System. No used equipment will be allowed.

B. This section includes the performance specification for providing the standby power generation and includes, but is not limited to, a packaged engine generator system, weatherproof housing, exhaust silencer and fittings, fuel system, control panel, battery and charger, automatic transfer switch, and appurtenances, connections, and supplies required to provide a fully functioning system.

C. The following references shall be followed for the design of the emergency power generation system.

1. ANSI/NEMA 250: Enclosures for electrical equipment (1,000 volts maximum).

2. ANSI/NEMA MG 1: Motors and generators.

3. ANSI/NFPA: National electrical code.

4. NFPA 110 Level 1.

5. ANSI/NFPA 99: Health care facilities.

6. ANSI/NEMA AB 1: Molded case circuit breakers.

7. NEMA ICS 1: General Standards for industrial Control and Systems.

8. NEMA ICS 2: Standards for Industrial Control Devices, Controllers, and Assemblies.

9. NEMA ICS 6: Enclosures for Industrial Controls and Systems.

D. The following documents are required before the Owner will accept the system for ownership and maintenance:

1. Submit shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion requirements, and electrical diagrams including schematic and interconnection diagrams.

2. Submit product data showing dimensions, weights ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibrator isolators, fuel system, radiator, and remote annunciator.

3. Submit record of system load test.

4. Accurately record location of engine generator and mechanical and electrical connections.

5. Submit 5 copies for each segment, per size, operation and maintenance data upon delivery of the emergency generator.

6. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and fuel system, oil sampling and analysis for engine wear, and emergency maintenance procedures.

7. Provide a full five-year warranty for engine and alternator against wear and defects from date of startup or three months after delivery, whichever occurs first, including the generator and transfer switch.

8. Furnish service and maintenance of emergency generator system for two years every four months from date of startup or three months after delivery, whichever occurs first.

9. Provide two additional sets of each fluid (except fuel), oil, and air filter element require for the engine generator system.

10. Furnish one set of tools for each segment (3 total) for preventive maintenance of the engine generator system. Package tools in an adequately sized metal box that is fitted for padlock and turned over to the Owner.

11. List of special tools, maintenance materials, and replacement parts.

PART 2 - PRODUCTS

2.1 GENERATOR

A. The generator shall be one of the following power systems. All control panels, breakers, transfer switches, and other appurtenances shall be provided by the same manufacturer or authorized distributor and will be guaranteed to operate with the system. All parts of the system shall be covered under a single warranty by the generator manufacturer. The accepted generator manufacturer shall have a facility authorized service center within 150 miles of the project site.

B. Approved generator manufacturers are:

1. Caterpillar

2. Cummings

3. Kohner

4. Generac

5. Or Engineer Approved Equal

C. Approved automatic transfer switch manufacturers are:

1. Caterpillar

2. Cummings

3. Kohler

4. Generac

5. ASCO

6. Zenith

7. Or Engineer Approved Equal

D. 480 volt, 3-Phase, diesel fuel operated generator will be provided.

1. Note: The size as indicated on the plans is based on minimum kW requirements. If the manufacturer does not have the size shown, the next available size shall be used.

E. Qualifications:

1. Manufacturer: company specializing in packaged engine generator system with minimum ten years experience.

2. Supplier: authorized distributor of engine generator manufacturer with service facilities within 150 miles of the project site. The service facility must be staffed with a minimum of 4 technicians capable of providing warranty service on the proposed equipment (generator and ATS).

3. The supplier must carry sufficient inventory to cover no less than 80% parts service within 24 hours and 95% within 48 hours. 80% of the spare parts inventory necessary to provide service or repairs for each size (as a group) generator set being provided.

2.2 ENGINE

A. Type: Water-cooled inline or V-type, diesel engine, operating at no more than 1800 rpm. Shall be provided with a skid-mounted double wall fuel storage tank. Sized as required to operate all loads shown on the drawings.

B. The engine shall have a rating sufficient to operate at 100 percent load for duration of the power outage specified elevation and ambient temperature limits. The unit has been sized to start all motors at each location.

C. The engine shall have an electronic governor.

D. The generator shall be capable of delivering full load amps with up to 5% total harmonic distortion.

E. Safety devices: engine shutdown on high water temperature, low oil pressure, over-speed, and engine over-crank. Limits as determined by manufacturer.

F. Engine Accessories: lube oil filter, intake air filter, lube oil cooler, gear-drive water pump. Include water temperature gage, and lube oil pressure gage on engine-generator control panel. For diesel fuel units, include fuel filter, fuel pumps, fuel priming pumps, fuel primer gage, as required.

G. Engine starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.

H. Engine Jacket Heater: thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90 degrees F (32 degrees C), and suitable for operation on 208 or 120 volts AC.

I. Radiator: radiator using glycol coolant, with blower type fan, sized to maintain safe engine temperature in ambient temperature of 110 degrees F (43 degrees C). Radiator air flow restriction: 0.5 inches of water (9.34 mm of mercury), maximum.

2.3 GENERATOR

A. Generator: ANSI/NEMA MG 1; three phase, four-pole, re-connectable brushless synchronous generator with brushless exciter.

B. Insulation: ANSI/NEMA MG1, Class F.

C. Temperature Rise: 130 degrees C standby.

D. Enclosure: ANSI/NEMA MG1; open drip proof.

2.4 AUTOMATIC TRANSFER SWITCH (ATS)

A. Provide an automatic transfer switch that is recommended by the manufacturer of the generator set. The ATS shall be rated as UL 1008. For indoor or outdoor corrosive environments the switch shall be housed in a NEMA 4X stainless steel enclosure. For non-corrosive outdoor environments the switch shall be housed in a NEMA 4 enclosure. For non-corrosive indoor environments the switch shall be housed in a NEMA 12 enclosure.

B. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVALABLE, SWITCH POSITION.

C. Test Switch: Required.

D. Return To Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

E. Transfer Switch Auxiliary Contacts: 1 normally open; 1 normally closed.

F. Alternate Source Monitor: Monitor alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent from rated nominal voltage.

G. Provide adjustable time delay on transfer and re-transfer.

H. The ATS shall be supplied with surge protection.

2.5 ACCESSORIES

A. Diesel Fuel System: The fuel storage tank's volume shall be large enough to hold enough fuel to run the generator for 48 hours at full load (i.e. two booster pumps). The tank shall be double walled painted steel fuel tank used as the base of the generator with fuel gauge, overfill protection, stage II vapor recovery, audible leak detectors, per DEP and EPA requirements. All joints shall be fully welded before preparation and painting. Provide low-level fuel indicator. The painting shall be 100% shop applied as follows:

1. Organic Zinc-rich/Urethane/Urethane Coating System
    a. Surface Preparation: SSPC-SP6 Commercial Blasting Cleaning
    b. Prime Coat: Series 90-97 Tnemac-Zinc at 2.5 to 3.5 mils DFT
    c. Intermediate and Finish: Series 1075 Endura-Shield-Color at 2.0 to 3.0 mils DFT each coat
    d. Minimum Total DFT: 7.0 mils
2. The bottom of the fuel tank shall be coated with 8 mil coal tar epoxy.
3. In addition, the fuel tank will be manufactured so the bottom of the tank will not come in full contact with the concrete slab.
4. The fuel level shall be monitored by the site control system. The level shall be transmitted to the control system through a transducer with a 4-20mA output.

B. Batteries: Heavy duty, diesel starting type lead-acid storage batteries. Match battery voltage to starting system. Include necessary cables and clamps.

C. Battery charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection. Full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide enclosure to meet ANSI/NEMA 250, Type 1 requirements, and unit to be mounted inside of generator enclosure.

D. Generator Enclosure:

1. Standard: Enclosures shall be painted steel, 14-gauge construction, with stainless steel hardware. Doors shall be keyed and padlockable.
2. Sound Attenuated: Enclosures shall be painted steel, 14-guage construction, with stainless steel hardware. Doors shall be weather-protective seals; keyed and padlockable.

Non-hydroscopic sound-insulating materials. The maximum "dB" rating shall be 80 dB. The panel openings shall be designed so as not to allow wind-driven rain to enter the enclosure and cause damage to the unit while in operation. The enclosure shall be designed to withstand 110 mph wind speed.

3. High Wind Enclosures: Enclosure designed to withstand 130 mph wind speed, Exposure C, Importance Factor 1.15, partially enclosed condition in accordance with methodology contained in ASCE 7-98. Provide sealed shop drawings by an Engineer licensed in the State of Florida. All other conditions of E.2 above and Generator Tabulation Form apply.

E. Enclosure shall also be designed with removal louvers for servicing generator. Generator enclosure to house battery tray, battery charger, generator circuit breakers. All electrical controls shall be contained within the enclosures.

F. Exhaust Silencer: For standard enclosures the silencer may be mounted outside the unit. On sound attenuated enclosures the silencer shall be mounted inside the unit. Along with the exhaust silencer, additional exhaust piping shall be provided (along with necessary mounting hardware) to route the exhaust from underneath the 1st floor installation location (as shown on the project plans) to a safe area outside of the building.

G. Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:

1. All indications for protection and diagnostics according to NFPA 110 Level 1, including remote and local annunciation.

2. Frequency Meter: 45-65 Hz range, 3-1/2 inch (89 mm) dial.

3. AC Output Voltmeter: 3-1/2 inch (89 mm) dial, 2 percent accuracy, with phase selector switch.

4. AC Outlet Ammeter: 3-1/2 inch (89 mm) dial, 2 percent accuracy, with phase selector switch.

5. Output voltage adjustment.

6. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, and overcrank.

7. Engine start/stop selector switch.

8. Engine running time meter.

9. Oil pressure and water temperature gages.

10. Auxiliary Relay: 3 PDT, operates when engine runs, with contact terminals pre-wired to terminal strip.

11. Provision for regularly scheduled starting and operation of engine generator for maintenance purposes.

H. Generator circuit breaker: Each generator shall be supplied with a unit mounted circuit breaker rated for the capacity of the generator and coordinated with the ATS.

2.6 REMOTE COMMUNICATIONS

A. Remote Alarm Contacts: Pre-wire SPCT contacts to terminal strip for remote alarm functions required by ANSI/NFPA 99. The generator control panel shall provide dry contacts for the following signals at a minimum:
1. Generator Running
2. Generator Common Fault
3. Low Fuel

B. All alarm conditions shall be made available for connection to control unit at the generator site for transmission to a central communication facility. Additionally, all level monitored by the microprocessor shall also be made available through 4-20 ma signals or other compatible method.

C. The supplier of the generator set is responsible for labeling where these signals are available, but not for connecting them to the local monitoring system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of the generator will be performed by the electrical contractor under the supervision of the general contractor.

3.2 TESTING

A. The contractor shall provide the first tank of fuel in addition to the fuel required to perform the load bank test.

B. Provide full load test utilizing portable test bank, for four (4) hours minimum.

C. During test, record the following at 20 minute intervals:

1. Kilowatts

2. Amperes

3. Voltage

4. Coolant temperature

5. Ambient temperature

6. Frequency

7. Oil pressure

D. Test alarm and shutdown circuits by simulating conditions.

E. Manufacturer's representative should be present to prepare, start, test, and adjust systems. Adjust generator output voltage and engine speed.

END OF SECTION

SECTION 16910

CONTROL PANEL CONSTRUCTION

PART 1 - GENERAL

1.01 SCOPE

A. The Supplier shall furnish, test, and startup all furnished electrical control panels and control system components related to their furnished equipment.

B. Specifically included are the following control panels:

1. Booster Pump RTU

1.02 SUBMITTALS

A. Product Data: For each type of product supplied. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

C. Additional Shop Drawing Requirements:

1. Point - to - Point Wiring Drawings.
2. Fabrication and nameplate legend drawings
3. Internal wiring schematic and layout drawings
4. Systems schematic drawings illustrating all components being supplied complete with electrical interconnections.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR CONTROL PANELS

A. All control panes shall be constructed in accordance with the following standards: National Electrical Manufacturers Association (NEMA), Institute of Electrical and Electronics Engineers (IEEE), Underwriter Laboratories (UL), Nation Fire Protection Association (NFPA), and Instrumentation Systems and Automation Society (ISA)

B. All control panels shall be constructed in a UL approved production facility and bear all applicable UL labels for panel construction (i.e. UL508A, etc.).

C. The completed panel shall be factory tested prior to shipment. Field installation by the Contractor shall consist only of setting the panel in place and making necessary pneumatic and/or electrical connections.

D. All control panels shall be designed to operate at the service voltage as indicated in the project plans.

2.02 CONTROL PANEL ENCLOSURES

A. Unless otherwise noted, all control panels shall be provided with a NEMA 4X, Stainless Steel enclosure packages as manufactured by Hoffman, or Engineer approved equal. The enclosure shall be constructed with a 3-point steel latching mechanism and padlocking stainless steel handles. Latch rods to have rollers for easier door closing.

B. All control panels and associated hardware shall be constructed of 304 stainless-steel unless otherwise noted.

C. All interior components shall be mounted with stainless steel hardware and shall be clearly identified with plastic identification nametags. The tags shall be white with black lettering.

D. Door shall be provided with heavy gauge stainless steel hinges.

E. All control panels shall be constructed of 14 gauge stainless steel. Control panels shall also include a 10 gauge mild steel sub-panel mounted on collar studs for equipment mounting.

F. All control panel seams shall be continuously welded and ground smooth.

G. Data pockets shall be provide on all interior panel doors. The equipment supplier shall provide laminated schematics in each pocket for the associated control panel.

H. All cabinets shall be sized to accommodate the equipment required plus 25% spare space.

2.03 CONTROL PANEL COOLING REQUIREMENTS

A. Air conditioners and sun shields shall be supplied as required to keep the equipment mounted inside the control panels operating within the manufacturers operating temperature requirements. The air conditioner unit shall not exchange the air inside the control panel with the air outside the control panel. The unit shall be coated to provide environmental protection and maintain the enclosure rating it is mounted to/penetrating.

B. The manufacturer of the control panels and cabinets shall provide all necessary cooling/heating equipment required to maintain temperature and humidity within the operating requirements of all equipment located within panels and cabinets. Coordination for electrical/mechanical connection is the responsibility of the Contractor. At the time of submittals, the Contractor shall submit calculations indicating that such requirements have been met.

C. All exterior control panels designed for exterior mounting shall be provided with equipment rated for 60º Celsius or provided with air conditioners.

2.04 CONTROL PANEL WIRING

A. Wiring, where required, shall be general-purpose open type, neatly bundled and laced or installed in plastic wiring troughs. Wire shall be stranded No. 16 AWG minimum, with thermoplastic insulation rated for 600V and 90 degrees C.

B. All equipment mounting backboards shall be provided with nonmetallic slotted ducts. All nonmetallic slotted ducts shall have spare space equal to 40% of the depth of the duct.

C. Wiring colors shall be as follows:

1. All ungrounded AC conductors operating at the supply voltage shall be “Black”
2. All ungrounded AC control conductors operating at a voltage less than or equal to the supply shall be “Red”
3. All grounded AC current carrying conductors shall be “White”
4. All ground conductors shall be “Green”
5. All ungrounded DC control conductors shall be “Orange”
6. All grounded DC control conductors shall be “Brown”
7. All intrinsically safe circuits shall be “Blue”
8. A wiring color code legend shall be mounted inside the control panel door.

D. All wires entering and leaving all panels shall be terminated at barrier type terminal strips. All terminals shall be identified and labeled per the Owner’s standard naming conventions. It shall be the Supplier’s responsibility to coordinate with the Engineer for the Owner’s accepted naming conventions. (All terminal strips shall be designed for #12 AWG, XHHW-2, 90 degree C field wiring for terminations.)

E. No terminal strip may be located closer than 8” from any side or bottom of the control panel. This is designed to allow for adequate wire bending radius for field terminations.

F. All wiring shall be clearly marked with an identification number consistent with the wiring schematic.

G. Devices mounted on the enclosure door or interior dead front panel shall be run in spiral wrap to avoid pinch points when opening and closing the enclosure door(s) or interior panels

2.05 PANEL MOUNTED DEVICES

A. Indicating lights to be heavy duty, push-to-test type, oil tight, industrial type with integral transformer for 120 VAC applications. Lenses shall be colored as noted on drawings or as required by the equipment manufacturers if not specified on the drawings. Legend plates shall be factory engraved as required. Lights shall be 30mm Square D 9001 Series, Allen Bradley 800T or approved equal.

B. Momentary pushbuttons to be heavy duty, oil tight, industrial type with full guard and momentary contact rated at 10 Amps continuous at 120 VAC. Legend plates shall be factory engraved as required. Pushbutton shall be 30mm Square D 9001 Series, Allen Bradley 800T or approved equal.

C. Selector switches, on/off and H.O.A. to be heavy duty, oil tight, industrial type with contact rated at 120 VAC, 10 amps continuous service. Legend plates shall be factory engraved as required. Switches shall be 30mm Square D 9001 Series, Allen Bradley 800T or approved equal.

D. Current to voltage converters, 4-20mAdc to 1-5Vdc shall be as manufactured by Phoenix Contact or Engineer approved equal.

E. D.C. power supplies shall be as manufactured by PLC Manufacturer, PULS, Phoenix Contact, or approved equal and shall be sized for 1.5 times the application requirements. (No open power supplies will be allowed.)

F. All relays shall be 3PDT Potter Brumfield KRPA series based on the application requirements for switching and ampacity. Units shall incorporate a lamp in parallel with relay coil.

G. All circuit breakers shall be of the same AIC rating as the panel or MCC to which they are connected, and shall be required to selectively coordinate above 0.1 seconds.

H. All motor starters shall be manufactured by Square D, Allen Bradley or engineer approved equal. All starters shall be NEMA rated (no IEC devices). All motor speed controllers shall have the following capabilities: remote start/stop, status output, running output, and remote speed.

I. All reduced voltage starters shall be manufactured by Square D (Altistart), Allen Bradley (SMC Flex) or engineer approved equal.

J. All variable frequency drives shall be manufactured by Square D (Altivar 630), Allen Bradley (PowerFlex 753) or engineer approved equal. Each variable frequency drive shall be supplied with an Ethernet communication module for the control and monitoring of the associated device.

K. H-O-A selector switches are required for each motor starter contained within

a control panel. All adjustable speed controllers (VFDs) shall be provided with manual speed adjustment devices (separate from any HMI or Operator Interface Panel), which may be located on the face of the enclosure. H-O-A selector switches and manual speed switches shall allow the operator to control all motors and valves manually in the event of a PLC failure.

L. Runtimes for each motor starter located in the control panel shall be tracked with elapsed time meters mounted on the enclosure.

M. Power distribution blocks shall be block style distribution blocks manufactured by Square D, Mersen or Engineer approved equal. All distribution blocks shall be provided with polycarbonate safety covers to provide dead front protection. The safety cover shall have a test prod hole for testing purposes

N. Fuse blocks/holders shall be UL style fuse blocks manufactured by Bussmann, Mersen or Engineer approved equal.

O. General purpose fuses shall be Bussmann, Mersen, or Engineer approved equal. Unless otherwise noted the fuse rating and type shall be determined based on the equipment (which the fuse is protecting) manufacturer's recommendations for overcurrent protection.

P. Semiconductor fuses shall be Mersen Amp Trap series fuses or Engineer approved equal. Unless otherwise noted the fuse rating and type shall be determined based on the equipment (which the fuse is protecting) manufacturer's recommendations for overcurrent protection.

Q. All control transformers shall be sized to provide 25% spare capacity. The transformer connections shall be provided with protective covers to guard against accidental contact, and the transformer shall be provided with primary and secondary fusing per the manufacturer's recommendations.

R. Each control panel shall be provided with a ground fault duplex service receptacle that is accessible from the interior dead-front panel. The service receptacle shall be capable of providing 15A at 125VAC.

S. All intrinsically safe barrier relays shall be UL listed and shall be manufactured by Phoenix Contact or Engineer approved equal.

T. All circuit breakers shall be manufactured by Square D, Eaton Cutler Hammer, or Engineer approved equal. A main circuit breaker shall be provided for each control panel.

U. Pilot lights shall be provided for each starter located inside the control panel. The lights shall be as follows: Green (Run), Red (Alarm/Fault), Amber (Warning).

V. Control power transformers shall be provided in each control panel with a

supply voltage other than 120V or 120/208V. Control power transformers shall be manufactured by Square D, Allen Bradley or engineer approved equal and provided with both primary and secondary fuses per the NEC.

2.06 MISCELLANEOUS

A. Engraved laminated plastic nameplates shall be furnished for each front panel mounted instrument. The Contractor shall coordinate with the Owner for nameplate color and naming conventions. All instruments and components shall be tagged on rear with embossed plastic tape labels.

B. No pneumatic tubing shall be installed inside the control panels.

PART 3 - EXECUTION

3.01 CONTRACTOR'S RESPONSIBILITY

A. The Contractor shall coordinate the work of the service personnel during construction, testing, and acceptance of the work.

B. The Contractor shall receive final approval on all panel, enclosure, and equipment layouts by the Engineer prior to fabrication or installation.

3.02 QUALITY ASSURANCE

A. All control panels shall be factory tested and certified prior to releasing for shipment. The testing shall consist of but not limited to the following:

1. Point to point testing of all wiring prior to application of power
2. The intended supply voltage shall be applied to the control panel and all components shall be tested for proper operation and calibration.
3. The programmable logic controller and operator interface code shall be loaded, and each shall be tested for functionality.
4. All components shall be checked to confirm that each device has been installed per the plans and specifications as well as the Manufacturer’s recommendations.
5. The enclosure shall be inspected for defects and shall be repaired or replaced if necessary.
6. All labeling and identification tags shall be verified and be clean and visible.

B. The control panel manufacturer shall be required to test and provide the test results of all control panels supplied for the project. The documentation shall contain the results of the tests listed above as well as any rework items and subsequent repairs that were required prior to shipment. In addition, the manufacturer must certify this document prior to the release for shipment. Prior to

shipment one copy of the applicable documentation shall be placed in the drawing pocket of each enclosure, and three copies shall be sent to the Engineer.

3.03 INSTALLATION

A. All equipment and devices for the work shall be installed in the locations shown on the drawings, in accordance with the manufacturer's recommendations, and in compliance with the requirements of these specifications.

B. The Contractor shall be responsible for coordinating the installation of all equipment in the proposed locations with all other trades performing work on the project that may be affected.

3.04 FINAL INSPECTION

A. Include all changes and/or alterations in the control panels prior to final inspection and acceptance by the owner.

B. Any changes and/or alterations in the Control Panels shall be reflected/updated in all Control Panel Schematics prior to acceptance by the Owner. This includes all electronic copies delivered to the Owner.

END OF SECTION

GEOTECHNICAL ENGINEERING STUDY
CEWSA WTP Improvements
Eclectic, Alabama
Project No: 1352
November 26, 2024

4890 University Square
Suite 2
Huntsville, Alabama 35816
256-541-0165

November 26, 2024

Ardurra
200 Clinton Avenue, Suite 601
Huntsville, Alabama 35801

ATTN: Ms. Ashley O. Turnbull, P.E.

SUBJECT: Report of Geotechnical Engineering Study – Revision 1
CEWSA WTP Improvements
Eclectic, Alabama
Project No: 1352

Ladies & Gentlemen:

GTEC has completed the geotechnical engineering study for the above referenced project. We provided our services in general accordance with our Proposal P-00318 Rev 1, dated August 23, 2024 and authorized by Ms. Ashley O. Turnbull, PE on August 26, 2024. The purpose of our services was to explore the subsurface soil conditions and groundwater level in order to provide foundation and site preparation recommendations. This report presents our understanding of the project, provides the results of the field exploration and laboratory testing, and discusses our conclusions and recommendations. After you have reviewed our report, we recommend a telephone call to discuss our recommendations.

GTEC thanks you for the opportunity to serve you and looks forward to continued involvement on this and future projects. Please contact the project personnel below with questions concerning this project.

Respectfully submitted,

GTEC,

Kathleen Bernal, E.I.
Staff Engineer

Rachel T. Finch, P. E.
Senior Engineer

Distribution: aturnbull@ardurra.com

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1.0 EXECUTIVE SUMMARY

This summary is provided for the convenience of the reader. Our full report should be read and understood before using our recommendations for design.

As shown on Drawing No. 1352-2, each boring encountered soft or firm clay soils or loose sand to depths ranging from 3.5 to 5 feet below the surface. In the proposed structural footprints, GTEC recommends completely undercutting the unstable soils to stiff clay or medium dense sand or better suitable materials. To reduce settlement to less than 1 inch in the proposed storage tank area, GTEC recommends over-excavating to 7 feet and backfilling with No. 57 stone. To reduce settlement to less than 1 inch in the proposed GAC Vessel footprint, GTEC recommends construction of the foundation and piping be delayed 30 days following placement of the soil fill to allow for consolidation settlement due to the fill to occur.

Delayed readings indicated a stabilized groundwater level about 7 feet below the surface (ELEV 638 feet) in the storage tank and booster pump areas. We anticipate water will infiltrate excavations for undercut or trenching during construction if undercutting or trenching more than 7 feet in these areas.

2.0 INTRODUCTION

GTEC has completed a geotechnical engineering study for the planned water treatment plant improvements in Eclectic, Alabama. This work was authorized on August 29, 2024 by Ms. Ashley O. Turnbull, PE of Ardurra.

The purposes of this study were to:

- Explore the general nature of the subsurface conditions based on soil tests across the site;
- Provide a professional opinion regarding the suitability of the site for the intended construction;
- Provide foundation design information and guidelines; and
- Identify likely foundation construction or site development problems.

This report outlines the services provided, describes the surface and subsurface conditions, discusses site geology, and addresses the items listed above.

Assessment of the environmental aspects of this site, including previous land use or the determination of the presence of any chemical, industrial, or hazardous waste is beyond the scope of this study.

3.0 EXPLORATION METHODS

Subsurface conditions at the site of development were investigated by drilling soil test borings. Locations for the borings were determined using a handheld, consumer-grade GPS unit. Therefore, the boring locations as shown on the appended Drawing No. 1352-2, should be considered approximate. The boring elevations, as shown on the appended Boring Logs, were estimated by overlaying the boring locations on the topographic contours of the provided "*Central Elmore WTP Upgrade"* drawing, by Ardurra, dated 7/19/2024, and should be considered approximate.

The borings were advanced using a track-mounted Diedrich D-50 Turbo drilling rig with hollow stem, continuous flight augers. Samples of the soils were obtained using a split spoon sampler at select intervals during Standard Penetration Tests (SPT) conducted in general accordance with ASTM D1586. The SPT "N" value gives an indication of the consistency or relative density of the soils found. Relatively undisturbed samples of the cohesive subsurface materials were also obtained in general accordance with ASTM D1587. The unconfined compressive strength of cohesive soil samples was estimated in the field using a calibrated pocket penetrometer reading (Pp).

Results of the SPT tests, Pp tests, and sampling locations in each boring were recorded by a GTEC field engineer and are presented in the appended Boring Logs. The logs contain information concerning the boring method, dates, sample depths, descriptions of the soils or rocks, and other characteristics encountered during drilling. The field engineer classified the soil in general accordance with ASTM D2488, which utilizes the Unified Soil Classification System (USCS, as per ASTM D2487), and prepared the Boring Logs that were the basis for engineering evaluation and recommendations. The group symbol for each soil type is indicated in the Boring Logs. The final boring logs represent GTEC's interpretation of the field logs based on the results of the engineering review and laboratory testing of the field samples. Borings were either backfilled with auger cuttings the same day or after obtaining delayed water level readings.

4.0 SITE CONDITIONS

The subject property is located at the existing Central Elmore Water & Sewer Authority (CEWSA) treatment plant at the intersection of Mt. Hebron Road and Lake Point Road in Eclectic, Alabama. Two approximately 100 feet in diameter water tanks are located at the southwest corner of the plant and are surrounded with gravel. The proposed improvements are located east of the water tanks. Three bulk storage tanks are located in the northeastern corner of the proposed improvements and south of the main treatment building. Two paved roads from Mt. Hebron Road access the site. The site south of the bulk storage tanks is grass covered and tree lined on the east side. A 36-inch water line crosses the central area of the site, connecting the existing water tanks to the finished water pumping station to the north. An 18- to 24-inch storm pipe crosses the southern area of the site. Based on the provided topographic data on the "*Central Elmore WTP Upgrade"* drawing, by Ardurra and dated 7/19/2024, site grades range from about

655 feet at the east side of the proposed construction site to about 645 feet at the west side of the site. Based on conversations with the CEWSA facility manager, about 14 to 15 feet of soil was previously cut out from the west side of the site for construction of the existing water tanks. Based on historical aerials from Google Earth™ imagery, it appears the grading and water tanks were constructed sometime between 2012 and 2014. In general, surface water drains away from the site to the wooded areas to the east and to the west of the site. Photograph 1 shows the general site conditions at the time of our field activities.

PHOTOGRAPH 1

Description: Facing south in the proposed GAC system area

PHOTOGRAPH 2

Description: Facing north near the existing water tanks

5.0 SUBSURFACE CONDITIONS

At the surface, each boring encountered topsoil which ranged in thickness from 3 to 8 inches. Five general silt and sand soil layers were encountered below the topsoil. Sand content increased with depth at the site. Split spoon refusal was encountered between 30 and 35 feet below the existing ground surface in borings B-1 and B-2. Specific soil properties for each layer encountered are presented below along with a summary of laboratory tests data from select samples.

Borings B-1, B-2, and B-3 encountered fill layers below the surface materials which extended to depths between 1.5 and 3.5 feet. The layer for borings B-1 and B-2 consisted of silty or gravelly sand that was brownish red or gray in color. The layer for boring B-3 consisted of a sandy, elastic silt that was red and tan in color. Standard penetration test (SPT) values in this layer ranged from 4 to 39 blows per foot (bpf) with an average of 16 bpf. Pocket penetrometer test values ranged from 1.75 to 2.5 tons per square foot (tsf) with an average of 2.25 tsf. Natural moisture contents ranged from 3 to 26 percent with an average of 19 percent.

Below the surface materials, boring B-4 encountered a firm residual layer that extended to a depth of about 3.5 feet. The layer consisted of sandy, micaceous, elastic silt that was red and tan in color and had varying amounts of gravel-sized chert. SPT values in this layer were 5 bpf and pocket penetrometer test values were 4.5 tsf. The natural moisture content was 29 percent. The

following table is a summary of the Atterberg limit and sieve analysis tests performed on soil samples from this layer.

Boring Number	Sample Depth (feet)	Water Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve (%)
B-4	0 to 1.5	28.6	54	23	69.4

Below the firm residual layer or surface/fill materials, borings B-3, B-4, and B-5 encountered a residual layer with increased consistency. The layer extended to a depth of about 3 to 8.5 feet. The layer consisted of micaceous, elastic silt that was red and tan in color and had varying amounts of sand. SPT values in this layer ranged from 6 to 17 bpf with an average value of 10 bpf. Pocket penetrometer test values ranged from 1.5 to 3.75 tsf with an average of 2.5 tsf. Natural moisture contents ranged from 22 to 34 percent with an average of 27 percent. The following table is a summary of the sieve analysis tests performed on soil samples from this layer.

Boring Number	Sample Depth (feet)	Water Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve (%)
B-3	3.5 to 5.0	32.7	-	-	92.0

Below the upper residual layer, each boring, except boring B-3, encountered a loose residual layer with increased sand and gravel-sized content. The layer extended to a depth of about 5 to 10 feet. The layer consisted of micaceous, silty sand that was tan, brown, and red in color and had varying amounts of gravel. SPT values in this layer ranged from 4 to 10 bpf with an average value of 6 bpf. Pocket penetrometer test values ranged from 1.0 to 2.5 tsf with an average of 1.75 tsf. Natural moisture contents ranged from 22 to 34 percent with an average of 28 percent.

Each boring encountered a lower residual layer with increased density and gravel-sized content. The layer extended to the boring termination depths ranging from 20 to 40 feet. The layer consisted of micaceous, silty sand that was tan, brown, and red in color and had varying amounts of gravel-sized chert. SPT values in this layer ranged from 5 to greater than 100 bpf with a typical value of 14 bpf. Higher SPT values were likely inflated due to the increased partially weathered rock in this layer. Pocket penetrometer test values ranged from 0.5 to 3.25 tsf with an average of 1.5 tsf. Natural moisture contents ranged from 12 to 30 percent with an average of 24 percent. The following table is a summary of the Atterberg limit tests performed on soil samples from this layer.

Boring Number	Sample Depth (feet)	Water Content (%)	Liquid Limit (%)	Plasticity Index (%)	Percent Passing #200 Sieve (%)
B-2	5.0 to 7.0	26.2	43	6	37.4

Split spoon refusal was encountered between 30 and 35 feet below the surface in borings B-1 and B-2.

Groundwater was encountered between 13 and 18.5 feet below the surface during drilling. Subsequent groundwater level readings taken 5 hours after drilling, indicated that the stabilized groundwater level was about 7 feet below the surface in the proposed storage tank and booster pumps area. Because of the geology of this region, the groundwater levels are generally a function of seasonal precipitation and locally heavy rainfall events. Consequently, the groundwater levels can and do fluctuate with time.

6.0 SITE GEOLOGY

Published information indicates the subject site is underlain by the Kowaliga Gneiss. According to the United States Geological Survey, the Kowaliga Gneiss consists of coarse-grained granodiorite to quartz monzonite with large plagioclase augen and is generally shared among margins.

7.0 PROPOSED CONSTRUCTION

GTEC, LLC understands that Ardurra is working with Central Elmore Water & Sewer Authority (CEWSA) to design improvements to their existing water treatment plant (WTP) located at the intersection of Mt. Hebron Road and Lake Point Road in Eclectic, Alabama. Based on the provided *"Central Elmore WTP Upgrade"*, SRF Submittal by Ardurra, dated September 27, 2024, the proposed improvements include a new storage tank, booster pumps, and granular activated carbon (GAC) treatment vessels. The planned top of concrete elevations (TOC. EL.) for the storage tank is 645.08 feet, the planned TOC. EL. for the booster pumps is 645.50 feet, and the planned TOC. EL. for the GAC vessels is 660.50 feet. The water storage tank will have a diameter of 25 feet, a 60,000-gallon capacity, and will be supported by a mat foundation. The GAC vessels will be supported by a 40-foot by 38-foot ground supported mat with turndown edges. The booster pumps will be supported by a ground supported slab with turndown edges, and the eastern edge of the pad will have a 5-foot-tall, cast-in-place retaining wall where the pad will cut into the existing slope. We anticipate less than 2 feet of cut/fill for the storage tank, 1 to 5 feet of cut for the booster pump area, and up to about 5 feet of fill for the GAC vessel tanks.

According to the information provided, we understand proposed improvements could also include asphalt repair and site piping, replacing the existing sodium hypochlorite system, and replacing the existing programmable logic controller (PLC) system. These proposed improvements are not included in the base scope of services for this study.

8.0 BASIS FOR RECOMMENDATIONS

The following recommendations are based on the subsurface data and experience with similar geologic environments. Because the structural elements of the design greatly influence the design recommendations, GTEC must be provided the opportunity to review the following comments and recommendations if locations, elevations, and loadings differ from what is described in the Proposed Construction section of this report. Our recommendations for the proposed development are based, in part, on the data obtained during our subsurface exploration at test locations spaced across the project site. However, variations in subsurface conditions can exist between our test locations which may not be indicated by our field testing and laboratory testing programs. If variations from the conditions described in our report are encountered in the future or if the proposed construction information is incorrect or changed, the recommendations of this report should not be considered valid unless GTEC reviews the changes and verifies or modifies our recommendations.

9.0 DESIGN RECOMMENDATIONS

The following section provides information to the owner and the design team for coordination with other project components including structural and civil planning.

9.1 Earthwork

9.1.1 Undercut and Over-Excavation

As shown on Drawing No. 1352-2, each boring encountered soft or firm clay soils or loose sand to depths ranging from 3.5 to 5 feet below the surface. In the proposed structures' footprints, GTEC recommends completely undercutting the unstable soils to stiff clay or medium dense sand or better suitable materials. The undercut areas should extend laterally 5 feet beyond structures' footprints. Following removal of the material, the entire excavated area should then be proofrolled or evaluated as directed by the geotechnical engineer. Engineered fill should then be placed and properly compacted as backfill to the planned finished subgrade elevation.

Undocumented fill material was encountered in most of the borings. Typically, the fill consisted of suitable materials which appeared to be placed with inconsistent compactive effort. Inherit risks are associated with undocumented fill, including possible areas of poor compaction and deleterious materials. GTEC recommends the undocumented fill be carefully reviewed during construction following topsoil stripping. Undercutting and replacement should be expected in the structural areas.

Due to the settlement potential of the soils in the tank area, we recommend over-excavation to a depth of at least 7 feet below the ground surface or to below the 36-inch pipes at the base of the tank. The backfill in the tank area should consist of ASTM No. 57 stone placed in one-foot lifts and compacted in place with a tamper or vibratory roller.

9.1.2 Site Grading

The foundation recommendations are reliant on the earthwork results during the site grading phase. Topsoil and unsuitable soils removal should extend at least five feet beyond structural limits. Existing underground utilities should be relocated outside of building areas. Once the topsoil is removed and any undercut operations are complete, the stability of the exposed subgrade should be assessed by proofrolling prior to fill placement. The proofrolling should be performed using a loaded dump truck (20 tons) or other similar rubber-tired equipment. Our geotechnical engineer should observe the proofrolling and provide recommendations for treatment if unstable soils are noted during the proofrolling operations. Unstable soils should generally be undercut as directed by a GTEC engineer.

Structural fill is defined as inorganic natural soil free of deleterious materials and debris. Structural fill should have a maximum particle size of 3 inches or less and a maximum dry density of at least 95 pounds per cubic foot (pcf) when tested by the standard Proctor method (ASTM D-698). The material should have a liquid limit no higher than 50 and plasticity index no higher than 30. Soil fill for building areas should be placed in relatively thin (8-inch or less) layers. The soil should be compacted to a minimum of 98 percent of the soil's maximum dry density as determined by the standard Proctor moisture-density relationship test.

9.2 Foundations Design

9.2.1 Storage Tank – Mat Foundations

The foundations for the proposed storage tank may be supported on a mat foundation bearing on newly placed controlled structural fill, medium dense to dense sand or stiff to very stiff residual soil. Based on an anticipated bearing pressure for the storage tank of up to 1,200 psf with a mat diameter of approximately 25 feet, we estimate total settlement of the foundations for the structures will be 2 inches and differential to be less than 0.75 inches. This induced settlement exceeds allowable criteria for most reinforced concrete foundations and piping connections.

To reduce settlement to less than 1 inch and differential to be less than 0.5 inches, we recommend over-excavating to 7 feet and backfilling with No. 57 stone. With over-excavating and stone backfill, we recommend a long-term modulus of subgrade reaction for the mat

foundation with newly placed controlled structural fill of 8 pounds per square inch per inch (psi/in).

Our settlement analysis was performed on the basis of our assumed structural loading conditions and grading assumption discussed in the Proposed Construction section of this report. Actual settlements experienced by the building and the time required for these soils to settle will be influenced by undetected variations in subsurface conditions, final structural loads, final ground surface grades, and the quality of fill placement and foundation construction.

9.2.2 GAC Vessels – Mat Foundations

The foundations for the proposed GAC vessels may be supported on a mat foundation bearing on newly placed controlled structural fill, medium dense to dense sand or stiff to very stiff residual soil. Based on an anticipated long-term bearing pressure for the GAC vessels of up to 885 psf with a mat dimension of approximately 38 feet by 40 feet and up to 5 feet of imported fill placed in the southeast corner of the site area, we estimate total settlement of the foundations for the structures will be 2 inches and differential to be less than 0.75 inches. We recommend a long-term modulus of subgrade reaction for the mat foundation of 3 psi/in.

Of the 2 inches of total settlement, 1.2 inches is due to the imported fill. To reduce settlement of the mat foundation to less than 1 inch and differential to be less than 0.5 inches, we recommend construction of the foundation and piping be delayed 30 days following placement of the soil fill. This delay allows for completion of settlement due to the soil fill. If imported soil is placed at least 30 days prior to construction of the mat foundation, we recommend a long-term modulus of subgrade reaction of 7 psi/in.

Our settlement analysis was performed on the basis of our assumed structural loading conditions and grading assumption discussed in the Proposed Construction section of this report. Actual settlements experienced by the building and the time required for these soils to settle will be influenced by undetected variations in subsurface conditions, final structural loads, final ground surface grades, and the quality of fill placement and foundation construction.

We understand that temporary higher loads will be incorporated for overturning during seismic loading. These temporary loads will not cause long term settlement. Based on the temporary incorporated higher loads, we recommend a short-term bearing capacity of 3,000 psf.

9.2.3 Booster Pumps and Retaining Walls – Shallow Foundations

Provided the project site is prepared as recommended, the proposed booster pumps and retaining walls may be supported on a monolithic slab with turndown foundations bearing on newly placed controlled structural fill, medium dense to dense or stiff to very stiff residual soil. Based on an anticipated structural column load of less than 50 kips, an anticipated strip load of

less than 3 kips per linear foot, and the subsurface conditions encountered in our test borings, we recommend that foundations be designed for a maximum allowable bearing pressure of up to 3,000 pounds psf. Strip foundations should have a minimum width of 18 inches. Foundations should bear at a depth of at least 12 inches below the finish exterior site grades to lessen the potential for damage from seasonal moisture variation and for bearing capacity considerations. Based on the boring data, assumed structural loading, and provided the site is prepared as recommended, we estimate total foundation settlements would be less than 1-inch, with differential settlement of ½ of the estimated total settlement. The magnitude of differential settlements will be influenced by the variability of underlying soils across the footprint of the structures and the variation of foundation loads.

9.3 Site Seismic Category

Based on the field boring data and the requirements of the International Building Code (IBC) Section 1613, this site meets the requirements of a Site Class D. The IBC contains a provision for using other design values if shear wave measurements are collected. GTEC can provide these services, if requested.

9.4 Ground-Supported Slabs

Ground-supported slabs may be placed on properly compacted controlled structural fill over an approved soil subgrade following subgrade preparation as discussed in the Earthwork Recommendations section. A standard modulus of subgrade reaction ("k") of 150 pounds per square inch per inch (psi/in) may be used for the design of the slabs-on-grade. A four-inch-thick layer of open-graded coarse aggregate such as No. 57 or No. 67 should be placed beneath the floor slab. This granular base would function as a leveling and load distributing material as well as a capillary break beneath the slab. A vapor retarder should be used beneath slabs that will be covered by tile, wood, carpet, impermeable coatings, or if other moisture-sensitive equipment or materials will be in contact with the slab. However, the use of vapor retarders may result in excessive curling of concrete slabs during curing. We refer the concrete slab designer to ACI 302.1R-04, Sections 4.1.5 and 11.11, for further discussion on vapor retarders, curling, and the means to lessen potential concrete shrinkage and curling.

Proper jointing of the concrete slabs-on-grade can reduce cracking. ACI suggests that unreinforced, plain concrete slabs may be jointed at spacing of 24 to 36 times the slab thickness, up to a maximum spacing of 15 feet. Utility or other construction excavations in the prepared subgrade should be backfilled to a controlled fill criterion to provide uniform support.

9.5 Free-Standing Walls

Retaining walls are designed either in an at-rest or active condition, depending on whether the top of the wall is restrained from movement prior to backfilling. Permanent below grade walls planned for the structures should be designed to resist at-rest earth pressures. Free-standing site

retaining walls should be designed to resist active pressures. Earth pressures on the walls will be a function of the excavation shape and the extent to which the retained soil can be replaced by granular material below the water table as described below. Surcharge loads and hydrostatic pressures have not been factored into the lateral earth pressure parameters presented below. The fill material used behind the walls should be reviewed and approved by the geotechnical engineer prior to their placement. Using a 1 horizontal to 1 vertical (1H:1V) wedge of select material can significantly reduce the horizontal loads on the wall. The following earth pressure coefficients are recommended for above grade wall design.

Retaining Wall Parameters		
Parameter	**No. 57 Stone**	**In-Situ Soil/Fill**
Back Slope Profile	Horizontal	Horizontal
Angle of Internal Friction	35 degrees	25 degrees
Cohesion	--	0 psf
Active Backfill Pressure Coefficient with 3H:1V Backslope	0.27	0.5
Passive Earth Pressure Coefficient	--	2.4
Unit Weight	105 pcf	125 pcf
Interface Friction Factor with Mass Concrete	--	0.35

To limit water infiltration behind the walls, the upper two feet of backfill should consist of select soil fill compacted to 98 percent standard Proctor. We recommend the structural soil fill be placed in accordance with the Earthwork section of this report. The observation of the construction of the retaining wall backfill should be performed on a full-time basis to ensure adequate consolidation of the stone and proper compaction of the soil backfill. We recommend using a self-propelled compactor such as a 1-ton, twin-drum Ramex (or similar). The crushed stone should be placed in relatively thin lifts, no greater than 6-inches thick. The geotechnical engineer should observe placement of the first few lifts to assist in determining the approximate number of compactor passes which appear to accomplish adequate compaction. In areas not accessible to the Ramex compactor, hand compaction equipment such as vibra-plates, should be used. The maximum lift thickness in these areas should not exceed 4-inches. No heavy equipment or construction loads should be allowed within 5 feet of the walls. This will help prevent equipment surcharge loads from adding lateral earth pressures to the retaining wall.

10.0 CONSTRUCTION CONSIDERATIONS

The principal purpose of this section is to comment in general on the items related to earthwork, foundation construction, and pavement placement. It is valuable that GTEC's geotechnical engineer be retained to provide soil-engineering services during the construction phases of the project. The geotechnical engineer can also assist in interpretation of differing subsurface conditions that may be encountered and recommend remedial work, if needed.

10.1 Site Preparation

Prior to construction, the existing gravel and any underground utilities should be demolished and removed from the construction limits. Underground utility lines should be relocated or capped off outside the construction area. We do not recommend active or non-active utility lines associated with previous development be located within the proposed structure footprints. All utility excavations should be backfilled with properly compacted structural fill. Any abandoned utility pipes, if left in place outside of structure footprints, should be filled-in under pressure with cement grout with a minimum 28-day compressive strength of 500 pounds per square inch (psi).

The entire construction area should be stripped of grass, trees, stumps, vegetation, organic-laden soils, debris, or any other deleterious materials to a minimum of 5 feet outside the limits of structural areas. Depressions or low areas resulting from stripping and or clearing operations should be backfilled to prevent ponding with approved structural fill and compacted in accordance with the Earthwork section. We recommend site preparation be monitored by the geotechnical engineer or their representative to verify that the recommendations presented herein are implemented. After stripping surficial soils, we recommend the areas to receive fill be proofrolled as described the Earthwork section. Proofrolling should be performed with a fully loaded tandem-axle dump truck or similar piece of rubber-tired equipment with a minimum loaded weight of 20 tons. The purpose of the proofrolling is to detect any localized or isolated weak soil zones in building and pavement areas prior to backfilling.

10.2 Structural Fill Placement and Compaction

Prior to fill placement, representative samples of each structural fill material should be collected and tested by GTEC to determine the material's moisture-density characteristics (including the maximum dry density, optimum water content, gradation and Atterberg limits). These tests are needed for quality control of the structural fill and to determine if the fill material meets project specification requirements as outlined in the Earthwork Recommendations section of this report. Successful reuse of the excavated, on-site soils as compacted structural fill will depend on the water content and the plasticity of the soils encountered during excavation. Once fill placement begins, a qualified soils technician should perform field density tests to document the degree of compaction being obtained in the field. Structural fills should be placed in thin (6 to 8-inch) loose lifts and compacted to 98 percent of the standard Proctor maximum dry density (ASTM Test Method D698) at or near optimum water content (maximum deviation of ±3 percent). Some

moisture conditioning (such as wetting or drying) may be required during the filling operation to obtain the required degree of compaction. The moisture conditioning is highly dependent on weather conditions and site drainage conditions. Therefore, the grading contractor should be prepared to both dry and wet the fill materials to obtain the specified compaction during grading.

10.3 Groundwater Control

Delayed readings indicated a stabilized groundwater level about 7 feet below the surface (ELEV 638 feet) in the storage tank and booster pump areas. We anticipate water will infiltrate excavations for undercut or trenching during construction if undercutting or trenching more than 7 feet in these areas. Due to the proximity of the existing clearwell water tanks and possibly causing settlement to these structures, we do not recommend the contractor dewater excavations below a depth of 10 feet during construction.

10.4 Surface Water Control

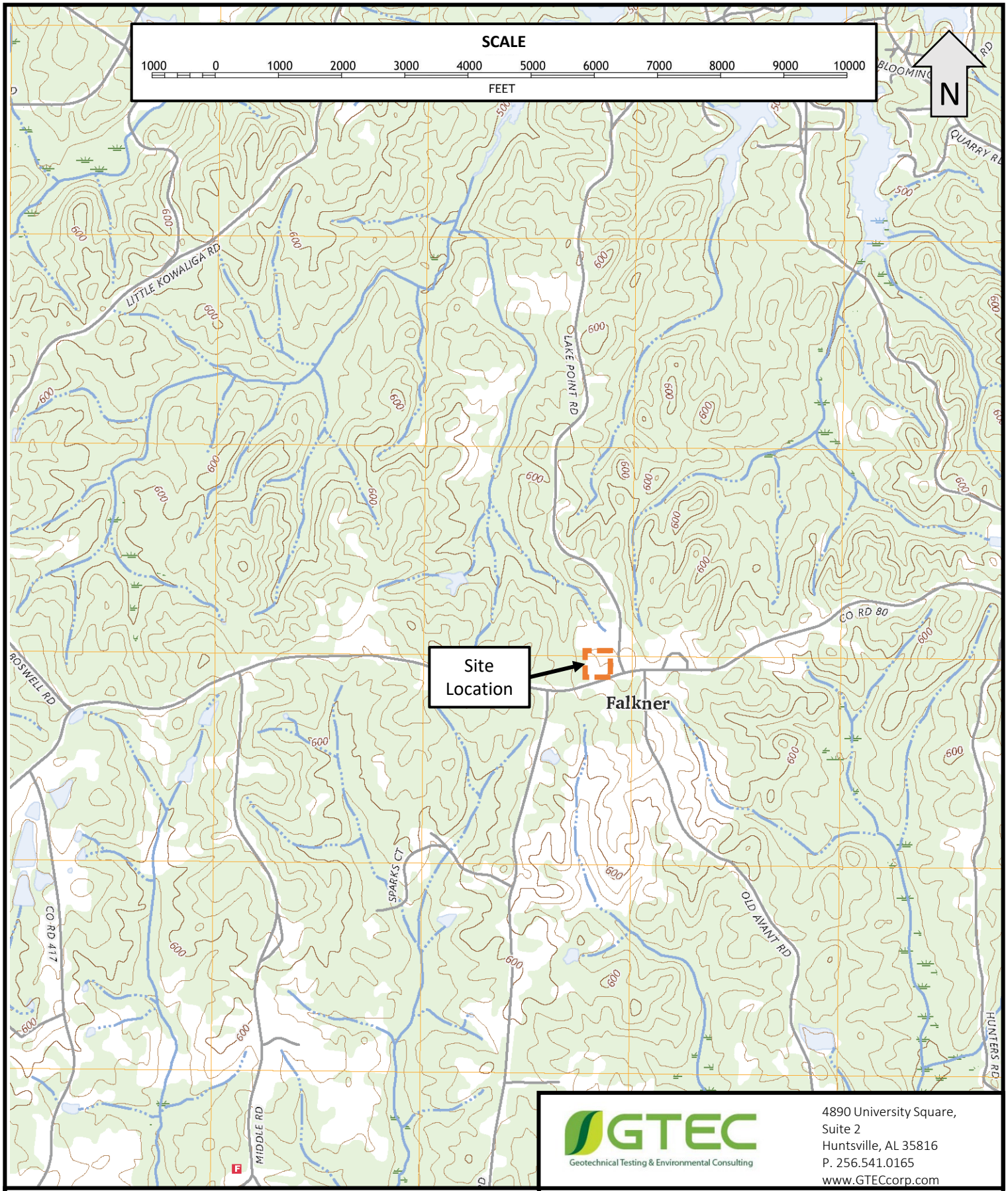
If free water is allowed to stand on stable subgrade soils, these soils can absorb water, freeze, swell, and experience a reduction in their support capability. As a result, we recommend that the subgrade surface be graded to provide positive drainage away from the construction areas and towards suitable drainage handling areas, such as a perimeter ditch, French drain, culvert, or retention pond. Trapped or perched water conditions could develop during periods of inclement weather and during seasonally wet periods. Such conditions could cause seepage into excavations and deeper cuts. Therefore, grading of the project should be performed in such a manner to prevent ponding of water and promote runoff away from construction areas. If site grading is performed during the seasonally wet months or after extended periods of inclement weather, wet and water softened near surface soil conditions should be expected.

10.5 Excavations

Excavations required for construction of this project must be performed in accordance with the United States Department of Labor, Occupational Safety and Health Administration (OSHA) guidelines (29 CFR 1926, Subpart P, Excavations) or other applicable jurisdictional codes for permissible temporary side-slope ratios and or shoring requirements. The OSHA guidelines require daily inspections of excavations, adjacent areas, and protective systems by a “competent person” for evidence of situations that could result in caveins, indications of failure of a protective system, or other hazardous conditions. Excavated soils, equipment, building supplies, etc., should be placed away from the edges of the excavation at a distance equaling or exceeding the depth of the excavation. The contractor is responsible for providing the “competent person” and all aspects of site excavation safety.

11.0 LIMITATIONS

There are important limitations to this and all geotechnical studies. This report has been prepared for the exclusive use of Ardurra, or their agents, for specific application to the proposed water treatment improvements project in Eclectic, Alabama, in accordance with generally accepted soil and geotechnical engineering practices. No other warranty, express or implied, is made. Our conclusions and recommendations are based on design information furnished to us, the data obtained from the field-testing program, and generally accepted geotechnical engineering practice. The findings and recommendations do not reflect variations in subsurface conditions, which could exist in unexplored areas of the site. Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions in other areas will differ from those at the test locations or that the construction process has altered the soil conditions. Therefore, our experienced geotechnical engineer should evaluate executed construction to verify that the conditions anticipated in design actually exist. Otherwise, we assume no responsibility for construction compliance with the design concepts, specifications, or recommendations. In the event that changes are made in the design or location of the improvements, the recommendations presented in this report shall not be considered valid unless the changes are reviewed by our firm and conclusions of this report modified or verified in writing. If this report is copied or transmitted to a third party, it must be copied or transmitted in its entirety, including text, appendices, and enclosures. Interpretations based on only a part of this report may not be valid.



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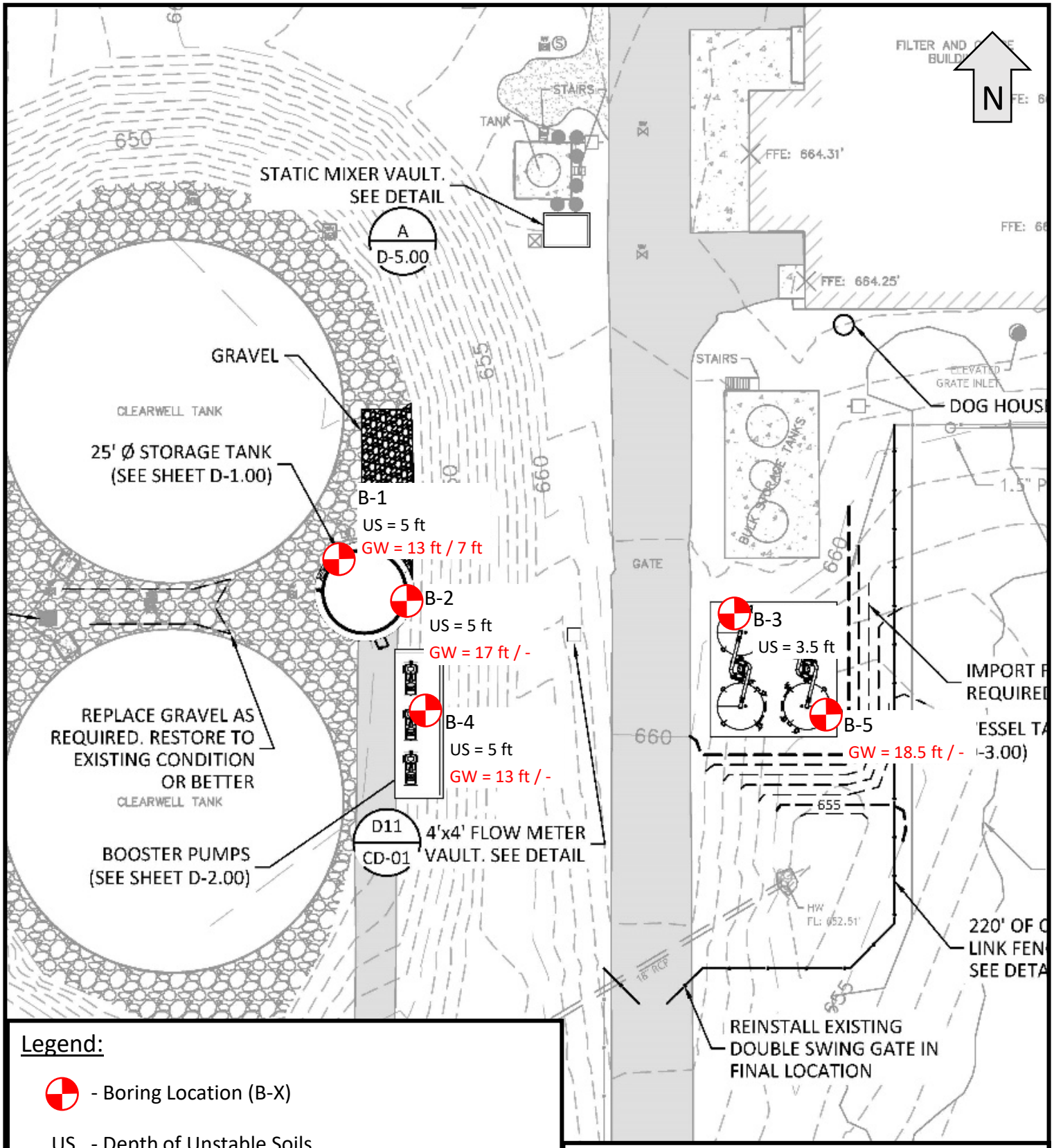
SITE LOCATION PLAN

Scale: As Shown

Project Name:	CEWSA WTP Improvements
Drawn By:	KB
Location:	Eclectic, Alabama
Date:	9/16/2024
Drawing No.:	1352-1



Legend:

- Boring Location (B-X)

US - Depth of Unstable Soils

GW - Depth to Groundwater During Drilling/Delayed

Reference: *"Central Elmore WTP Upgrade, Site Plan"*, Ardurra, dated 7/19/2024

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TEST LOCATION PLAN

Scale: 1" = 40'

Project Name:	CEWSA WTP Improvements
Drawn By:	KB
Location:	Eclectic, Alabama
Date:	9/6/2024
Drawing No.:	1352-2

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4890 Univ. Square Ste 2,
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CEWSA WTP Improvements

Lat/Lon: 32.69573889/-86.05252778 SOIL BORING: B-1

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type: Diedrich D-50 Turbo
Tooling: 2-1/4" Hollow Stem Auger
Surface Elevation: 645'

Depth (ft)	Visual Classification and Remarks	Depth of Sample (ft)	Sample Number	Sample Graphic	Uncorrected N-Value	Pocket Penetrometer (tsf)	Lab Sample ID	Moisture Content (%)
	TOPSOIL, 3 inches (0.3)	0 ft	S-1		39	-	S-1	26.2
	WELL-GRADED SAND WITH GRAVEL (SW), few fines, fine grained, brownish red, very dense, moist, fill (1.5)	1.5 ft	S-2		24	2.5	S-2	2.7
	WELL-GRADED GRAVELLY SAND (SW), few fines, fine grained, gray, dense, moist, fill (3.5)	3.5 ft	S-3		4	2.25	S-3	34.2
5	SILTY SAND (SM), few gravel, some fines, micaceous, fine grained, tan, brown and red, loose, moist, residuum (5.0)	6 ft	S-4		10	1.75	S-4	30.2
	SILTY SAND (SM), few gravel, some fines, micaceous, fine grained, tan, brown and red, medium dense, moist, residuum	8.5 ft	S-5		8	2.5	S-5	26.2
10		13.5 ft	S-6		15	1.0	S-6	20.1
15		18.5 ft	S-7		22	-	S-7	18.4
20	SILTY SAND (SM), little gravel, little fines, micaceous, fine grained, tan, brown and red, dense to very dense, moist, residuum (18.5)	23.5 ft	S-8		27	1.5	S-8	20.6

REMARKS

Water Levels

Water encountered at 13 ft

Water encountered 5 hours after drilling at 7 ft

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CEWSA WTP Improvements

Lat/Lon: 32.69573889/-86.05252778 SOIL BORING: B-1

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type: Diedrich D-50 Turbo
Tooling: 2-1/4" Hollow Stem Auger
Surface Elevation: 645'

Depth (ft)	Graphic Log	Visual Classification and Remarks	Samples: Depth of Sample (ft)	Sample Number	Sample Graphic	Uncorrected N-Value	Pocket Penetrometer (tsf)	Lab: Lab Sample ID	Moisture Content (%)
		SILTY SAND (SM), little gravel, little fines, micaceous, fine grained, tan, brown and red, dense to very dense, moist, residuum	28.5 ft						
				S-9		69	1.25	S-9	14.0
30									
		33.5	33.5 ft						
		CLAYEY SAND WITH GRAVEL (SC), little gravel, little fines, micaceous, fine to medium grained, tan, brown, and red, very dense, moist, residuum		S-10		100	1.5	S-10	19.9
35			38.5 ft						
				S-11		100			
		40.0							
40		Boring Terminated at 40 ft							
45									

REMARKS

Water Levels

▽ Water encountered at 13 ft

▼ Water encountered 5 hours after drilling at 7 ft

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CEWSA WTP Improvements

STA/OFS: /5 ft west of B-1

SOIL BORING: B-1A

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type: Diedrich D-50 Turbo
Tooling: 2-1/4" Hollow Stem Auger
Surface Elevation: 645'

Depth (ft)	Graphic Log	Visual Classification and Remarks	Samples: Depth of Sample (ft)	Sample Number	Sample Graphic	Pocket Penetrometer (tsf)
		Augered without sampling				
		3.5				
		Augered without sampling				
		5.0	5 ft			
5		Pushed Shelby tube		UD-1		3.50
		7.0				
		Augered without sampling				
		10.0	10 ft			
10		Pushed Shelby tube		UD-2		3.75
		12.0				
		Boring Terminated at 12 ft				
15						
20						

REMARKS

Backfilled at time of drilling

Water Levels

▽ Dry During Drilling

▼ -

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CEWSA WTP Improvements

Lat/Lon: 32.69570833/-86.05246111 SOIL BORING: B-2

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type: Diedrich D-50 Turbo
Tooling: 2-1/4" Hollow Stem Auger
Surface Elevation: 646'

Depth (ft)	Visual Classification and Remarks	Depth of Sample (ft)	Sample Number	Sample Graphic	Uncorrected N-Value	Pocket Penetrometer (tsf)	Lab Sample ID	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines	% Sand	% Gravel
	TOPSOIL, 5 inches (0.4)	0 ft	S-1		7	1.75	S-1	21.0				
	SILTY SAND (SM), little gravel, some fines, fine grained, brownish red, loose, moist, fill (1.5)	1.5 ft	S-2		10	1.0	S-2	21.7				
	SILTY SAND (SM), few gravel, some fines, micaceous, fine grained, tan, brown and red, loose to medium dense, moist, residuum (5.0)	3.5 ft	S-3		6	1.5	S-3	23.7				
5	SILTY SAND (SM), few gravel, some fines, micaceous, fine grained, tan, brown and red, medium dense, moist, residuum	5 ft	UD-1			3.5	UD-1	26.2	43-37-6	37.4	53.1	9.5
		7 ft	S-4		9	0.5	S-4	25.8				
		8.5 ft	S-5		9	1.5	S-5	25.8				
10		13.5 ft	S-6		12	1.0	S-6	28.5				
15												
▽		18.5 ft										
	SILTY SAND (SM), with gravel, some fines, micaceous, fine grained, tan, brown and red, dense to very dense, moist, residuum (18.5)		S-7		32	1.5	S-7	22.9				
20		23.5 ft	S-8		50	3.25	S-8	11.6				

REMARKS

Pushed Shelby tube from 5-7 ft. Backfilled at time of drilling.

Water Levels

▽ Water encountered at 17 ft

▼ -

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CEWSA WTP Improvements

Lat/Lon: 32.69570833/-86.05246111

SOIL BORING: B-2

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type: Diedrich D-50 Turbo
Tooling: 2-1/4" Hollow Stem Auger
Surface Elevation: 646'

Depth (ft)	Graphic Log	Visual Classification and Remarks	Samples: Depth of Sample (ft)	Samples: Sample Number	Samples: Sample Graphic	Samples: Uncorrected N-Value	Samples: Pocket Penetrometer (tsf)	Lab: Lab Sample ID	Lab: Moisture Content (%)	Lab: Atterberg Limits (LL-PL-PI)	Lab: % Fines	Lab: % Sand	Lab: % Gravel
		SILTY SAND (SM), with gravel, some fines, micaceous, fine grained, tan, brown and red, dense to very dense, moist, residuum	28.5 ft	S-9		50	2.0	S-9	12.0				
30		30.0 Boring Terminated at 30 ft											
35													
40													
45													

REMARKS

Pushed Shelby tube from 5-7 ft. Backfilled at time of drilling.

Water Levels

Water encountered at 17 ft

-

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CEWSA WTP Improvements

Lat/Lon: 32.69569167/-86.05211111

SOIL BORING: B-3

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type: Diedrich D-50
Tooling: 2-1/4" Hollow Stem Auger
Surface Elevation: 660'

Depth (ft)	Visual Classification and Remarks	Depth of Sample (ft)	Sample Number	Sample Graphic	Uncorrected N-Value	Pocket Penetrometer (tsf)	Lab Sample ID	Moisture Content (%)	% Fines	% Sand	% Gravel
	TOPSOIL, 8 inches (0.7)	0 ft	S-1		4	2.5	S-1	21.4			
	SANDY, ELASTIC SILT (MH), few gravel, some fines, low plasticity, red and tan, firm, moist, fill (3.5)	1.5 ft	S-2		4	2.0	S-2	24.2			
		3.5 ft	S-3		7	2.5	S-3	32.7	57	35	8
5	SANDY, ELASTIC SILT (MH), few gravel, some fines, low plasticity, red and tan, stiff to very stiff, moist, residuum (8.5)	6 ft	S-4		11	1.75	S-4	28.9			
		8.5 ft	S-5		5	1.5	S-5	25.3			
10	SILTY SAND (SM), few gravel, some fines, miscaceous, fine grained, tan, brown and red, loose, moist, residuum	13.5 ft	S-6		6	-	S-6	28.1			
15	(18.5)	18.5 ft	S-7		8	1.5	S-7	29.6			
20	SILTY SAND (SM), few gravel, some fines, miscaceous, fine grained, tan, brown and red, medium dense, moist, residuum (20.0)										
	Boring Terminated at 20 ft										

REMARKS
Backfilled at time of drilling

Water Levels

▽ Dry During Drilling

▼ -

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CEWSA WTP Improvements

Lat/Lon: 32.69561667/-86.05243611

SOIL BORING: B-4

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type: Diedrich D-50 Turbo
Tooling: 2-1/4" Hollow Stem Auger
Surface Elevation: 647'

Depth (ft)	Visual Classification and Remarks	Depth of Sample (ft)	Sample Number	Sample Graphic	Uncorrected N-Value	Pocket Penetrometer (tsf)	Lab Sample ID	Moisture Content (%)	Atterberg Limits (LL-PL-PI)	% Fines	% Sand	% Gravel
	TOPSOIL, 3 inches (0.3)	0 ft	S-1		5	4.5	S-1	28.6	54-31-23	69.4	26.9	3.7
	SANDY, ELASTIC SILT (MH), trace organics, trace gravel, little sand, medium plasticity, red and tan, firm, moist, residuum (1.5)	1.5 ft	S-2		9	2.0	S-2	23.5				
	SANDY, ELASTIC SILT (MH), trace organics, trace gravel, little sand, medium plasticity, red and tan, stiff, moist, residuum (3.5)	3.5 ft	S-3		7	1.75	S-3	32.7				
5	SILTY SAND (SM), few gravel, some fines, micaceous, fine grained, tan, brown, and red, loose, moist, residuum (5.0)	6 ft	S-4		16	1.5	S-4	28.9				
	SILTY SAND (SM), few gravel, some fines, micaceous, fine grained, tan, brown, and red, medium dense to dense, moist, residuum	8.5 ft	S-5		9	1.5	S-5	25.3				
10		13.5 ft	S-6		15	1.5	S-6	27.9				
15		18.5 ft	S-7		29	-	S-7	29.6				
20	Augered without sampling (20.0)											

REMARKS
Backfilled at time of drilling

Water Levels

Water encountered at 13 ft

-

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CEWSA WTP Improvements

Lat/Lon: 32.69561667/-86.05243611

SOIL BORING: B-4

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type	Diedrich D-50 Turbo
Tooling	2-1/4" Hollow Stem Auger
Surface Elevation	647'

Depth (ft)	Graphic Log	Visual Classification and Remarks	Samples: Depth of Sample (ft)	Samples: Sample Number	Samples: Sample Graphic	Samples: Uncorrected N-Value	Samples: Pocket Penetrometer (tsf)	Lab: Lab Sample ID	Lab: Moisture Content (%)	Lab: Atterberg Limits (LL-PL-PI)	Lab: % Fines	Lab: % Sand	Lab: % Gravel
		Augered without sampling											
30													
35													
40		40.0 Boring Terminated at 40 ft											
45													

REMARKS

Backfilled at time of drilling

Water Levels

Water encountered at 13 ft

-

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CEWSA WTP Improvements

Lat/Lon: 32.69561111/-86.05203611

SOIL BORING: B-5

Date Started:	09/17/2024	Date Completed:	09/17/2024	Location Accuracy:	Not Surveyed
Project No:	1352	Client Name:	Ardurra	Drilling Firm:	South Bros Drilling
Hammer Type:	Auto	Logged By:	Kathleen Bernal	Hammer Efficiency:	85%

Rig Type: Diedrich D-50 Turbo
Tooling: 2-1/4" Hollow Stem Auger
Surface Elevation: 655'

Depth (ft)	Visual Classification and Remarks	Depth of Sample (ft)	Sample Number	Sample Graphic	Uncorrected N-Value	Pocket Penetrometer (tsf)	Lab Sample ID	Moisture Content (%)
	TOPSOIL, 8 inches (0.7)	0 ft	S-1		6	2.75	S-1	25.3
	SANDY, ELASTIC SILT (MH), few gravel, some sand, few black oxides, micaceous, low plasticity, red and tan, stiff to very stiff, moist, residuum	1.5 ft	S-2		9	3.75	S-2	33.6
		3.5 ft	S-3		11	2.50	S-3	22.3
5		6 ft	S-4		17	1.5	S-4	22.1
	(8.5)	8.5 ft	S-5		5	2.5	S-5	25.3
10	SILTY SAND (SM), few gravel, some fines, micaceous, fine grained, tan, brown and red, loose, moist, residuum (10.0)							
	SILTY SAND (SM), few gravel, some fines, micaceous, fine grained, tan, brown and red, medium dense, moist, residuum	13.5 ft	S-6		8	-	S-6	26.5
15		18.5 ft	S-7		12	1.5	S-7	25.0
▽								
20	(20.0) Boring Terminated at 20 ft							

REMARKS

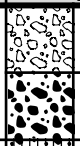
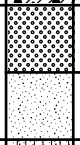
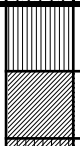
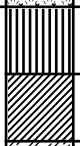
Backfilled at time of drilling

Water Levels

▽ Water encountered at 18.5 ft

▼ -

BORING LEGEND

SOIL SYMBOLS					
Major Divisions				**Group Symbols**	**Typical Names**
Coarse Grain Soils More Than 50% Retained on No. 200 Sieve	**Gravels** 50% or More of Coarse Fraction Retained on #4 Sieve	Clean Gravels		GW	Well-graded gravels and gravel-sand mixtures,little or no fines
				GP	Poorly graded gravels and gravel-sand mixtures,little or no fines
		Gravels With Fines		GM	Silty gravels, gravel-sand-silt mixtures
				GC	Clayey gravels, gravel-sand-clay mixtures
	Sands More Than 50% of Coarse Fraction Passes #4 Sieve	Clean Sands		SW	Well-graded sands and gravelly sands, little orno fines
				SP	Poorly graded sands and gravelly sands, littleor no fines
		Sands With Fines		SM	Silty sands, sand-silt mixtures
				SC	Clayey sands, sand-clay mixtures
Fine Grain Soils 50% or More Passes No. 200 Sieve	**Silts and Clays** Liquid Limit 50% or Less			ML	Inorganic silts, very fine sands, rock flour, siltyor clayey fine sands
				CL	Inorganic clays or low to medium plasticity, gravelly or sandy clays, lean clays
				CL-ML	Silty clays, gravelly or sandy silty clays
				OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays Liquid Limit Greater Than 50%			MH	Inorganic silts, micaceous or diatomaceous finesands or silts, elastic silts
				CH	Inorganic clays of high plasticity, fat clay
				OH	Organic clays of medium to high plasticity
Highly Organic Soils				PT	Peat, muck and other highly organic soils

Other Commonly Used Soil Symbols

	Topsoil
	Asphalt
	Concrete
	Fill

Rock Symbols

	Limestone
	Sandstone
	Conglomerate
	Shale

Sample Types

	Split Spoon Sample
	Undisturbed Sample
	Rock Core

Secondary Constituent

Trace	Less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

Other Symbols

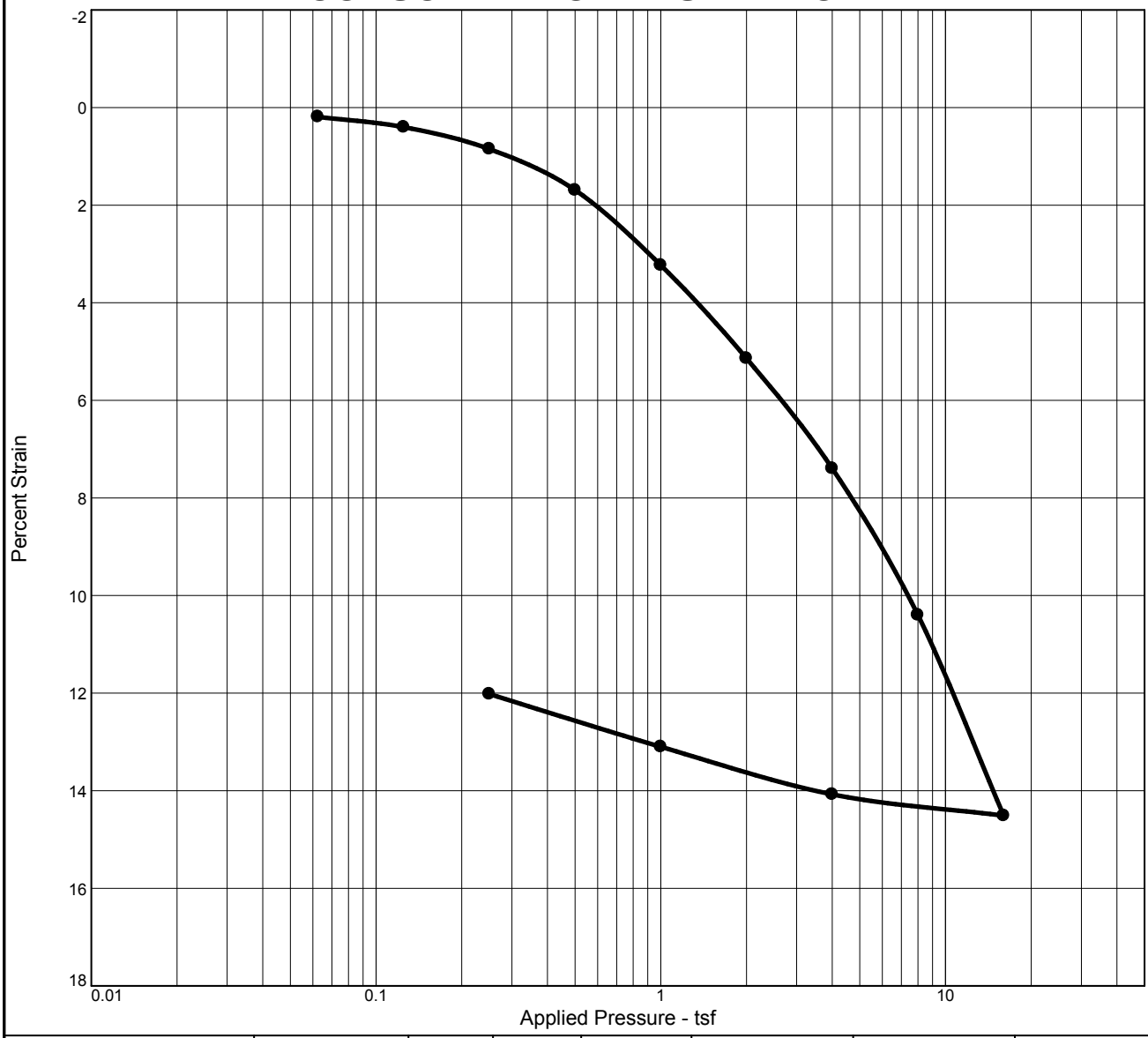
	Groundwater Level During Drilling
	Extended Groundwater Level

Laboratory Descriptions

	Atterberg Limits, shown as LL-PL-PI Liquid Limit – Plasticity Limit – Plasticity Index

GTEC

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	Initial Void Ratio
Saturation	Moisture							
	21.7 %	85.6	43	6		0.3165	2.4	

MATERIAL DESCRIPTION	USCS	AASHTO
Silty Sand with gravel, micaceous, fine grained, tan, brown, and red, moist, residuum	SM	A-5(0)

Project No. 1352 **Client:** Ardurra

Project: CEWSA WTP Improvements

Location: B-2 **Depth:** 5-7 ft **Sample Number:** UD-1

GTEC
Geotechnical Testing & Environmental Consultants

Remarks:

Figure 1

Tested By: L Williams **Checked By:** L Williams

FIELD PROCEDURES

SOIL TEST BORING, ASTM D1586

The borings were advanced using augers powered by a motor-driven drill rig. At regular intervals, soil samples were obtained with a standard 1.4-inch I.D., 2.0- inch O.D., split-tube sampler. The sampler was initially seated 6 inches to penetrate any loose cuttings and then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated as the *standard penetration resistance*. Standard penetration resistance, when properly evaluated, is an index to soil strength and density. Field personnel logged and described the samples as they were obtained. Representative portions of each soil sample were then sealed in labeled glass jars or plastic bags and transported to our laboratory. The samples were examined by a geotechnical engineer or engineering geologist to visually check the field descriptions. Boring data, including sample intervals, penetration resistances, soil descriptions, and groundwater level are shown on the Boring Logs.

The unconfined compressive strength of cohesive soil samples can be estimated in the field using calibrated pocket penetrometer readings (Pp). This test involves pushing a spring-loaded piston 0.25 inches in diameter into an SPT sample, undisturbed sample, or excavation side wall and measuring the spring deflection. The recorded deflection is correlated to unconfined compressive strength.

THIN-WALLED TUBE SAMPLING, ASTM D1587

A relatively undisturbed sample of the cohesive subsurface materials was obtained in borings by hydraulically pressing 3-inch O.D. thin-wall sampling tube 24 inches into the underlying soils at a selected depth. The tube is then removed from the ground, and the tube is sealed to maintain the moisture content of the sample. Relatively undisturbed sample intervals are shown on the Boring Logs.

LABORATORY PROCEDURES

MOISTURE CONTENT OF SOILS, ASTM D2216

The moisture content of soils is an indicator of various physical properties, including strength and compressibility. Selected samples obtained during exploratory drilling were taken from their sealed containers. Each sample was weighed and then placed in an oven heated to 110°C + 5°. The sample remained in the oven until the free moisture had evaporated. The dried sample was removed from the oven, allowed to cool, and re-weighed. The moisture content was computed by dividing the weight of evaporated water by the weight of the dry sample. The results, expressed as a percent, are shown on the Boring Logs.

ATTERBERG LIMITS DETERMINATION, ASTM D4318

Representative samples were subjected to Atterberg limits testing to determine the soil's plasticity characteristics. The plasticity index (PI) is the range of moisture content through which the soil deforms as a plastic material. It is bracketed by the liquid limit (LL) and the plastic limit (PL). The liquid limit is the moisture content at which the soil becomes wet enough to flow as a viscous fluid. To determine the liquid limit, a soil specimen is first passed through a No. 40 sieve. The materials finer than the No. 40 sieve are retained, and the moisture content is then manipulated until the soil is in a viscous fluid state. A portion of this soil is then placed in a brass cup of standardized dimensions. A groove is cut through the middle of the soil specimen with a grooving tool of standard dimensions. The cup is attached to a cam that lifts the cup 10 mm and then allows the cup to fall onto a hard rubber base. The cam is rotated at about 2 cycles per second until the two halves of the soil specimen come in contact at the bottom of the groove for a distance of 1/2 inch. The number of blows required to achieve this 1/2-inch contact is recorded, and part of the specimen is subjected to a moisture content determination. The remainder of the specimen is allowed to air dry for a short time, and the grooving process and cam action repeated. This testing sequence is repeated until more than 25 blows is required to achieve the required groove contact. After the number of blows vs. moisture content for the various test points are plotted on arithmetic graph paper, the moisture content corresponding to 25 blows is designated the liquid limit.

The plastic limit (PL) is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into threads 1/8-inch diameter. The plastic limit is determined by taking a pat of soil remaining from the liquid limit test and repeatedly rolling, kneading, and air drying it until the soil breaks into threads about 1/8 inches in diameter and 3/8 inches long. The moisture content of these soil threads is then determined and is designated the plastic limit. The results of the liquid and plastic limits tests are tabulated on the Boring Logs.

DETERMINATION OF SOILS FINER THAN NO. 200 SIEVE, ASTM D1140

The clay and silt content of granular soils affects their physical properties such as strength, compressibility, and permeability. Selected soil samples were tested to determine the percent, by weight, of soil particles finer than the No. 200 sieve (silt and clay size particles). Soil particles finer than 75 microns were flushed through a No. 200 sieve using water. The coarse materials retained on the No. 200 sieve were dried to obtain their dry weight. The dry weight of materials retained on the No. 200 sieve was compared to the dry weight of the total test specimen. The difference in weight, expressed as a percentage of the pre-wash weight, is designated as the percentage of "fines" (silt and clay size particles).

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

VICINITY MAP
1" = 2,000'

LOCATION MAP
1" = 250'

FOR:

CENTRAL ELMORE WATER AND SEWER AUTHORITY

716 U.S. HIGHWAY 231
WETUMPKA, AL
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811 Know what's below. Call before you dig.

NO.	DATE	REVISION	BY

ALABAMA LICENSED No. 36223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

G-00

100% ISSUE FOR BID
07/11/2025

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DRAWING INDEX

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G-03	GENERAL AND CIVIL ABBREVIATIONS
G-04	PROCESS SYMBOLS, ABBREVIATIONS AND LEGENDS
G-05	STRUCTURAL GENERAL NOTES
G-06	PROCESS AND INSTRUMENTATION LEGEND SHEET 1 OF 2
G-07	PROCESS AND INSTRUMENTATION LEGEND SHEET 2 OF 2
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D-2.01	BOOSTER PUMPS SECTIONS
S-2.00	BOOSTER PUMPS FOUNDATION PLAN & SECTIONS
E-2.00	BOOSTER PUMPS ELECTRICAL PLAN
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ED-05	ELECTRICAL DETAILS 1
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ED-07	ELECTRICAL DETAILS 3
ID-01	INSTALLATION DETAILS PROCESS AND INSTRUMENTATION

DIRECTIONAL NOTES

1. THE CONTRACTOR IS TO BE AWARE THAT THERE ARE OTHER EXISTING UTILITIES, BOTH ABOVE AND BELOW GROUND, ON THIS PROJECT. HE IS TO COORDINATE HIS INSTALLATION WITH THE OTHER UTILITIES.
2. THE CONTRACTOR IS TO BE AWARE THAT HE IS RESPONSIBLE FOR CLEARING ALL TREE UNDERGROWTH, ROCKS, AND ANY OTHER OBSTRUCTIONS THAT HE MAY ENCOUNTER IN ORDER TO PERFORM HIS WORK.
3. THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE PRESENCE AND LOCATION OF ALL UNDERGROUND UTILITIES PRIOR TO HIS BID AND CONSTRUCTION. THE CONTRACTOR SHALL REPAIR ANY DAMAGES TO OTHER UTILITIES AT NO ADDITIONAL COST TO THE OWNER.
4. THE CONTRACTOR SHALL VERIFY CONNECTIONS, WHERE INDICATED ON DRAWINGS, WITH THE OWNER. CONTRACTOR SHALL GIVE 24 HOURS NOTICE BEFORE REQUIRING THIS MEETING.
5. THE CONTRACTOR IS RESPONSIBLE FOR REPLACING OR REPAIRING ANY DAMAGED PUBLIC OR PRIVATE PROPERTY OR FACILITIES TO THE SAME OR BETTER CONDITION AS EXISTED PRIOR TO THE CONSTRUCTION. THE CONTRACTOR WILL COORDINATE THE REPLACEMENT / REPAIR WITH THE ENGINEER AND THE FINAL INSTALLATION SHALL MEET THE APPROVAL OF THE ENGINEER.
6. THE EXISTING UTILITIES IN THIS CONSTRUCTION AREA ARE NOT NECESSARILY SHOWN ON THE PLANS. DATA CONCERNING UTILITIES SHOWN SHALL BE CONSIDERED AS APPROXIMATE ONLY.
7. THE ARRANGEMENT OF EQUIPMENT SHOWN IS NOT INTENDED TO SHOW EXACT DIMENSIONS PARTICULAR TO A SPECIFIC MANUFACTURER. THE DRAWINGS ARE IN PART DIAGRAMMATIC AND SOME FEATURES OF EQUIPMENT SHOWN MAY REQUIRE REVISION TO MEET ACTUAL EQUIPMENT REQUIREMENTS. THE CONTRACTOR SHALL CONFIRM ALL CRITICAL DIMENSIONS FOR ACTUAL EQUIPMENT THAT MAY IMPACT CONSTRUCTION, ACCESS OR REMOVAL AND MAINTENANCE OF EQUIPMENT.
8. ALL PIPING CONNECTING TO EQUIPMENT SHALL BE PROVIDED WITH UNIONS OR COMPANION FLANGES LOCATED SO THAT PIPING MAY BE READILY DISMANTLED FROM EQUIPMENT.
9. CONTRACTOR SHALL FIELD VERIFY DIMENSIONS AND ELEVATIONS PRIOR TO BEGINNING CONSTRUCTION. SIGNIFICANT DEVIATIONS FROM INFORMATION SHOWN ON DRAWINGS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.

EROSION

1. ALL DISTURBED AREAS ARE TO BE GRASSED UNLESS OTHERWISE SHOWN ON PLANS. SOIL EROSION AND SEDIMENT CONTROL DEVICES ARE TO BE PLACED AS REQUIRED BY THE ADEM APPROVED NPDES PERMIT. CARE SHALL BE TAKEN TO PREVENT SOIL EROSION OR SEDIMENT TRANSFER FROM THE PROJECT ONTO ADJACENT PROPERTIES. BEST MANAGEMENT PRACTICES (BMP'S) SHALL BE IMPLEMENTED IN ACCORDANCE WITH THE PROJECT EROSION CONTROL PLAN PREPARED BY THE CONTRACTOR AND APPROVED BY ADEM.
2. FULL IMPLEMENTATION AND CONTINUED MAINTENANCE OF EFFECTIVE STRUCTURAL AND NON-STRUCTURAL COMPONENTS ARE REQUIRED TO BE DONE ON A WEEKLY BASIS BY THE CONTRACTOR.
3. ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT (ADEM) MAY DIRECT THE CONTRACTOR AT ANY TIME TO ADD OR TAKE AWAY FROM THE DESIGNED BMP. THIS SHALL BE DONE AT NO ADDITIONAL COST TO THE OWNER.
4. ANY CONSTRUCTION IN PROXIMITY TO ANY STATE WATERS, (STREAMS, CREEKS, RIVERS OR LAKES) REQUIRED PRECONSTRUCTION WATER SAMPLES TO ENSURE TRIBIDITY OF THESE WATERS DURING CONSTRUCTION ARE NOT ELEVATED BY MORE THAN 50 NTU CHANGE ABOVE BACKGROUND (UPSTREAM AND DOWNSTREAM), OR CANNNOT CAUSE THE TURBIDITY CHANGE WHICH RESULTS IN "SUBSTANTIAL VISIBLE CONTRAST" WITH BACKGROUND CONDITIONS, OR CANNOT IMPACT BENEFICIAL USES OF STATE WATERS.
5. INSPECTIONS ARE REQUIRED TO BE PERFORMED BY A QCI/QCP (QUALIFIED CREDENTIALED INSPECTOR/QUALIFIED CREDENTIALED PROFESSIONAL) AS DEFINED BY ADEM PRIOR TO BEGINNING ANY WORK (INITIAL INSPECTION), AFTER A QUALIFYING RAINFALL EVENT OF 0.75" IN A 24 HOUR PERIOD. IF NO QUALIFYING RAINFALL EVENT TAKES PLACE IN A 30 DAY PERIOD A MONTHLY INSPECTION SHALL BE PERFORMED. EVERY 6 MONTHS AN INSPECTION SHALL BE PERFOMRED BY A QCP (QUALIFIED CREDENTIALED PROFESSIONAL). AT THE COMPLETION OF CONSTRUCTION A FINAL INSPECTION SHALL BE PERFOMRED BY A QCP (QUALIFIED CREDENTIALED PROFESSIONAL).
6. CONSTRUCTION IS DEFINED AS ANY LAND DISTURBANCE OR DISCHARGE OF POLLUTANTS ASSOCIATED WITH, OR THE RESULT OF BUILDING, EXCAVATION, LAND CLEARING, GRUBBING, PLACEMENT OF FILL, GRADING, BLASTING, RECLAMATION, AREAS IN WHICH CONSTRUCTION MATERIALS ARE STORED IN ASSOCIATION WITH A LAND DISTURBANCE OR HANDLED ABOVE GROUND, AND OTHER ASSOCIATED AREAS INCLUDING, BUT NOT LIMITED TO CONSTRUCTION SITE VEHICLE PARKING, EQUIPMENT OR SUPPLY AREAS, MATERIAL STOCKPILES, TEMPORARY OFFICE AREAS, AND ACCESS ROADS.
7. ANY UPSET CONDITIONS OF A NON-STRUCTURAL COMPONENT OF THE BMP SHALL BE REPARIED WITHIN 7 CALENDAR DAYS OF VERBAL NOTIFICATION TO THE CONTRACTOR. ANY UPSET CONDITIONS OF A STRUCTURAL COMPONENT SHALL BE REPARIED WITHIN 15 CALENDAR DAYS OF VERBAL NOTIFICATION TO THE CONTRACTOR. ALL VERBAL NOTIFICATIONS WILL BE PROVIDED IN WRITING WITHIN 5 BUSINESS DAYS TO THE CONTRACTOR. FAILURE TO REPAIR THESE COMPONENTS SHALL RESULT IN A STOP WORK SITUATION UNTIL ALL REPAIRS HAVE BEEN MADE TO THE BMP TO THE SATISFACTION OF THE QCI/QCP OR ADEM OFFICIALS.
8. AT ANY POINT DURING THE CONSTRUCTION OF THIS PROJECT STOCKPILES, BORROW AREAS, CUT SLOPES OR FILL AREAS ARE NOT ACTIVE FOR 13 DAYS, THESE AREAS SHALL BE SEEDED OR COVERED TO ENSURE NO EROSION OF THESE AREAS OCCURS.
9. ANY NONCOMPLIANCE WITH ADEM, QCP (QUALIFIED CREDENTIALED PROFESSIONAL), QCI (QUALIFIED CREDENTIALED INSPECTOR) OR OTHER STATE, FEDERAL OR CITY MUNICIPALITIES MAY CAUSE A STOP WORK SITUATION.
10. CONTRACTOR SHALL ABIDE BY THE DIRECTION OF THE QCI/QCP (QUALIFIED CREDENTIALED INSPECTOR/QUALIFIED CREDENTIALED PROFESSIONAL) AT ALL TIMES DURING CONSTRUCTION.
11. ANY AND ALL FINES IMPOSED BY ADEM OR ANY OTHER GOVERNMENTAL AGENCIES SHALL BE THE RESPONSIBILITY OF THE CONTRACTOR IN CHARGE OF THE BMP PLAN AT NO ADDITIONAL COST TO THE OWNER.
12. THE BMP SHALL BE MONITORED AND MAINTAINED BY THE CONTRACTOR AS NECESSARY AFTER CONSTRUCTION IS COMPLETE AND SUBSTATIAL GROWTH HAS BEGUN ON THE ENTIRE SITE.
13. AT THE COMPLETION OF CONSTRUCTION, AFTER ALL GRASSED AREAS HAVE SUBSTANTIAL GROWTH OF ALL BMP COMPONENTS SHALL BE REMOVED BY THE CONTRACTOR AND THE CONTRACTOR SHALL NOTIFY THE QCP (QUALIFIED CREDENTIALED PROFESSIONAL) FOR FINAL INSPECTION.

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716 U.S. HIGHWAY 231
WETUMPKA, AL
36093

NO.	DATE	REVISION	BY

CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

DRAWING INDEX AND PROJECT NOTES

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN

07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

G-01

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07/11/2025

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GENERAL SYMBOLS

SYMBOLS	DESCRIPTION
	PROPERTY LINES
	PREFERRED SETBACK
UGP	UNDERGROUND POWER
FM	FORCEMAIN
SS	SANITARY SEWER
SD	STORM DRAIN
W	WATER
RW	RAW WATER
OHP	OVERHEAD POWER
FO	UNDERGROUND FIBER
TB	TOP OF BANK
BB	BOTTOM OF BANK
CONC	CONCENTRATE TO WASTE
	CHAINLINK FENCE
	WIRE/WOOD FENCE
	UNDERGROUND PIPING
12	EXISTING CONTOUR
12	NEW CONTOUR
	MANHOLE
	LAYDOWN BOUNDARY

PLAN NOTE DESIGNATION

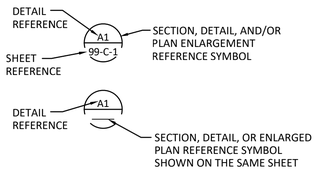
X

1 PLAN NOTE, SEE LIST ON SAME DRAWING

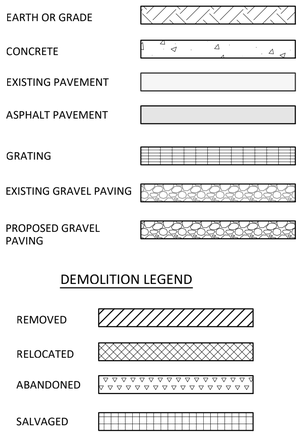
VIEW TITLE DESIGNATION

SECTION CUT DESIGNATION

DETAIL DESIGNATION



PATTERN LEGEND



DEMOLITION LEGEND

NORTH ARROW

DISCIPLINE IDENTIFIER

DISCIPLINE	IDENTIFIER
GENERAL	G
CIVIL	C
PROCESS	D
STRUCTURAL	S
ELECTRICAL	E
PROCESS & INSTRUMENTATION	I
CIVIL DETAILS	CD
PROCESS DETAILS	DD
STRUCTURAL DETAILS	SD
ELECTRICAL DETAILS	ED

SITE IDENTIFIER

SITE	IDENTIFIER
STORAGE TANK	01
BOOSTER PUMPS	02
GAC VESSELS	03
HYPOCHLORITE FEED SYSTEM	04
STATIC MIXER	05

SURVEY LEGEND

A	AIR CONDITIONER	A/G	ABOVE GROUND
	BOLLARD	B.F.E.	BASE FLOOD ELEVATION
	CONTROL POINT	BH	BORE HOLE
CO	CLEAN OUT	C/G	CURB & GUTTER
	COMMUNICATION MARKER	CI	CAST IRON PIPE
TMH	COMMUNICATION MANHOLE	CMP	CORRUGATED METAL PIPE
DS	DOWNSPOUT	CPP	CORRUGATED PLASTIC PIPE
E	ELECTRIC BOX	DB	DEED BOOK
	FIRE DEPT CONNECTION	DI	DUCTILE IRON PIPE
	FIRE HYDRANT	DWI	DOUBLE WING INLET
FP	FLAG POLE	FES	FLARED END SECTION
FUEL	FUEL PUMP	FFE	FINISHED FLOOR ELEVATION
	GAS MARKER	FL	FLOW LINE
	GAS METER	GRT	GRATE INLET
GV	GAS VALVE	HW	HEADWALL
	GRATE INLET	JB	JUNCTION BOX
GEN	GENERATOR	LF	LINEAR FEET
	GROUND LIGHT	LSA	LANDSCAPE AREA
	GUY ANCHOR	M.B.L.	MINIMUM BUILDING LINE
	GUY POLE	MH	MANHOLE
HH	HAND HOLE	OTI	OPEN THROAT INLET
	HANDICAP SIGN	PB	PLAT BOOK
ICV	IRRIGATION CONTROL VALVE	PE	POLYETHYLENE PIPE
	LIGHT POLE	PG	PAGE
MB	MAIL BOX	P.U.D.E.	PUBLIC UTILITY AND DRAINAGE EASEMENT
M	MONITORING WELL	PVC	POLYVINYL CHLORIDE PIPE
PIV	POST INDICATOR VALVE	(R)	RECORDED
P	POWER METER	RCP	REINFORCED CONCRETE PIPE
	ROUND GRATE INLET	RGRT	ROUND GRATE INLET
S	SANITARY MANHOLE	R.O.W.	RIGHT OF WAY
ST	SEPTIC TANK	SC	SECTIONALIZING CABINET
	SIGN	SPW	SLOPED PAVED HEADWALL
D	STORM MANHOLE	SSMH	SANITARY SEWER MANHOLE
SP	SUPPORT POST	STMH	STORM MANHOLE
T	TELEPHONE PEDESTAL	SWI	SINGLE WING INLET
T	TRANSFORMER CABINET	TC	TERRA COTTA PIPE
	TREE	T.V.A.	TENNESSEE VALLEY AUTHORITY
	UTILITY POLE	U&D	UTILITY AND DRAINAGE
V	UTILITY VAULT	U/G	UNDERGROUND
	WATER METER	VCP	VITRIFIED CLAY PIPE
	WATER SPIGOT	WS	WELDED STEEL PIPE
WV	WATER VALVE	WW	WING WALL
U	UNKNOWN MANHOLE		ASPHALT
x	BARBED WIRE FENCE		BRICK PAVERS
o	CHAIN LINK FENCE		CONCRETE
	EXTENT OF STANDING/FLOWING WATER		GRAVEL
	GUARDRAIL		ROCK WALL
	HOG WIRE FENCE		RIP-RAP
OHP	OVERHEAD POWER		STANDING WATER
OHU	OVERHEAD UTILITIES		REGULATORY FLOODWAY
	RAILROAD TRACKS		ZONE AE
S	SANITARY SEWER		ZONE X (SHADED)
	STORM SEWER		SET 1/2" REBAR CAPPED "HSM CA #1031"
UGC	UNDERGROUND COMM		FOUND MONUMENTATION (AS NOTED)
G	UNDERGROUND GAS		FOUND CONCRETE MONUMENT
UGP	UNDERGROUND POWER	#	ADJOINING OWNER INFORMATION (SEE TABLE)
STM	UNDERGROUND STEAM		
WATER	UNDERGROUND WATER		
UU	UNKNOWN UTILITIES		
	WOOD FENCE		
610.00	IMPERVIOUS SPOT ELEVATION		
610.0	PERVIOUS SPOT ELEVATION		

SURVEY NOTES:

PERFORMED BY: HALIBURTON SURVEYING & MAPPING, INC.

DATE OF SURVEY: 07/11/2024.

VERTICAL DATUM: ELEVATIONS SHOWN HEREON ARE BASED ON THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), GEOID 18.

HORIZONTAL DATUM: HORIZONTAL COORDINATES ARE REFERENCED TO ALABAMA WEST ZONE STATE PLANE COORDINATE SYSTEM OF 1983 (NAD 83), AS DETERMINED BY REDUNDANT RTK GPS OBSERVATIONS.

FLOOD INFORMATION: THE PROJECT LIES WITHIN FLOOD ZONE "X" (UNSHADED) PER F.E.M.A. FIRM COMMUNITY PANEL 010146, MAP NUMBER 01083C0189F, MAP REVISED DATE AUGUST 16, 2018.

PROJECT CONTROL INFORMATION

NAME	NORTHING	EASTING	ELEVATION	DESCRIPTION
CP 1	799339.31'	589172.44'	653.31'	1/2" CAPPED REBAR "HSM CONTROL"
CP 2	798831.83'	589120.93'	665.98'	1/2" CAPPED REBAR "HSM CONTROL"
CP 3	799126.98'	589022.35'	656.93'	1/2" CAPPED REBAR "HSM CONTROL"

THIS SHEET CONTAINS STANDARD INFORMATION APPLICABLE TO ENGINEERING AND ARCHITECTURAL PROJECTS. NOT ALL THE INFORMATION SHOWN HERE IS USED ON THIS PROJECT.

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716 U.S. HIGHWAY 231
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36093

NO.	DATE	REVISION	BY

CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

LEGENDS AND SYMBOLS

ALABAMA LICENSED PROFESSIONAL ENGINEER
No. 35223
SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

G-02

100% ISSUE FOR BID
07/11/2025

April 23, 2019 C:\Users\tmsmith\DC\ACCDocs\ardurra, inc\2024-0776-00 project files\03-Prod\03-Dwgs\GAB.dwg

GENERAL ABBREVIATIONS

ABDN	ABANDON/ABANDONED
ADDL	ADDITIONAL
ADJ	ADJUSTABLE
AFF	ABOVE FINISH FLOOR
AL	ALUMINUM
ALT	ALTERNATE
APPROX	APPROXIMATE
ASSY	ASSEMBLY
AUX	AUXILIARY
AVG	AVERAGE
B/	BOTTOM OF
BLDG	BUILDING
BOT	BOTTOM
C/C	CENTER TO CENTER
CCW	COUNTER CLOCKWISE
CL	CENTERLINE
CLR	CLEAR
CONC	CONCRETE
CONT	CONTINUOUS
CONTR	CONTRACTOR
CTR	CENTER
CW	CLOCKWISE
DBL	DOUBLE
DEF	DEFLECTION
DEG	DEGREE
DET	DETAIL
DIA OR Ø	DIAMETER
DIAG	DIAGRAM
DIM	DIMENSION
DISCH	DISCHARGE
DN	DOWN
DR	DRIVE
DWG	DRAWING
E	EAST
EA	EACH
EL or ELEV	ELEVATION
ELEC	ELECTRIC
EQ	EQUAL
EQUIP	EQUIPMENT
EW	EACH WAY
EXP	EXPANSION
EXST	EXISTING
EXT	EXTERIOR
FF	FINISH FLOOR
FIN	FINISH
FL	FLUSH OR FLOOR
FLEX	FLEXIBLE
FRP	FIBERGLASS REINFORCED PLASTIC
FT	FOOT/FEET
GA	GAUGE
GR	GRADE
HDW	HARDWARE
HORIZ	HORIZONTAL
HP HT OR HGT	HIGH POINT HEIGHT
HVAC	HEATING, VENTILATING, AND AIR CONDITIONING
ID	INSIDE DIAMETER
IN	INCHES
INSTL	INSTALLATION
INT	INTERIOR
L	ANGLE
LB	POUND
LDG	LANDING
LH	LEFT HAND
LOC	LOCATION
LP	LOW POINT
MATL	MATERIAL
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTER
MECH	MECHANICAL
MEMB	MEMBRANE
MFD	MANUFACTURED
MFG	MANUFACTURING
MFR	MANUFACTURER
MIN	MINIMUM
MISC	MISCELLANEOUS
MTL	METAL
N	NORTH
NA	NOT APPLICABLE
NIC	NOT IN CONTRACT
NO	NUMBER
NTS	NOT TO SCALE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OPNG	OPENING
OPP	OPPOSITE
P&ID	PROCESS AND INSTRUMENTATION DIAGRAM
PC	POINT OF CURVATURE
PJF	PREFORMED JOINT FILLER
PI	POINT OF INTERSECTION
PNL	PANEL
PRESS	PRESSURE
PT	POINT OF TANGENCY
PTD	PAINTED
PVC	POLYVINYL CHLORIDE
PVI	POINT OF VERTICAL INTERSECTION
R	RISER
RAD	RADIUS
REF	REFERENCE
REM	REMOVABLE
REQD	REQUIRED
RH	RIGHT HAND
RM	ROOM
RPM	REVOLUTIONS PER MINUTE
RT	RIGHT
S SCH	SOUTH SCHEDULE
SEC	SECONDARY
SECT	SECTION
SHT	SHEET
SIM	SIMILAR
SL	SLOPE
SP	SPACE OR SPACING
SQ or SQR	SQUARE
SS or SST	STAINLESS STEEL
STA	STATION
STAG	STAGGERED
STL	STEEL
STR	STRUCTURE
SYM	SYMMETRICAL
T&B	TOP AND BOTTOM
T/	TOP OF
TAN	TANGENT
TEMP	TEMPERATURE
THRU	THROUGH
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE
VERT	VERTICAL
W	WEST
W/	WITH
W/O	WITHOUT
YR	YEAR

CIVIL ABBREVIATIONS

ACP	ASBESTOS - CEMENT PIPE
ANC	ANCHOR
AP	AERIAL POWER
ASPH	ASPHALT
AT	AERIAL TELEPHONE
BNDY	BOUNDARY
BFO	BURIED FIBER OPTIC
BM	BENCH MARK
BO	BLOW-OFF
BOC	BACK OF CURB
C&G	CURB AND GUTTER
CB	CATCH BASIN
CI	CURB INLET
CIP	CAST IRON PIPE
CMP	CORRUGATED METAL PIPE
CO	CLEAN OUT
DI	DUCTILE IRON PIPE
DR	DRAIN
ENCSMT	ENCASEMENT
EOA	EDGE OF ASPHALT
EOR	EDGE OF ROAD
EXC	EXCAVATE
FDN	FOUNDATION
FH	FIRE HYDRANT
FLG	FLANGE
FM	FORCEMAIN
FOC	FACE OF CURB
FTG	FOOTING
G	GAS LINE
GD	GUARD
GRTG	GRATING
GSP	GALVANIZED STEEL PIPE
HB	HOSE BIBB
HDPE	HIGH DENSITY POLYETHYLENE
INL	INLET
INV	INVERT
IP	IRON PIN
LF	LINEAR FEET
MH	MANHOLE
PE	PLAIN END
PEX	PEX PIPE
PH	POST HYDRANT
PL	PROPERTY LINE
PP	POWER POLE
PSI	POUNDS PER SQUARE INCH
PT	POINT OF TANGENCY
ROW	RIGHT OF WAY
RP	RADIUS POINT
RCP	REINFORCED CONCRETE PIPE
RET	RETAINING
SD	STORM DRAIN
SLP	STRUCTURAL LAYOUT POINT
SS	SANITARY SEWER
TBM	TEMPORARY BENCH MARK
TS&V	TAPPING SLEEVE AND VALVE
UC	UNDERGROUND CABLE
UG	UNDERGROUND GAS
UP	UNDERGROUND POWER
UT	UNDERGROUND TELEPHONE
VCP	VITRIFIED CLAY PIPE
W	WATER
WL	WATERLINE
YH	YARD HYDRANT

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GENERAL AND CIVIL ABBREVIATIONS

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

G-03

100% ISSUE FOR BID
07/11/2025

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PIPING SYMBOL GENERAL NOTES

1. SIMPLIFIED JOINT SYMBOL IS USED FOR ALL SINGLE LINE PIPING SHOWN ON THE INTERIOR AND EXTERIOR PIPING DRAWINGS.
2. BOTH SIMPLIFIED AND COMPLEX JOINT REPRESENTATIONS MAY BE SHOWN ON THE DRAWINGS.
3. UNLESS MODIFIED BY THE GENERAL PROJECT NOTES OR DETAILED ON THE LAYOUT AND SCHEMATIC DRAWINGS PIPE AND FITTING JOINT REQUIREMENTS FOR THE VARIOUS PIPE MATERIALS ARE DEFINED IN THE SPECIFICATIONS.

FLOW IDENTIFIER

PIPE IDENTIFIER	DESCRIPTION
AIR	AIR
BLEND	RO PERMEATE BLEND
BW	BACKWASH
BR	BRINE SOLUTION
CAU	PHOSPHATE
CIP	RO CIP CLEANING FEED
CIPR	RO CIP CLEANING RETURN
CONC	RO CONCENTRATE TO WASTE
DRN	DRAIN
EFFL	EFFLUENT
FE	FILTERED EFFLUENT
FIN	FINISHED WATER
FL	FLOURIDE
FTW	FILTER TO WASTE
NPW	NON POTABLE WATER
PHO	PHOSPHATE
PLW	PLANT WATER
PW	POTABLE WATER
OVF	OVERFLOW
PERM	RO PERMEATE
RW	RAW WATER
REC	RECIRCULATION WATER
STM	STORM
VNT	AIR VENT
WASTE	RECIRCULATION WASTE
CaCl2	CALCIUM CHLORIDE
NaClO	SODIUM HYPOCHLORITE
NaOH	SODIUM HYDROXIDE
SALT	SALT BRINE
SI	SCALE INHIBITOR
CAU	CAUSTIC
HYD	HYDROGEN
HYP	HYPOCHLORITE
FL	FLOURIDE
PHO	PHOSPHATE

PIPING SYMBOLOGY

DOUBLE LINE	SINGLE LINE	DESCRIPTION
		FLANGED JOINT ADAPTOR
		FLANGED JOINT
		RESTRAINT JOINT
		MECHANICAL JOINT
		DIRECTION OF FLOW
		FLEXIBLE EXPANSION JOINT
M	M	FLOW METER
		PIPE CONTINUATION CUT LINE
		DISMANTLING JOINT
	6-FIN-DI	PIPE IDENTIFICATION

6-FIN-DI
- MATERIAL
- FLOW IDENTIFIER
- SIZE

VALVE, GATE, AND DAMPER ACTUATOR SYMBOLS

SYMBOLS	DESCRIPTION
	GATE VALVE
	GLOBE VALVE
	BALL VALVE
	3-WAY BALL VALVE
	NEEDLE VALVE
	PINCH VALVE
	DIAPHRAGM VALVE
	BUTTERFLY VALVE
	PLUG VALVE
	CHECK VALVE
	BALL CHECK VALVE
	MUD VALVE
	FLOOR DRAIN
	CALIBRATION CYLINDER
	AIR RELEASE VALVE
HR	HOSE RACK
HB	HOSE BIB
P	PRESSURE GAUGE
HW	MANUAL HANDWHEEL
CW	MANUAL CHAINWHEEL
M	MOTOR OPERATOR
E	ELECTRIC OPERATOR
S	SOLENOID OPERATOR
T	TEMPERATURE PROBE
	MANUAL PRESSURE GAUGE
	ULTRASONIC TRANSDUCER
	PRESSURE REDUCING VALVE
	BRINE/POTABLE WATER FILTER

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS SYMBOLS, ABBREVIATIONS AND LEGENDS

ALABAMA LICENSED PROFESSIONAL ENGINEER
No. 35223
SHAKIL AMIN
07/11/2025

JOB NO:	2024-0776-00
DATE:	07/19/2024

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GENERAL NOTES:

1. CONTRACTOR SHALL COORDINATE BETWEEN ARCHITECTURAL, STRUCTURAL, MECHANICAL, ELECTRICAL AND OTHER DRAWINGS. ANY DISCREPANCIES OR CONFLICTS (INCLUDING DIMENSIONAL CONFLICTS) BETWEEN DRAWINGS OF DIFFERENT DISCIPLINES SHALL BE BROUGHT TO THE ATTENTION OF THE ARCHITECT. CONTRACTOR SHALL NOT PROCEED WITH SHOP DRAWING PREPARATION OR ANY CONSTRUCTION UNTIL THE ARCHITECT HAS GIVEN DIRECTION OF RESOLUTION OF THE DISCREPANCY OR CONFLICT.

2. CONSTRUCTION METHODS, SEQUENCES AND PROCEDURES ARE THE CONTRACTOR'S RESPONSIBILITY. THE CONTRACTOR SHALL TAKE NECESSARY PRECAUTIONS TO PROTECT AND MAINTAIN THE STRUCTURAL INTEGRITY OF ALL NEW AND EXISTING CONSTRUCTION AT ALL STAGES. THE CONTRACTOR SHALL COMPLY WITH ALL APPLICABLE SAFETY AND ERECTION REQUIREMENTS OF ALL GOVERNING PUBLIC AGENCIES DURING CONSTRUCTION. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROTECTING THE ADJACENT PROPERTY AND ROADWAYS WITH SHORING OR OTHER NECESSARY MEANS.

3. CONTRACTOR SHALL COORDINATE WITH THE ARCHITECTURAL, MECHANICAL, PLUMBING, CIVIL AND ELECTRICAL DRAWINGS AND VERIFY THE LOCATIONS AND SIZES OF CHASES, INSERTS, OPENINGS, SLEEVES, FINISHES, DEPRESSIONS AND OTHER PROJECT REQUIREMENTS.

4. USE MANUFACTURER'S CERTIFIED DRAWINGS, DETAILS AND SPECIFICATIONS FOR EQUIPMENT ANCHORAGE AND INSTALLATION.

5. ALL CONSTRUCTION JOINTS SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE INCORPORATED INTO THE STRUCTURE. ADDITIONAL CONSTRUCTION JOINTS TO FACILITATE CONSTRUCTION SHALL BE LOCATED AND DETAILED ON THE SHOP DRAWINGS FOR REVIEW.

6. STRUCTURAL MEMBERS & CONNECTIONS SHOWN, HAVE BEEN DESIGNED TO CARRY IN PLACE DESIGN LOADS ONLY. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE SUPPORT OF ANY ADDITIONAL LOADS AND FORCES IMPOSED DURING CONSTRUCTION, TRUCKING, ERECTING AND HANDLING.

7. THE CONTRACTOR SHALL ENSURE THAT CONSTRUCTION LOADS DO NOT EXCEED THE DESIGN LIVE LOADS INDICATED ON THE STRUCTURAL DRAWINGS AND THAT THESE LOADS ARE NOT PUT ON THE STRUCTURAL MEMBERS PRIOR TO THE TIME THAT THE CONCRETE REACHES THE FULL SPECIFIED DESIGN STRENGTH, STEEL MEMBERS & THEIR CONNECTIONS ARE FULLY BOLTED AND / OR WELDED, AND ALL OTHER FRAMING MEMBERS AND THEIR CONNECTIONS ARE IN PLACE.

8. CONTRACTOR SHALL BRACE ALL BASEMENT-TYPE WALLS RETAINING EARTH UNTIL RESTRAINING SLABS & STRUCTURAL ELEMENTS ARE IN PLACE AND REACH REQUIRED DESIGN STRENGTH.

9. ALL THE CONTRACTOR'S PROPOSED SUBSTITUTIONS MUST BE APPROVED BY ARCHITECT/ENGINEER PRIOR TO FABRICATION OR ANY PERTINENT WORK.

10. THE DETAILS DESIGNATED AS "TYPICAL DETAILS" AND THE SECTIONS APPLY GENERALLY TO THE DRAWINGS IN AREAS WHERE CONDITIONS ARE SIMILAR TO THOSE DESCRIBED OR DEPICTED, UNLESS SPECIFICALLY NOTED OTHERWISE.
11. ALL DIMENSIONS SHOWN TAKE PRECEDENCE OVER SCALE SHOWN ON PLANS, SECTIONS, AND DETAILS. DO NOT SCALE THE DRAWINGS.

12. ALL SECONDARY STRUCTURAL ELEMENTS AND NON-STRUCTURAL ELEMENTS THAT ARE NOT SPECIFICALLY DETAILED IN THE CONTRACT DOCUMENTS SHALL BE DESIGNED BY THE CONTRACTOR, UNDER THE DIRECT SUPERVISION OF A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF ALABAMA, TO MEET ALL APPLICABLE BUILDING CODE REQUIREMENTS. EXAMPLES OF THESE ELEMENTS MAY INCLUDE BUT ARE NOT LIMITED TO: LIGHT-GAUGE FRAMING, ALUMINUM CANOPIES, EQUIPMENT SUPPORT ABOVE THE PRIMARY ROOF STRUCTURE, SEISMIC BRACING FOR M.P.E. COMPONENTS, ELEVATOR SUPPORT RAILS AND BEAMS, RACK STORAGE SYSTEMS, STAIRS & HANDRAILS, LADDERS, LIGHT POLE FOUNDATIONS AND RETAINING WALLS INDEPENDENT OF THE PRIMARY BUILDING.

13. THE CONTRACTOR SHALL FIELD-VERIFY ALL RELEVANT EXISTING CONDITIONS & DIMENSIONS PRIOR TO PERFORMING ANY PERTINENT WORK. THIS INFORMATION SHALL BE INCORPORATED INTO THE SHOP DRAWINGS PRIOR TO ARCHITECT/ENGINEER REVIEW.

14. ELM HAS NOT REVIEWED FOR SUITABILITY OR ADEQUACY ANY PORTION OF THIS PROJECT NOT SPECIFICALLY DEPICTED AND DETAILED IN THESE DRAWINGS. ELM'S SERVICES HAVE BEEN PERFORMED UNDER THE PRESUMPTION THAT THE REMAINING PORTIONS OF THE WORK HAVE BEEN DESIGNED, SPECIFIED AND/OR CONSTRUCTED TO MEET OR EXCEED THE REQUIREMENTS OF THE JURISDICTION'S BUILDING CODE. WHERE SUCH ELEMENTS HAVE BEEN GENERICALLY INDICATED IN THESE DRAWINGS, THEY HAVE BEEN SHOWN ONLY FOR THE CONTRACTOR'S REFERENCE.

SITE AND FOUNDATION:

1. STRIP THE BUILDING PAD OF ALL PAVEMENT, ORGANIC MATERIALS AND TOPSOIL. EXCAVATE, WHERE REQUIRED, TO BUILDING AND STRUCTURE SUBGRADE.

2. UNDERCUT ALL SOFT AREAS AS DIRECTED BY THE GEOTECHNICAL ENGINEER. ROCK REMOVAL SHALL BE PER THE GEOTECHNICAL REPORT RECOMMENDATIONS. BACKFILL FINISH SUBGRADE WITH COMPACTED ENGINEERED FILL. PROPERLY PREPARE SLAB SUBGRADE WITHIN THE STRUCTURAL FOOTPRINT TO PROVIDE A MODULUS OF SUBGRADE REACTION (k) OF ***150*** PCI (MINIMUM).

3. ACCEPTABLE FILL MATERIAL SHALL BE FREE OF ORGANICS, AND HAVE A P.I. OF LESS THAN 35, L.L. OF LESS THAN 55, MAXIMUM STONE SIZE OF 2" AND A MAXIMUM DRY DENSITY OF GREATER THAN 95 PCF.

4. FILL, WHERE REQUIRED, IS TO BE PLACED IN 8" LOOSE LIFTS AND COMPACTED TO 98% STANDARD PROCTOR (ASTM D-698), WITHIN ±2% OF OPTIMUM MOISTURE CONTENT. PERFORM FIELD DENSITY TESTING FOR EACH 2500 SQUARE FEET PER FOOT OF FILL.

5. BACKFILL FOUNDATION AND RETAINING WALLS WITH CRUSHED STONE MEETING THE REQUIREMENTS OF A.H.D. No. 57 STONE PLACED IN A 45 DEGREE WEDGE EXTENDING FROM THE BASE OF THE WALL UP TO 12" BELOW FINISHED GRADE, U.N.O. PLACE STONE IN 6" LIFTS & COMPACT WHILE MONITORED BY THE GEOTECHNICAL ENGINEER.

6. FOUNDATIONS SHALL BEAR ON MATERIAL CAPABLE OF SUPPORTING A MINIMUM OF 3000 PSF.

7. GEOTECHNICAL REPORT: FOUNDATION DESIGN IS BASED ON THE GEOTECHNICAL REPORT BY GTEC, PROJECT NO. 1352 AND DATED OCTOBER 18, 2024. THE GENERAL CONTRACTOR SHALL OBTAIN A COPY OF THE GEOTECHNICAL REPORT AND SHALL ADHERE TO ALL REQUIREMENTS AND RECOMMENDATIONS THEREIN.

8. ALL FOUNDATION BEARING SURFACES SHALL BE REVIEWED BY THE GEOTECHNICAL ENGINEER PRIOR TO PLACING CONCRETE TO ENSURE THEIR COMPLIANCE WITH THE BEARING PRESSURES AND SLAB SUBGRADE REQUIREMENTS NOTED. ALL FOUNDATION BEARING ELEVATIONS ARE ESTIMATED AND MAY BE ADJUSTED IN THE FIELD BY THE GEOTECHNICAL ENGINEER AS REQUIRED.

DESIGN CRITERIA:

1. BUILDING CODES AND STANDARDS:
   A. INTERNATIONAL BUILDING CODE 2021
   B. AMERICAN SOCIETY OF CIVIL ENGINEERS, ASCE 7
   C. AMERICAN CONCRETE INSTITUTE, ACI 318

2. GRAVITY DESIGN LIVE LOADS:
   A. EQUIPMENT WEIGHT + 100 PSF

3. GRAVITY DESIGN SNOW LOADS:
   A. GROUND SNOW LOAD (Pg) = 5 PSF
   B. SNOW EXPOSURE FACTOR (Ce) = 0.9
   C. SNOW LOAD IMPORTANCE FACTOR (Is) = 1.1
   D. THERMAL FACTOR (Ct) = 1.2

4. LATERAL DESIGN LOADS:
   A. WIND: PER IBC & ASCE 7, WIND SPEED Vult = 123 MPH (Vasd = 96 MPH)
   B. EARTHQUAKE: PER IBC & ASCE 7

CONCRETE:

1. CONCRETING OPERATIONS SHALL COMPLY WITH ACI 117 AND ACI 301.

2. CONCRETE COVER OVER REINFORCING (U.N.O.)
   A. CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH: 3 IN.
   B. EXPOSED TO EARTH, LIQUID, WEATHER, OR BEARING ON WORK MAT OR SLABS SUPPORTING EARTH COVER:
      SLABS AND JOISTS: 2 IN.
      BEAMS AND COLUMNS:
      STIRRUPS, SPIRALS, AND TIES: 2 IN.
      PRIMARY REINFORCEMENT: 2 1/2 IN.
      WALLS: 2 IN.
      FOOTINGS AND BASE SLABS:
      FORMED SURFACES: 2 IN.
      TOP OF FOOTINGS AND BASE SLABS: 2 IN.

3. ALL CONSTRUCTION JOINTS SHOWN ON THE STRUCTURAL DRAWINGS SHALL BE INCORPORATED INTO THE STRUCTURE. ADDITIONAL CONSTRUCTION JOINTS TO FACILITATE CONSTRUCTION SHALL BE LOCATED AND DETAILED ON THE SHOP DRAWINGS FOR REVIEW. APPLY A BONDING AGENT (MEETING ASTM C1059, TYPE II) WHERE FRESH CONCRETE IS PLACED AGAINST HARDENED (OR PARTIALLY HARDENED) CONCRETE SURFACES.

4. LOCATE HORIZONTAL JOINTS IN WALLS AND COLUMNS AT UNDERSIDE OF FLOOR STRUCTURE (BOTTOM OF BEAMS, JOISTS & GIRDERS, OR BOTTOM OF SLABS IN FRAMING SYSTEMS THAT DO NOT INCLUDE BEAMS) AND AT THE TOP OF FOOTINGS OR FLOOR SLABS (EXCEPT WHERE SPECIFICALLY INDICATED).

5. HORIZONTAL CONSTRUCTION JOINTS SHALL NOT BE PERMITTED IN BEAMS, SLABS, JOISTS, FOOTINGS OR WALLS, UNLESS SHOWN ON THE STRUCTURAL DRAWINGS.

6. CONSTRUCTION JOINTS IN CONCRETE BEAMS, FOOTINGS, JOISTS & SLABS SHALL BE AT OR NEAR MIDSPAN, WITH VERTICAL BULKHEAD AND HORIZONTAL KEYS, UNLESS SHOWN OTHERWISE.

7. ALL EXPOSED CONCRETE EDGES SHALL BE CHAMFERED. CONTRACTOR SHALL COORDINATE WITH ARCHITECTURAL DRAWINGS FOR REVEALS, FORM TIES, STEPS, NOTCHES AND LOCATIONS OF CONSTRUCTION JOINTS IN EXPOSED CONCRETE.

8. EPOXY ANCHORS SHALL BE "HIT-HY 200" BY HILTI, OR "SET-3G" BY SIMPSON. SCREW-TYPE ANCHORS SHALL BE "KWIK HUS-EZ" BY HILTI, OR "TITEN-HD" BY SIMPSON. DO NOT USE EXPANSION BOLTS WHERE EPOXY ANCHORS OR SCREW ANCHORS ARE INDICATED.

9. ALUMINUM MATERIAL SHALL NOT BE EMBEDDED IN CONCRETE UNLESS THE MATERIAL IS FIRST SUFFICIENTLY COATED TO PREVENT ALUMINUM-CONCRETE REACTION OR ELECTROLYTIC REACTIONS.

10. HORIZONTAL CONDUITS, SLEEVES OR PLUMBING SHALL NOT BE PERMITTED IN FOOTINGS, BEAMS OR SLABS WITHOUT PRIOR WRITTEN APPROVAL OF THE STRUCTURAL ENGINEER OF RECORD.

11. VERTICAL CONDUITS, SLEEVES OR PLUMBING MAY BE PLACED THROUGH SLABS AS REQUIRED. MULTIPLE SLEEVES/CORES THROUGH SLABS MUST BE SPACED WITH A MINIMUM OF 3 x DIAMETERS ON-CENTER, BUT NOT LESS THAN 8" CLEAR BETWEEN SLEEVES/CORES. THE SLAB REINFORCING MUST BE PRESERVED BETWEEN ADJACENT SLEEVES.

REINFORCING:

1. ALL REINFORCING SHALL CONFORM TO THE LATEST REVISION OF ASTM SPECIFICATION A615, GRADE 60, UNLESS NOTED OTHERWISE.

2. ALL REINFORCING SHALL BE DETAILED IN ACCORDANCE WITH A.C.I. STANDARD 315, OF LATEST REVISION. SUBMIT FABRICATION & PLACEMENT DRAWINGS FOR REVIEW.

3. NO REINFORCING BAR SHALL BE WELDED IN ANY MANNER, UNLESS SPECIFICALLY SHOWN OR NOTED ON THE DRAWINGS. IF ALLOWED, ALL WELDING SHALL COMPLY WITH AWS D1.4, AND REINFORCING BARS SHALL BE ASTM A706 WELDABLE REBAR ONLY.

4. PROVIDE FULL EMBEDMENT FOR ALL DOWELS. IF NOT OTHERWISE SPECIFIED, DOWEL SIZE AND SPACING SHALL BE THE SAME AS MAIN REINFORCING, AND SHALL BE TERMINATED WITH ACI STANDARD HOOKS.

5. PROVIDE CORNER BARS IN FOOTINGS, WALLS, TURNDOWN SLABS & BOND BEAMS TO MATCH THE SIZE AND SPACING OF THE HORIZONTAL REINFORCING. LEG LENGTH SHALL BE EQUIVALENT TO A CLASS "A" LAP SPLICE UNLESS NOTED OTHERWISE.

6. ALL WELDED WIRE FABRIC (WWF) SHALL CONFORM TO ASTM A185, SHALL BE LAPPED A MINIMUM OF 6" FOR PLAIN WIRE (OR 8" FOR DEFORMED WIRE) AND SHALL BE FURNISHED IN SHEETS ONLY (NO ROLLS).

7. ALL WALL AND/OR SLAB OPENINGS SHALL BE DETAILED ON THE SHOP DRAWINGS FOR ARCHITECT/ENGINEER REVIEW, INCLUDING ADDED REINFORCEMENT AS SHOWN IN TYPICAL DETAILS. UNLESS NOTED OTHERWISE, AT OPENINGS LARGER THAN 12" IN CONCRETE WALLS AND FLOOR SLABS PROVIDE 2#5 BARS AT FOUR SIDES AND FOUR CORNERS OF THE OPENING. EXTEND BARS 2'-0" BEYOND CORNERS OF OPENING.

8. SPLICES FOR REINFORCING ARE SHOWN SPECIFICALLY ON STRUCTURAL DRAWINGS. ADDITIONAL SPLICES TO FACILITATE CONSTRUCTION SHALL BE CLASS "B" TENSION LAP SPLICES, AND SHALL BE DETAILED ON THE SHOP DRAWINGS FOR REVIEW.

9. CONCRETE BEAM LONGITUDINAL REINFORCING BARS MAY BE SPLICED ONLY AS SHOWN ON THE DRAWINGS EXCEPT THE REINFORCING DESIGNATED AS "CONTINUOUS" SHALL HAVE A CLASS "B" LAP SPLICE. THE LAP SPLICES SHALL BE MADE OVER SUPPORTS FOR BOTTOM & INTERMEDIATE BARS AND AT MID-SPAN FOR TOP BARS. HOOK TOP & BOTTOM BARS AT EXTERIOR SUPPORTS & TERMINATIONS. TOP & BOTTOM BAR HOOKS AND INTERMEDIATE BARS SHALL EXTEND TO WITHIN 2" OF THE EXTERIOR FACE OF CONCRETE.

CONCRETE STRUCTURAL OUTLINE SPECIFICATIONS:

1. G.C. IS RESPONSIBLE FOR DESIGN OF FORMWORK AND SHORING IN COMPLIANCE WITH ACI 301 "SPECIFICATION FOR STRUCTURAL CONCRETE". COMPLY WITH ACI 117, "SPECIFICATIONS FOR TOLERANCES FOR CONCRETE CONSTRUCTION AND MATERIALS". PROTECT FRESHLY-PLACED CONCRETE FROM PREMATURE DRYING AND EXCESSIVE COLD OR HOT TEMPERATURES IN ACCORDANCE WITH ACI 305R, ACI 306.1 & ACI 301.

2. SUBMIT SHOP DRAWINGS DETAILING THE FABRICATION OF ALL COMPONENTS TO BE EMBEDDED INTO CONCRETE, INCLUDING REINFORCING BARS.

3. AFTER APPLYING FLOAT FINISH TO SLABS, APPLY FIRST TROWEL FINISH AND CONSOLIDATE CONCRETE BY HAND OR POWER-DRIVEN TROWEL. CONTINUE TROWELLING PASSES AND RESTRAIGHTEN UNTIL SURFACE IS UNIFORM IN TEXTURE AND APPEARANCE. FINISH AND MEASURE SURFACE SO GAP AT ANY POINT BETWEEN CONCRETE SURFACE AND AN UNLEVELED FREESTANDING 10-FOOT-LONG STRAIGHTEDGE, RESTING ON TWO HIGH SPOTS AND PLACED ANYWHERE ON THE SURFACE, DOES NOT EXCEED 1/8 INCH. (HARD MACHINE TROWELLING OF AIR-ENTRAINED CONCRETE SLABS IS NOT RECOMMENDED DUE TO THE INCREASED LIKELIHOOD OF SURFACE DELAMINATION. THE G.C. SHALL TAKE SPECIAL CARE IN CONCRETING OPERATIONS, INCLUDING DELAYING TROWEL FINISHING OPERATIONS AS LONG AS POSSIBLE, AND MINIMIZING THE INTENSITY AND DURATION OF TROWELING).

4. CURE CONCRETE SLABS ACCORDING TO ACI 308.1 BY MOISTURE-CURING OR BY APPLICATION OF A CURING COMPOUND CONFORMING TO ASTM C309, TYPE 1, CLASS B.

5. SLAB BOLSTERS FOR SUPPORT OF REINFORCING SHALL BE STEEL WITH PLASTIC-COATED LEGS.

6. CONCRETE MIX DESIGNS SHALL BE SUBMITTED FOR APPROVAL, AND SHALL COMPLY WITH THE FOLLOWING:

   A. COMPRESSIVE STRENGTH: 4500 PSI
   B. AGGREGATE: WELL-GRADED WITH 3/4 INCH NOMINAL MAXIMUM AGGREGATE SIZE
   C. AIR CONTENT & WATER-CEMENTITIOUS MATERIALS RATIO:
      CONCRETE EXPOSED TO WEATHER: 5.0% +/-1.5% w/c = 0.40 MAX.
      CONCRETE NOT EXPOSED TO WEATHER: N/A w/c = 0.45 MAX.
   D. MAXIMUM SLUMP: 5 INCHES (WITHOUT ADDITION OF WATER REDUCER)
      8 INCHES (WITH WATER REDUCING ADMIXTURE ADDED TO 2 TO 4 IN. SLUMP)
   E. LIMIT THE PERCENTAGE, BY WEIGHT, OF CEMENTITIOUS MATERIALS OTHER THAN PORTLAND CEMENT IN CONCRETE AS FOLLOWS:
      1. FLY ASH: 25 PERCENT
      2. COMBINED FLY ASH & POZZOLAN: 25 PERCENT
   F. DO NOT USE ADMIXTURES CONTAINING CALCIUM CHLORIDE

7. A QUALIFIED INDEPENDENT TESTING AGENT SHALL BE ENGAGED TO SAMPLE CONCRETE, PERFORM TESTS AND SUBMIT TEST REPORTS DURING CONCRETE PLACEMENT. TESTING AGENCY WILL CONDUCT AND INTERPRET TESTS AND STATE IN EACH REPORT WHETHER TESTED WORK COMPLIES WITH OR DEVIATES FROM REQUIREMENTS. MINIMUM TESTING REQUIREMENTS ARE AS FOLLOWS:

   A. VERIFY SIZE AND PLACEMENT OF REINFORCING AND EMBEDDED ITEMS
   B. OBTAIN ONE SAMPLE FOR EACH DAY'S POUR OF EACH CONCRETE MIX EXCEEDING 5 CU. YARDS, BUT LESS THAN 25 CU. YARDS, PLUS ONE SET FOR EACH ADDITIONAL 50 CU. YARDS.
   C. TESTS SHALL INCLUDE SLUMP (ASTM C143), AIR CONTENT (ASTM C231), TEMPERATURE (ASTM C1064) UNIT WEIGHT (ASTM C567), AND COMPRESSIVE STRENGTH (ASTM C31/C39)
   D. CAST AND LABORATORY CURE ONE SET OF FOUR STANDARD CYLINDER SPECIMENS FOR EACH COMPOSITE SAMPLE.
   E. TEST ONE SPECIMEN AT 7 DAYS AND TWO AT 28 DAYS. HOLD ONE SPECIMEN IN RESERVE IF NEEDED FOR 56-DAY VERIFICATION BREAK.

8. CORRECT DEFICIENCIES IN OR REMOVE AND REPLACE CONCRETE & REINFORCING THAT INSPECTIONS AND TEST REPORTS INDICATE DO NOT COMPLY WITH SPECIFIED REQUIREMENTS. ADDITIONAL TESTING, AT CONTRACTOR'S EXPENSE, WILL BE PERFORMED TO DETERMINE COMPLIANCE OF CORRECTED WORK WITH SPECIFIED REQUIREMENTS.

SHOP DRAWINGS & SUBMITTALS:

1. STRUCTURAL DRAWINGS INDICATE TYPICAL AND CERTAIN SPECIFIC CONDITIONS ONLY. ALL CONDITIONS SHALL BE DETAILED ON THE SHOP DRAWINGS IN ACCORDANCE WITH SPECIFIED STANDARDS AND THE SPECIFIC REQUIREMENTS OF THIS PROJECT AS INDICATED ON THE DRAWINGS.

2. A LICENSE TO USE ANY PORTION OR ALL OF THE STRUCTURAL CAD FILES FOR THE LIMITED PURPOSE OF ASSISTING THE CONTRACTOR'S PREPARATION OF SHOP DRAWINGS FOR SUBMITTAL MAY BE PURCHASED FROM ELM (AT ELM's SOLE DISCRETION) UNDER A STANDARD FORM OF AGREEMENT FOR A FEE TO BE NEGOTIATED WITH ELM, NOT TO EXCEED ***$1000.00***.

3. IF SUBMITTALS CONTAIN ANY REPRODUCTIONS OF CONTRACT STRUCTURAL DRAWINGS (FROM CAD OR OTHERWISE) WITHOUT THE PRIOR PURCHASE OF EITHER A CAD OR BIM MODEL LICENSE, THEY WILL BE REJECTED AND RETURNED WITHOUT ENGINEER REVIEW.

4. THE GENERAL CONTRACTOR SHALL REVIEW ALL SUBMITTALS AND STAMP WITH APPROVAL PRIOR TO SUBMISSION TO ARCHITECT/ ENGINEER. SHOP DRAWINGS RECEIVED BY THE ARCHITECT/ENGINEER THAT HAVE NOT BEEN CHECKED AND COORDINATED BY THE CONTRACTOR WILL BE RETURNED WITHOUT ARCHITECT/ENGINEER'S REVIEW.

5. BY APPROVING AND SUBMITTING SHOP DRAWINGS, PRODUCT DATA AND SIMILAR SUBMITTALS, THE GENERAL CONTRACTOR REPRESENTS THAT THE CONTRACTOR HAS DETERMINED AND VERIFIED MATERIALS, FIELD MEASUREMENTS AND FIELD CONSTRUCTION CRITERIA RELATED THERETO, AND HAS CHECKED AND COORDINATED THE INFORMATION CONTAINED WITHIN THE SUBMITTAL WITH THE REQUIREMENTS OF THE WORK AND OF THE CONTRACT DOCUMENTS.

6. THE GENERAL CONTRACTOR SHALL SUBMIT SHOP DRAWINGS IN ELECTRONIC (PDF) FORMAT ONLY (INSTEAD OF PAPER COPIES). THESE WILL BE REVIEWED AND RETURNED BY THE STRUCTURAL ENGINEER IN PDF FORMAT ONLY. ALLOW TWO WEEKS FOR THE REVIEW OF EACH SUBMITTAL. WHERE MULTIPLE STRUCTURAL SUBMITTALS ARE SUBMITTED WITHIN A BRIEF TIME FRAME, ELM RESERVES THE RIGHT TO INCREASE THE TWO WEEK REVIEW ALLOWANCE AT OUR DISCRETION. TO MINIMIZE DISRUPTION TO THE PROJECT SCHEDULE, ELM RECOMMENDS THAT THE GENERAL CONTRACTOR DEVELOP AND SUBMIT A SCHEDULE OF SUBMITTALS FOR ARCHITECT/ENGINEER REVIEW AND COMMENT.

7. IN RE-SUBMITTALS, THE CONTRACTOR SHALL DIRECT SPECIFIC ATTENTION TO ALL CHANGES SINCE THE PREVIOUS SUBMISSION, USING REVISION CLOUDS OR OTHER MUTUALLY AGREED MEANS. ELM's APPROVAL OF A RESUBMISSION SHALL NOT APPLY TO ANY REVISIONS THAT WERE NOT SPECIFICALLY NOTED BY THE CONTRACTOR.

8. ELM's REVIEW OF SUBMITTALS SHALL BE FOR GENERAL CONFORMANCE WITH THE INFORMATION GIVEN AND DESIGN CONCEPT EXPRESSED IN THE STRUCTURAL CONTRACT DOCUMENTS. ELM'S REVIEW OF SUBMITTALS IS NOT CONDUCTED FOR THE PURPOSE OF DETERMINING THE ACCURACY AND COMPLETENESS OF OTHER DETAILS SUCH AS DIMENSIONS AND QUANTITIES, OR FOR SUBSTANTIATING PERFORMANCE OF SYSTEMS DESIGNED BY THE CONTRACTOR, ALL OF WHICH REMAIN THE RESPONSIBILITY SOLELY OF THE GENERAL CONTRACTOR.

9. THE GENERAL CONTRACTOR SHALL NOT BE RELIEVED OF RESPONSIBILITY FOR DEVIATIONS FROM REQUIREMENTS OF THE CONTRACT DOCUMENTS BY ELM' s APPROVAL OF SUBMITTALS UNLESS THE CONTRACTOR HAS SPECIFICALLY INFORMED ELM IN WRITING OF SUCH DEVIATION AT THE TIME OF SUBMITTAL AND ELM HAS GIVEN WRITTEN APPROVAL TO THE SPECIFIC DEVIATION. THE GENERAL CONTRACTOR SHALL NOT BE RELIEVED OF RESPONSIBILITY FOR ERRORS OR OMISSIONS IN A SUBMITTAL BY ELM's APPROVAL OF THE SUBMITTAL.

STATEMENT OF SPECIAL INSPECTIONS (STRUCTURAL):

1. PER THE INTERNATIONAL BUILDING CODE (2021 ed.) SPECIAL INSPECTIONS AND TESTING ARE REQUIRED PER THESE NOTES AND THE SCHEDULE OF SPECIAL INSPECTIONS.

2. THE OWNER OR REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE ACTING AS AN OWNER'S AGENT AS ALLOWED BY IBC 2021 SECTION 1704.2, SHALL ENGAGE A SPECIAL INSPECTION AGENCY, WHICH MEETS THE QUALIFICATIONS OF THE BUILDING OFFICIAL, FOR SPECIAL INSPECTION SERVICES REQUIRED BY THE BUILDING CODE AND AS DEFINED IN THE CONTRACT DOCUMENTS.

3. THE SPECIAL INSPECTION AGENCY SHALL PROVIDE SPECIAL INSPECTIONS, TESTING, AND PROCEDURES IN ACCORDANCE WITH CHAPTER 17 OF IBC 2021 THESE INSPECTIONS SHALL BE IN ADDITION TO THOSE SPECIFIED IN IBC SECTION 110.

4. THE SPECIAL INSPECTORS SHALL BE QUALIFIED IN ACCORDANCE WITH IBC 2021 SECTION 1704.2.1.

5. DUTIES OF THE SPECIAL INSPECTION AGENCY INCLUDES, BUT ARE NOT LIMITED TO:
   5.1. PROVIDE THE INSPECTION SERVICES DEFINED IN THE LIST OF SPECIAL INSPECTIONS INCLUDED IN NOTE #9 BELOW.
   5.2. OBSERVE THE WORK FOR CONFORMANCE WITH THE APPROVED CONTRACT DOCUMENTS AND SPECIFICATIONS, BRINGING ANY DISCREPANCIES TO THE IMMEDIATE ATTENTION OF THE GENERAL CONTRACTOR FOR CORRECTION. IF UNCORRECTED, THE ENGINEER AND BUILDING OFFICIAL ARE TO BE NOTIFIED.
   5.3. REPORTING FOR SPECIAL INSPECTIONS AND TESTING SHALL BE COMPLETED AT THE END OF EACH WEEK. A FINAL REPORT SHALL BE COMPILED AT THE END OF THE PROJECT. REPORTS ARE TO BE SUBMITTED TO THE BUILDING OFFICIAL, CLIENT, AND DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE.
   5.4. MAINTAIN A DISCREPANCY LOG, DOCUMENTING ITEMS THAT DID NOT MEET APPROVED CONTRACT DOCUMENT REQUIREMENTS, AND HOW/WHEN IT WAS CORRECTED. THIS LOG SHALL BE SUBMITTED WITH THE INSPECTION REPORTS.
   5.5 FOR RISK CATEGORY III OR IV STRUCTURES ONLY (PER "DESIGN CRITERIA" NOTES), THE SPECIAL INSPECTION AGENCY SHALL EMPLOY A REGISTERED DESIGN PROFESSIONAL TO PERFORM "STRUCTURAL OBSERVATIONS" IN ACCORDANCE WITH SECTION 1704.6 OF IBC 2021. THIS STRUCTURAL OBSERVER SHALL VISUALLY OBSERVE REPRESENTATIVE LOCATIONS OF STRUCTURAL SYSTEMS, DETAILS AND LOAD PATHS FOR GENERAL CONFORMANCE TO THE APPROVED CONSTRUCTION DOCUMENTS.

6. DUTIES OF THE GENERAL CONTRACTOR OR CONSTRUCTION MANAGER INCLUDE, BUT ARE NOT LIMITED TO:
   6.1. NOTIFY SPECIAL INSPECTOR THAT WORK IS READY FOR INSPECTION PRIOR TO WORK BEING PERFORMED.
   6.2. COOPERATE WITH SPECIAL INSPECTOR BY PROVIDING ACCESS TO WORK, MATERIAL FOR SAMPLES, AND TIME FOR INSPECTIONS.
   6.3. PROVIDE SPECIAL INSPECTOR WITH ACCESS TO APPROVED CONTRACT DOCUMENTS AND SPECIFICATIONS AT THE JOB SITE.
   6.4. MAINTAIN JOB SITE COPIES OF ALL REPORTS SUBMITTED BY THE SPECIAL INSPECTOR.

7. DEFINITIONS:
   7.1. CONTINUOUS SPECIAL INSPECTION - SPECIAL INSPECTION BY THE SPECIAL INSPECTOR WHO IS PRESENT WHEN AND WHERE THE WORK TO BE INSPECTED IS BEING PERFORMED
   7.2. PERIODIC SPECIAL INSPECTION - SPECIAL INSPECTION BY THE SPECIAL INSPECTOR WHO IS INTERMITTENTLY PRESENT WHERE THE WORK TO BE INSPECTED HAS BEEN OR IS BEING PERFORMED. (ALL ITEMS LISTED AS "PERIODIC" ARE REQUIRED TO BE FULLY INSPECTED. HOWEVER, THESE INSPECTIONS MAY BE PERFORMED AFTER A CERTAIN AMOUNT OF THE WORK HAS BEEN PERFORMED, BUT PRIOR TO THE WORK BEING CONCEALED OR CONFINED BY ON-GOING CONSTRUCTION.)

8. THE SPECIAL INSPECTIONS LISTED BELOW ARE A SUMMARY OF ONLY STRUCTURAL INSPECTIONS SPECIFIED BY IBC 2021 CHAPTER 17. REFERENCE THE SPECIFICATIONS AND CONSTRUCTION DOCUMENTS FOR ADDITIONAL INSPECTION REQUIREMENTS RELATED TO OTHER DISCIPLINES.

9. SPECIAL INSPECTIONS AND TESTING ARE REQUIRED PER THESE NOTES AND PER CHAPTER 17 OF IBC 2021 FOR THE FOLLOWING PORTIONS OF CONSTRUCTION:

SHOP FABRICATIONS	PER SECTION 1704.2.5 & 1705.11
CONCRETE CONSTRUCTION	PER SECTION 1705.3 & TABLE 1705.3
SOILS	PER SECTION 1705.6

10. INSPECTION OF FABRICATORS IS NOT REQUIRED WHERE THE FABRICATOR IS APPROVED IN ACCORDANCE WITH SECTION 1704.2.5.1 OF IBC 2021.

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SCALE: AS INDICATED

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WETUMPKA, AL
36093

NO.	DATE	REVISION	BY

CENTRAL ELMORE WTP UPGRADE

STRUCTURAL GENERAL NOTES

BAM
No. 25759
PROFESSIONAL
7/11/2025
CLAUDE H. MOORE

JOB NO: 2024-0776-00
DATE: 7/11/25

G-05

100% ISSUED FOR BID
7/11/25

July 10, 2017 C:\Users\mreck\DC\ACDocs\Ardurra, Inc\2024-0776-00\Project Files\03-Prod\03-Dwgs\G1-LG-06.dwg

MEANINGS OF IDENTIFICATION LETTERS

LETTER	FIRST LETTER		SUCCEEDING LETTERS		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	ANALYSIS		ALARM		
B	BURNER, COMBUSTION		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
C	USERS CHOICE			CONTROL	CLOSE
D	USER'S CHOICE	DIFFERENCE OR DIFFERENTIAL			DEVIATION
E	VOLTAGE (EMF)		SENSOR OR PRIMARY ELEMENT		
F	FLOW RATE	RATIO (FRACTION)			
G	USER'S CHOICE		GLASS, GAUGE, OR VIEWING DEVICE		
H	HAND (MANUALLY INITIATED)				HIGH
I	CURRENT (ELECTRICAL)		INDICATE		
J	POWER		SCAN		
K	TIME OR TIME SCHEDULE	TIME RATE OF CHANGE		CONTROL STATION	
L	LEVEL		LIGHT (PILOT)		LOW
M	USER'S CHOICE				MIDDLE OR INTERMEDIATE
N	USER'S CHOICE		USER'S CHOICE	USER'S CHOICE	USER'S CHOICE
O	USER'S CHOICE		ORIFICE (RESTRICTION)		OPEN
P	PRESSURE OR VACUUM		POINT (TEST CONNECTION)		
Q	QUANTITY	INTEGRATE OR TOTALIZE	INTEGRATE OR TOTALIZE		
R	RADIATION		RECORD		RUN
S	SPEED OR FREQUENCY	SAFETY		SWITCH	STOP
T	TEMPERATURE			TRANSMIT	
U	MULTIVARIABLE		MULTIFUNCTION	MULTIFUNCTION	
V	VIBRATION OR MECHANICAL ANALYSIS			VALVE, DAMPER, OR LOUVER	
W	WEIGHT OR FORCE		WELL OR PROBE		
X	UNCLASSIFIED	X AXIS	ACCESSORY DEVICES OR UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED
Y	EVENT, STATE OR PRESSENCE	Y AXIS		AUXILARY DEVICES	
Z	POSITION, DIMENSION	Z AXIS OR SAFETY INSTRUMENTED SYSTEM		DRIVER, ACTUATOR, OR UNCLASSIFIED FINAL CONTROL ELEMENT	

GENERAL INSTRUMENT SYMBOLS

- FIELD MONTED DISCRETE INSTRUMENTS/SIGNALS
- PILOT LIGHT
- DISCRETE INSTRUMENT MOUNTED ON FACE OF PRIMARY PANEL
- DISCRETE INSTRUMENT MOUNTED BEHIND OR INSIDE OF PRIMARY PANEL
- DISCRETE INSTRUMENT MOUNTED ON FACE OF LOCAL PANEL
- DISCRETE INSTRUMENT MOUNTED BEHIND OR INSIDE OF LOCAL PANEL
- PROGRAMMABLE LOGIC CONTROLLER SYSTEM I/O POINT SEE ABBREVIATION
- HMI INDICATOR/PLC SIGNAL
- HORN
- BEACON
- ANALOG INPUT
- ANALOG OUTPUT
- DIGITAL INPUT
- DIGITAL OUTPUT
- PULSE INPUT
- GENERAL CONTROL INTERLOCK FUNCTION

FUNCTION DESIGNATION AND ABBREVIATIONS

HAND SWITCH DESIGNATION

FR	FORWARD-REVERSE
HOA	HAND-OFF-AUTO
HOR	HAND-OFF-REMOTE
LOA	LOCAL-OFF-AUTO
LOR	LOCAL-OFF-REMOTE
LR	LOCAL-REMOTE
OCA	OPEN-CLOSE-AUTO
OOA	OPEN-OFF-AUTO
OOR	OPEN-OFF-REMOTE
OC	OPEN-CLOSE
OO	ON-OFF
OSC	OPEN-STOP-CLOSE
SS	START - STOP

INSTRUMENT FUNCTION

CH4	METHANE
CL2	CHLORINE RESIDUAL
CO2	CARBON DIOXIDE
DO	DISSOLVE OXYGEN
H2S	HYDROGEN SULFIDE
LEL	LOWER EXPLOSIVE LIMIT
MLSS	MIXED LIQUOR SUSPENDED SOLID
NH3	AMMONIA
NO2	NITRITE
NO3	NITRATE
02	OXYGEN (PURITY)
03	OZONE
ORP	OXIDATION REDUCTION POTENTIAL
pH	pH
TCL	TOTAL CHLORINE
TURB	TURBIDITY
TOC	TOTAL ORGANIC CARBON
TSS	TOTAL SUSPENDED SOLIDS

MEASUREMENT PRINCIPLE NOTATIONS

CON	CONDUCTANCE
DP	DIFFERENTIAL PRESSURE SENSING
FLN	FLOW NOZZEL
FLT	FLOW TUBE
GWR	GUIDE WAVE
RAD	RADAR
US	ULTRASONIC
VENT	VENTURI TUBE

INDICATING LIGHT/ALARM DESIGNATION

OVRLD	OVERLOAD
TRQ HI	TORQUE HIGH
TRQ HI-HI	TORQUE HIGH-HIGH

POWER SUPPLY ABBREVIATIONS

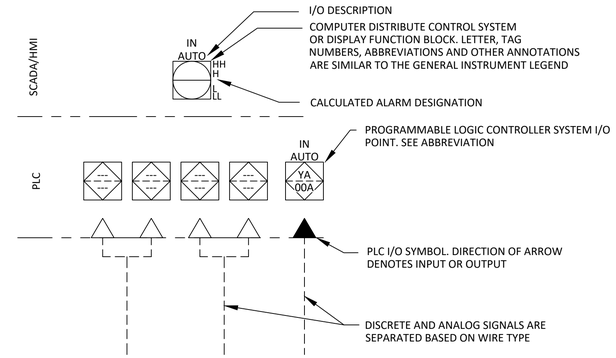
AS	AIR SUPPPLY
ES	ELECTRIC SUPPLY
GS	GAS SUPPPLY
HS	HYDRAULIC SUPPLY
NS	NITROGEN SUPPLY
SS	STEAM SUPPLPY
WS	WATER SUPPLY
120V	120VAC
480V	480VAC

120V — POWER SUPPLY SOURCE LABEL USED ONLY WHERE NECESSARY TO HELP CLARIFY AN INSTRUMENT OR SYSTEM FUNCTION.

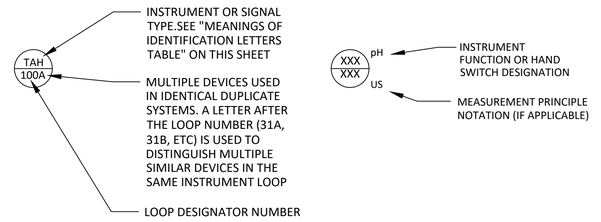
INSTRUMENT AND I/O ABBREVIATION DEFINITION

AAX	ANALYZER HORN
AAL	STROBE ALARM LIGHT
AE	ANALYZER SENSOR
AI	ANALYZER INDICATION
AIT	ANALYZER INDICATING TRANSMITTER
ASH	ANALYZER SWITCH HIGH
ASHH	ANALYZER SWITCH HIGH-HIGH
CB	CONTROL BLOCK REFERENCE (SCADA LEVEL)
FAL	FLOW ALARM LOW
FAH	FLOW ALARM HIGH
FC	FLOW CONTROLLER
FI	FLOW INDICATOR
FIC	FLOW INDICATING CONTROLLER
FE	PRIMARY FLOW ELEMENT/SENSOR
FG	FLOW SIGHT GAUGE
FIT	FLOW INDICATING TRANSMITTER
FQIT	FLOW TOTALIZING INDICATING TRANSMITTER
FSL	FLOW SWITCH LOW
FSH	FLOW SWITCH HIGH
FY	FLOW SIGNAL CONVERTER, REPEATER OR ISOLATOR
HIC	HAND INDICATING CONTROLLER
HMS	MOMENTARY PUSHBUTTON OR SELECTOR SWITCH
HS	HAND SWITCH
IE	CURRENT ELEMENT/SENSOR
IAH	CURRENT ALARM HIGH (MOTOR OVERLOAD)
ISH	CURRENT SWITCH HIGH
JA	POWER FAILURE
JI	POWER INDICATOR
JL	POWER INDICATING LIGHT
JIT	POWER INDICATING TRANSMITTER
KQI	TIME TOTALIZING INDICATOR
LE	PRIMARY LEVEL ELEMENT/SENSOR
LG	LEVEL SIGHT GAUGE
LI	LEVEL INDICATOR (LED OR SCREEN)
LIT	LEVEL INDICATING TRANSMITTER
LSL	LEVEL SWITCH LOW
LSH	LEVEL SWITCH HIGH
LY	LEVEL SIGNAL CONVERTER, REPEATER OR ISOLATOR
NI	STROKE POSITION SWITCH
NC	STROKE POSITION COMMAND
OAH	TORQUE ALARM HIGH
OAHH	TORQUE ALARM HIGH-HIGH
PDG	DIFFERENTIAL PRESSURE GAUGE
PDI	DIFFERENTIAL PRESSURE INDICATOR (LED OR SCREEN)
PE	PRIMARY PRESSURE ELEMENT/SENSOR
PG	PRESSURE GAUGE
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PSL	PRESSURE SWITCH LOW
PSH	PRESSURE SWITCH HIGH
SI	SPEED INDICATION (LED OR SCREEN)
SC	SPEED CONTROL
SIT	SPEED INDICATING TRANSMITTER
SS	START-STOP SWITCH
SSL	SPEED SWITCH LOW
SSH	SPEED SWITCH HIGH
TAL	TEMPERATURE ALARM LOW
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH-HIGH
TDI	DIFFERENTIAL TEMPERATURE INDICATOR (LED OR SCREEN)
TE	TEMPERATURE SENSOR / RESISTANCE TEMPERATURE DETECTOR
TSL	TEMPERATURE SWITCH LOW
TSH	TEMPERATURE SWITCH HIGH
TI	TEMPERATURE INDICATOR (LED OR SCREEN)
TIT	TEMPERATURE INDICATING TRANSMITTER
UA	MULTIVARIABLE/COMMON ALARM/COMMON FAULT
UCR	RUN COMMAND
UCS	STOP COMMAND
VAH	VIBRATION ALARM HIGH
WE	PRIMARY WEIGHT SENSOR/LOAD CELL
WIT	WEIGHT INDICATING TRANSMITTER
YA	GENERAL ALARM EVENT
YI	EVENT INDICATION (LED OR SCREEN)
YIR	RUNNING INDICATION
YIS	STOPPED INDICATION
YL	EVENT INDICATING LIGHT
YLR	RUNNING INDICATING LIGHT
YLS	STOPPED INDICATING LIGHT
ZI	POSITION INDICATOR
ZIC	CLOSED INDICATION
ZIO	OPEN INDICATION
ZLC	CLOSED INDICATING LIGHT
ZLO	OPEN INDICATING LIGHT
ZSC	CLOSED POSITION SWITCH
ZSO	OPEN POSITION SWITCH
ZIT	POSITION INDICATING TRANSMITTER
ZT	POSITION TRANSMITTER

TYPICAL TAG NUMBERS AND DESIGNATION



INSTRUMENTATION SYMBOLOGY AND DESIGNATION



SCADA SYSTEM ARCHITECTURE SYMBOLS

OFFICE EQUIPMENT

- PRINTER
- SCADA W5
- SCADA W5 - DOUBLE
- WALL MONITOR
- LAPTOP

SECURITY

- SECURITY CAMERA - FISHEYE
- SECURITY CAMERA - DIRECTIONAL
- KEYPAD
- CARD READER
- CAMERA INTERCOM

FIELD EQUIPMENT ANTENNAS

- YAGI ANTENNA
- MICROWAVE ANTENNA
- CELLULAR ANTENNA
- OMNIDIRECTIONAL ANTENNA

FIELD EQUIPMENT

- OIT - OPERATOR INTERFACE TERMINAL
- MC - MEDIA CONVERTER
- RADIO
- PLC - PROGRAMMABLE LOGIC CONTROLLER
- ROUTER - DIN RAIL MOUNT
- ACCESS CONTROLLER
- FOPP - FIBER OPTIC PATCH PANEL DIN RAIL MOUNT
- ENPP - ETHERNET PATCH PANEL DIN RAIL MOUNT
- UPS - UNINTERRUPTIBLE POWER SUPPLY
- ESW - ETHERNET SWITCH DIN RAIL MOUNT
- ESW - ETHERNET SWITCH DIN RAIL MOUNT WITH FIBER CAPABILITIES
- PQM - POWER QUALITY METER
- RIO - REMOTE INPUT/OUTPUT
- CTL - OEM CONTROLLER
- SA - SURGE ARRESTOR

RACK MOUNTED EQUIPMENT

- SER - SERVER
- FW - FIREWALL
- PMCS - POWER MONITORING CONTROL SYSTEM
- SVS - SERVER, SECURITY
- SVH - SERVER, HISTORY
- KVM - KEYBOARD VIDEO MOUSE
- NAS - NETWORK ATTACHED STORAGE
- PDU - POWER DISTRIBUTION UNIT
- ROUTER
- FOPP - FIBER OPTIC PATCH PANEL
- ENPP - ETHERNET PATCH PANEL
- ESW - ETHERNET SWITCH
- UPS - UNINTERRUPTIBLE POWER SUPPLY

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716 U.S. HIGHWAY 231
WETUMPKA, AL 36093

NO.	DATE	REVISION	BY
----	----	----	----

CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS AND INSTRUMENTATION LEGEND
SHEET 1 OF 2

ALABAMA LICENSED No. 34899-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

G-06

100% ISSUE FOR BID
07/11/2025

July 10, 2017 C:\Users\mreck\DC\ACCDocs\Ardurra, Inc\2024-0776-00\Project Files\03-Prod\03-Dwgs\G1-LG-07.dwg

EQUIPMENT IDENTIFICATION DESCRIPTION

AABB-CC-DDEE

AA - BASIN OR DISTRICT
BB - AREA CODE
CC - FUNCTION CODE
DD - PROCESS SEQUENCE
EE - QUANTITY OF LIKE EQUIPMENT

PIPELINE IDENTIFICATION DESCRIPTION

SS"-MMMMM-?

SS" - PIPE SIZE (INCHES)
MMMMM - PIPELINE MATERIAL CODE
PPP - PROCESS CODE

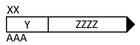
PIPE MATERIAL CODE

CS	CARBON STEEL
DI	DUCTILE IRON PIPE
FRP	FIBER REINFORCED PIPE
GC	GROOVED CLASS
HDPE	HIGH DENSITY POLYETHYLENE
PVC	PVC
PVC40	SCHEDULE 40 PVC
PVC80	SCHEDULE 80PVC
SS	STAINLESS STEEL

PROCESS CODE

OC	ODOR CONTROL
RQ	RAW WATER
RWP	RAW WATER PUMPING
RWS	RAW WATER STORAGE
SEP	SEPTAGE
SEW	SEWAGE
STS	STORM SEWER

PAGE CONNECTORS



XX - PROCESS CODE
Y - CONNECTOR DESIGNATION
ZZZZ - SHEET NUMBER
AAA - ORIGIN/DESTINATION DESCRIPTION

LINE SYMBOLS

- MAJOR PROPOSED PROCESS PIPING
- MINOR PROPOSED PROCESS PIPING
- MAJOR EXISTING PROCESS PIPING
- MAJOR FUTURE PROCESS PIPING
- MINOR EXISTING PROCESS PIPING
- MINOR FUTURE PROCESS PIPING
- BUILDING ENCLOSURE BARRIER
- ELECTRICAL OR ELECTRONIC SIGNAL
- DATA SIGNAL
- FO — FIBER OPTIC CABLE
- CAT6 — ETHERNET CAT6 CABLE
- PNEUMATIC SIGNAL
- WIRELESS SIGNAL
- HYDRAULIC SIGNAL
- HEAT TRACE

VALVES AND GATE SYMBOLS & ABBREVIATIONS

- BV - BALL VALVE
- BFV - BUTTERFLY VALVE
- DGV - DIAPHRAGM VALVE
- FWV - FOUR WAY VALVE
- GV - GATE VALVE
- GLV - GLOBE VALVE
- KGV - KNIFE GATE VALVE
- PNV - PINCH VALVE
- SG - SLIDING GATE
  SLG - SLUICE GATE
- PV - PLUG VALVE
- CKV - CHECK VALVE
- TWV - THREE WAY VALVE
- RV - RELIEF VALVE
- SPVV - PRESSURE & VACUUM RELIEF VALVE
- SVV - VACUUM RELIEF VALVE
- PTV - PILOT OPERATED RELIEF VALVE
- SLPV - PRESSURE RELIEF VALVE WITH SOLENOID
- PRV - PRESSURE REDUCING VALVE
- PRV - PRESSURE REDUCING VALVE(SELF ACTUATING TYPE)
- PSV - PRESSURE SUSTAINING VALVE
- PSV - PRESSURE SUSTAINING VALVE (SELF ACTUATING TYPE)
- CLVV - CHLORINE VACUUM REGULATOR ASSEMBLY
- BPV - BACK FLOW PREVENTER

VALVES AND GATE ACTUATOR SYMBOLS

- CURRENT-TO-PNEUMATIC
- DIAPHRAGM PRESSURE BALANCED
- DIAPHRAGM, SPRING OR OTHERWISE UNSPECIFIED
- ELECTRIC-HYDRAULIC
- HAND WHEEL
- INTELLIGENT ELECTRIC MOTOR
- SMALL MOTOR
- PNEUMATIC
  DA - DOUBLE ACTING
  SC - SPRING CLOSE
  SO - SPRING OPEN
- SOLENOID
- SOLENOID - MANUAL RESET
- SOLENOID - REMOTE RESET
- SPRING OR WEIGHT FOR RELIEF VALVE OR LOADED FOR SAFETY VALVE

PRIMARY ELEMENTS

- FLUME
- MAGNETIC FLOWMETER
- ORIFICE PLATE
- PITOT TUBE
- POSITIVE DISPLACEMENT
- ROTAMETER
- THERMAL MASS FLOW METER
- TURBINE OR PROPELLER TYPE
- ULTRASONIC FLOWMETER
- VENTURI TUBE, FLOW NOZZLE OR FLOW TUBE
- WEIR

PIPING SYMBOLS

- CAP
- COUPLING
- CONCENTRIC REDUCER
- ECCENTRIC REDUCER
- BLIND FLANGE
- DIAPHRAGM SEAL
- DRAIN
- EJECTOR / EDUCTOR
- EXPANSION JOINT
- FILTER
- FLEXIBLE HOSE
- FLOW CONDITIONER
- INLINE SILENCER
- REMOVABLE SPOOL
- BASKET STRAINER
- DUPLEX TYPE STRAINER
- T-TYPE STRAINER
- Y-TYPE STRAINER
- VENT COVER
- INLINE DIFFUSER
- PULSATION DAMPENER
- PRESSURE RUPTURE DISK

MECHANICAL PROCESS EQUIPMENT

- SMC - SCUM BOX
- COB - BELT CONVEYOR
- COS - SCREW CONVEYOR
- PSV - SCREEN DUMPSTER
- FSEP - FILTER SEPARATOR
- HEX - HEAT EXCHANGER, PLATE & FRAME

DRIVERS AND MIXERS

- DE - DIESEL ENGINE
- MXR - RAPID MIXER
- MXS - STATIC MIXER
- M - ELECTRIC MOTOR
- TB - TURBINE

PUMP SYMBOLS & ABBREVIATIONS (PMP)

- CLP - CENTRIFUGAL PUMP
- SCP - HORIZONTAL PUMP
- P - POSITIVE DISPLACEMENT PUMP
- VEP - VERTICAL INLINE PUMP
- VP - VERTICAL CAN PUMP
- PCP - PROGRESSIVE CAVITY PUMP
- SSP - SUMP PUMP
- SMP - SUBMERSIBLE PUMP
- VWP - VERTICAL TURBINE PUMP
- VEP - METERING PUMP
- PSP - PERISTALTIC METERING PUMP
- DMP - DIAPHRAGM METERING PUMP

COMPRESSOR/BLOWER SYMBOLS & ABBREVIATIONS (PMP)

- BLR - CENTRIFUGAL BLOWER
- PDB - POSITIVE DISPLACEMENT BLOWER
- CMP - CENTRIFUGAL COMPRESSOR
- CMB - LIQUID RING COMPRESSOR
- CMR - SCREW COMPRESSOR
- RCMP - RECIPROCATING COMPRESSOR
- DIF - AIR DIFFUSER
- DIR - TANK DIFFUSER

CHEMICAL FEED EQUIPMENT SYMBOLS & ABBREVIATIONS

- AUTOMATIC SWITCHOVER
- CCLM - CALIBRATION COLUMN
- VAP - CHLORINE DIOXIDE (CO_2) VAPORIZOR
- CYG - GAS CYLINDER
- POLYMER INJECTION RING DIFFUSER
- EWSH - EMERGENCY COMBINATION SHOWER AND EYEWASH STATION
- EW - EMERGENCY EYEWASH STATION
- ESH - EMERGENCY SHOWER
- EXC - EXPANSION TANK OR FUNNEL
- INJ - INJECTOR / EDUCTOR
- LS - LIME SLAKER, PASTE TYPE
- PBC - PRESSURE BUILDING COIL
- CYG - TON CONTAINER
- TOTE
- VAPOR SUPERHEATER

NOTES:

1. IN GENERAL THE P&ID SYMBOLS AND DEVICE IDENTIFICATIONS ARE BASED ON INTERNATIONAL SOCIETY OF AUTOMATION STANDARD PRACTICE ANSI/ISA-5.1 (2022). SOME MODIFICATIONS, ADDITIONS AND ALTERATIONS HAVE BEEN MADE AS NEEDED TO ACCOMMODATE THE PROJECT REQUIREMENTS
2. SOME CONTROL AND INTERLOCK REQUIREMENTS WHICH CAN BE MORE CLEARLY ILLUSTRATED ON SCHEMATICS DRAWINGS HAVE BEEN OMITTED FROM THE P&ID DRAWINGS.
3. THIS IS GENERAL LEGEND SHEET. SOME SYMBOLS AND ABBREVIATIONS MAY NOT BE UTILIZED ON THIS SPECIFIC PROJECT.
4. PIPING AND EQUIPMENT LEGEND APPLIES TO P&ID SHEETS ONLY.

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36093

NO.	DATE	REVISION	BY

CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS AND INSTRUMENTATION LEGEND
SHEET 2 OF 2

ALABAMA LICENSED No. 34089-E PROFESSIONAL ENGINEER 7/11/25 DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

G-07

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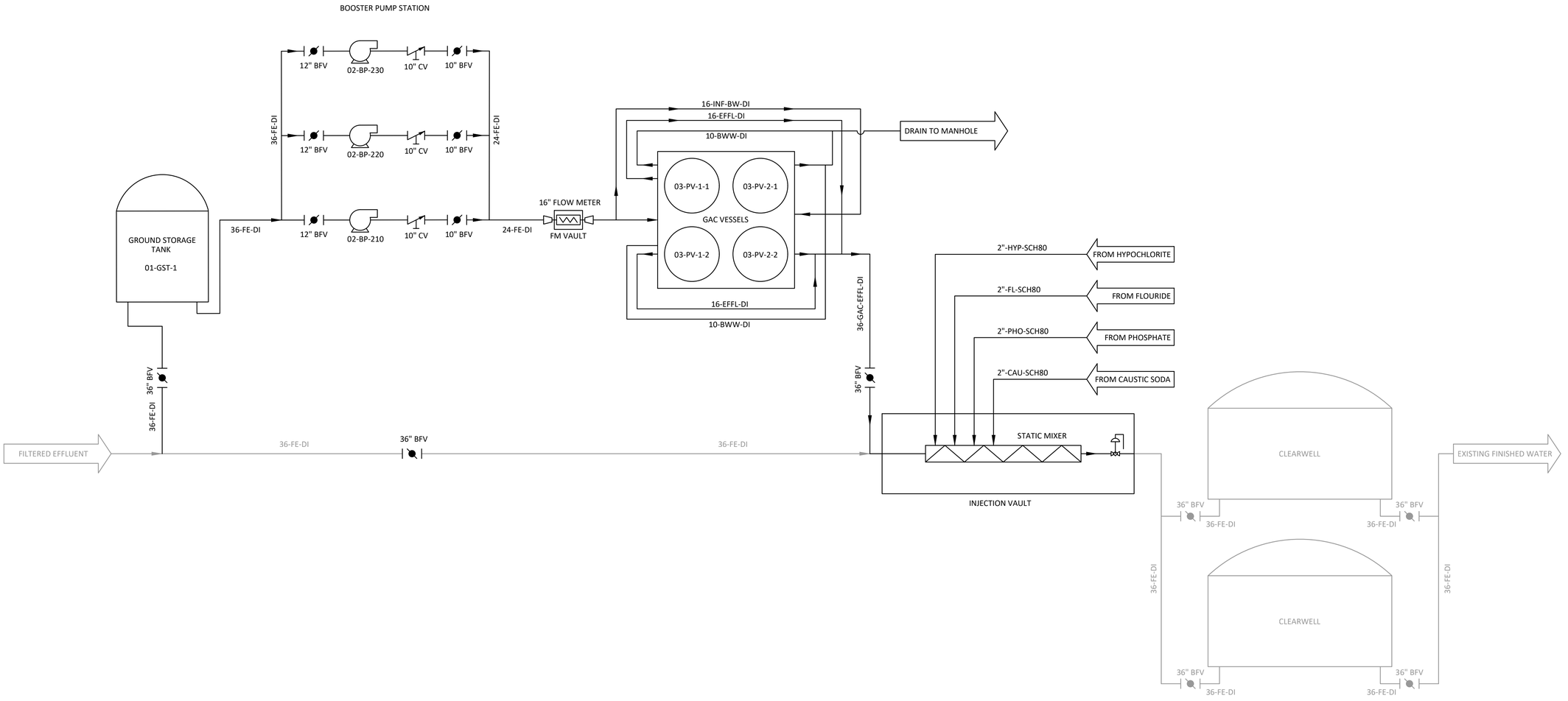
BOOSTER PUMP STATION



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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS FLOW DIAGRAM

ALABAMA LICENSED PROFESSIONAL ENGINEER
No. 35223
SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

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ABBREVIATIONS

A OR AMP	AMPERES
AFF	ABOVE FINISH FLOOR
AHU	AIR HANDLING UNIT
AIC	AMPERE INTERRUPTING CAPACITY
AM	AMMETER
AS	AMMETER SELECTION SWITCH
ASYM	ASYMMETRICAL
ATS	AUTOMATIC TRANSFER SWITCH
AT	AUTOMATIC TRANSFORMER
BCP	BACKUP CONTROL PANEL
C	CONDUIT
CB	CIRCUIT BREAKER
CKT	CIRCUIT
CLF	CURRENT LIMITING FUSE
CNTL	CONTROL
CT	CURRENT TRANSFORMER
Δ	DELTA CONNECTION
D	DEPTH
DP	DISTRIBUTION PANELBOARD
DS OR DISC	DISCONNECT SWITCH
DTC	DATA TERMINAL CABINET
EF	EXHAUST FAN
EG	EQUIPMENT GROUND
EMCP	ENERGY MANAGEMENT CONTROL PANEL
EGC	EQUIPMENT GROUNDING CONDUCTOR
EMT	ELECTRICAL METALLIC TUBING
ESTOP	EMERGENCY STOP
ETR	EXISTING TO REMAIN
EX OR EXIST.	EXISTING
EXP	EXPLOSION PROOF
F	FUSE
FA	FIRE ALARM
FCR	FLOAT CONTROL RELAY
FLR	FLOOR
FACP	FIRE ALARM CONTROL PANEL
FMPX	FIRE ALARM MULTIPLEX PANEL
G OR GND	GROUND
GEC	GROUNDING ELECTRODE CONDUCTOR
GF	GROUND FAULT
GFI	GROUND FAULT INTERRUPTING
H	HEIGHT
HP	HORSEPOWER
HV	HIGH VOLTAGE, 600VAC
HVAC	HEATING, VENTILATION AND AIR
IMC	INTERMEDIATE METAL CONDUIT
JB OR J	JUNCTION BOX
KVA	KILOVOLT – AMPS
KW	KILOWATTS
KWH	KILOWATT–HOUR
L	LENGTH
LA	LIGHTING ARRESTOR
LCP	LIGHTING CONTROL PANEL
LFMC	LIQUIDTIGHT FLEXIBLE METAL CONDUIT
LP	LIGHTING PANELBOARD
LV	LOW VOLTAGE, 240VAC
MCB OR MB	MAIN CIRCUIT BREAKER
MCC	MOTOR CONTROL CENTER
MFR	MANUFACTURER
MH OR MTG	MOUNTING HEIGHT
MLO	MAIN LUG ONLY
MMS	MICROPROCESSOR–BASED METERING SYSTEM
MT OR MTD	MOUNT OR MOUNTED
N	NEUTRAL
NC	NORMALLY CLOSED
NEC	NATIONAL ELECTRICAL CODE
NEMA	NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
NF	NON–FUSIBLE
NFPA	NATIONAL FIRE PROTECTION ASSOCIATES
NO	NORMALLY OPEN
NTS	NOT TO SCALE
P	POLE
PFC	POWER FACTOR CAPACITOR
PLC	PROGRAMMABLE LOGIC CONTROLLER
PMT	PAD MOUNT TRANSFORMER
PNL	PANEL
PVC	POLYVINYLCHLORIDE CONDUIT
RC	REMOTE CONTROL SWITCH
REC OR RECPT	RECEPTACLE
RGC	RIGID GALVANIZED CONDUIT
RMS	ROOT MEAN SQUARE
RTU	REMOTE TERMINAL UNIT
SS	STAINLESS STEEL, SOFT START
SW	SWITCH
SWBD	SWITCHBOARD
SYM	SYMMETRICAL
TBB	TELEPHONE BACKBOARD
TCP	TEMPERATURE CONTROL PANEL
TTC	TELEPHONE TERMINAL CABINET
TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
TYP	TYPICAL
UG	UNDERGROUND
UL	UNDERWRITER'S LABORATORIES
UNO	UNLESS NOTED OTHERWISE
V	VOLTS
VFD	VARIABLE FREQUENCY DRIVE
VM	VOLTMETER
VMS	VOLTMETER SELECTOR SWITCH
W	WIDTH
W/	WITH
WHDM	WATT HOUR DEMAND METER
WM	WATTMETER
WP	WEATHER PROOF
XFMR	TRANSFORMER
Y	WYE CONNECTION

GENERAL NOTES

1. ENTIRE INSTALLATION SHALL BE IN ACCORDANCE WITH THE FOLLOWING CODES AND STANDARDS:
   - 1.1. NFPA 70, NATIONAL ELECTRICAL CODE.
   - 1.2. NFPA 101 LIFE SAFETY CODE.
   - 1.3. NFPA 820 STANDARD FOR FIRE PROTECTION IN WASTEWATER TREATMENT AND COLLECTION FACILITIES.
2. WET WELLS ARE CLASS 1, DIV. 1, SPACES.
3. ALL ELECTRICAL CIRCUITS SHALL INCLUDE A GREEN GROUNDING CONDUCTOR SIZED PER NEC.
4. CONDUIT AND DEVICE LOCATIONS ARE SHOWN DIAGRAMMATICALLY ONLY, CONTRACTOR SHALL FIELD LOCATE OR ROUTE AS REQUIRED.
5. ALL CONDUIT SHALL BE INSTALLED PARALLEL AND PERPENDICULAR TO BUILDING STRUCTURE.
6. ALL PANEL LEGENDS SHALL BE RETYPED TO REFLECT UP TO DATE CONDITIONS. ALL PANEL LEGENDS SHALL INDICATE THE PANEL'S FEEDER CKT. SOURCE PANEL (OR SUBSTATION) AND ITS LOCATION.
7. ELECTRICAL EQUIPMENT AND DEVICES SHALL BE PROVIDED WITH PHENOLIC NAMEPLATES. ALL NAMEPLATES SHALL BE MECHANICALLY FASTENED WITH S.S. SCREWS OR RIVETS. THE USE OF ADHESIVE NAMEPLATES SHALL NOT BE ALLOWED.
8. CONTRACTOR SHALL MAINTAIN A SET OF PRINTS AND MARK–UP DURING CONSTRUCTION TO REFLECT "AS–BUILT" CONDITIONS. PRINTS SHALL BE DELIVERED TO THE ENGINEER UPON COMPLETION OF THE PROJECT AS A COMPLETE SET OF RECORD DRAWINGS. IN ADDITION, THE CONTRACTOR SHALL PROVIDE ELECTRONIC COPIES OF ALL UPDATES "AS–BUILT" DRAWINGS IN AUTOCAD 2007 FORMAT.
9. THE CONTRACTOR SHALL PROVIDE PULL BOXES IN POWER CIRCUIT CONDUIT AS REQUIRED, SO AS TO LIMIT THE NUMBER OF BENDS TO A MAXIMUM OF 360 DEGREES OR FOUR 90 DEGREE TURNS.
10. PROVIDE CONDUIT EXPANSION FITTINGS AS CONDUIT CROSSES BUILDING EXPANSION JOINTS.
11. ALL EXTERIOR ELECTRICAL ENCLOSURES SHALL BE NEMA 4X STAINLESS STEEL UNLESS OTHERWISE NOTED.
12. ALL SUPPORTING AND FASTENING DEVICES SHALL BE STAINLESS STEEL.
13. CONTRACTOR MAY COMBINE HOMERUNS TO ALL PANEL BOARDS PER NEC.
14. ALL RECEPTACLE BRANCH CIRCUITS OVER 75' IN LENGTH SHALL USE #10 AWG CONDUCTOR (FOR VOLTAGE DROP).
15. CONTRACTOR TO PROVIDE ALL REQUIRED POWER AND STARTERS FOR PROCESS EQUIPMENT (COORDINATE WITH PROCESS EQUIPMENT SUPPLIER).
16. ALL SERVICE ENTRANCE CONDUITS SHALL BE SCH. 80 PVC BURIED 4' BELOW GRADE WITH MARKER TAPE 6" ABOVE TOP OF CONDUIT.
17. CONTRACTOR SHALL PAY ALL FEES ASSESSED BY ELECTRICAL UTILITY CO.
18. CONTRACTOR SHALL COORDINATE INSTALLATION OF ELECTRICAL SERVICE WITH UTILITY COMPANY.
19. CONTRACTOR SHALL PROVIDE 2 SPARE FUSES FOR EACH FUSE INSTALLED INCLUDING ALL EQUIPMENT AND CONTROLS.
20. CONTROL AND POWER CONDUITS SHALL BE SEPARATED BY 12" MIN. AND SHALL BE IN SEPARATE JUNCTION BOXES AND DUCT BANKS. MAINTAIN 12" SEPARATION BETWEEN DUCT BANKS.
21. CONTRACTOR SHALL MAINTAIN OPERATION OF THE ELECTRICAL SERVICE DURING THE UPGRADE.
22. CONTRACTOR SHALL PROVIDE A GROUNDING SYSTEM AS DETAILED IN PLANS. THE INSTALLED GROUNDING SYSTEM SHALL HAVE A RESISTANCE OF LESS THAN 5 OHMS TO GROUND.
23. THE CONTRACTOR SHALL BE RESPONSIBLE FOR READING ALL PROJECT SPECIFICATIONS AND WILL BE RESPONSIBLE FOR MEETING ALL REQUIREMENTS OUTLINED IN THE SPECIFICATIONS.
24. ALL CONDUITS ABOVE GRADE, IN NON–HAZARDOUS LOCATIONS, SHALL BE RIGID ALUMINUM.
25. ALL CONDUITS BELOW GRADE SHALL BE PVC.
26. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING A COORDINATED ELECTRICAL SYSTEM IN ACCORDANCE WITH NEC ARTICLE 240.12 AND ARTICLE 700.27.
27. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING DETAILED ELECTRICAL EQUIPMENT LAYOUT DRAWINGS TO THE ENGINEER FOR APPROVAL PRIOR TO INSTALLATION.

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NO.	DATE	BY
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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

ELECTRICAL NOTES

ALABAMA LICENSED No. 34089-E PROFESSIONAL ENGINEER 7/11/25 DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

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SYMBOL	DESCRIPTION
	CONTACT, NORMALLY OPEN
	CONTACT, NORMALLY CLOSED
*	OPERATING COIL * DESIGNATION: C – CONTACTOR R – CONTROL RELAY M – MAGNETIC MOTOR STARTER – NON REVERSING MF – MAGNETIC MOTOR STARTER – FORWARD MR – MAGNETIC MOTOR STARTER – REVERSE MO – MAGNETIC MOTOR STARTER – OPEN MC – MAGNETIC MOTOR STARTER – CLOSE MH – MAGNETIC MOTOR STARTER – HIGH SPEED ML – MAGNETIC MOTOR STARTER – LOW SPEED SOV – SOLENOID OPERATED VALVE TD – TIME DELAY RELAY T – PROGRAMMABLE TIMER
ETM	METER, ELAPSED TIME
*	INDICATING LIGHT – FULL VOLTAGE TRANSFORMER OR LED * DESIGNATION: A – AMBER R – RED B – BLUE W – WHITE G – GREEN Y – YELLOW
*	INDICATING LIGHT, PUSH –TO–TEST * DESIGNATION: A – AMBER R – RED B – BLUE W – WHITE G – GREEN Y – YELLOW
	SWITCH, PUSHBUTTON, NORMALLY OPEN CIRCUIT
	SWITCH, PUSHBUTTON, NORMALLY CLOSED CIRCUIT
TL	SWITCH, PUSHBUTTON, TAG LINE, NORMALLY CLOSED CIRCUIT WITH MAINTAINED CONTACT
	SWITCH, PUSHBUTTON, TWO CIRCUIT, NORMALLY OPEN AND NORMALLY CLOSED
	SWITCH, EMERGENCY SHUTDOWN, MUSHROOM–HEAD PUSHBUTTON, NORMALLY CLOSED CIRCUIT WITH MAINTAINED CONTACT
H O A	SWITCH, MASTER OR CONTROL X – INDICATES CONTACT CLOSED
	MOMENTARY–CONTACT SWITCH
	SWITCH PRESSURE/VACUUM OPERATED. NORMALLY OPEN. CLOSING ON RISING PRESSURE
	SWITCH PRESSURE/VACUUM OPERATED. NORMALLY CLOSED OPENING ON RISING PRESSURE
	SWITCH, FLOW ACTUATED, NORMALLY OPEN, CLOSING ON INCREASE IN FLOW
	SWITCH, FLOW ACTUATED, NORMALLY CLOSED OPENING ON INCREASE IN FLOW
	SWITCH, TEMPERATURE ACTUATED, NORMALLY CLOSED OPENING ON RISING TEMPERATURE
	SWITCH, TEMPERATURE ACTUATED, NORMALLY OPEN CLOSING ON RISING TEMPERATURE
	CONTACT, TIME DELAY, NORMALLY OPEN WITH TIME DELAY CLOSING
	CONTACT, TIME DELAY, NORMALLY OPEN WITH TIME DELAY OPENING
	CONTACT, TIME DELAY, NORMALLY CLOSED WITH TIME DELAY OPENING
	CONTACT, TIME DELAY, NORMALLY CLOSED WITH TIME DELAY CLOSING
LS	SWITCH, LIMIT
TS	SWITCH, TORQUE
	SWITCH, LIQUID LEVEL ACTUATED, CLOSING ON RISING LEVEL
	SWITCH, LIQUID LEVEL ACTUATED, OPENING ON RISING LEVEL

SYMBOL	DESCRIPTION
25A	FUSE (AMPERE RATING SHOWN)
* 12KV 1200A 150A	FUSED DISCONNECT SWITCH, 3 POLE * DESIGNATION: LS – LOAD BREAK SWITCH DS – DISCONNECT SWITCH
1200A	POWER CIRCUIT BREAKER, MEDIUM–VOLTAGE, DRAWOUT TYPE (AMPERE RATING SHOWN)
500AT 600AF	CIRCUIT BREAKER, DRAWOUT TYPE, 600VAC OR LESS, 3P (TRIP AND FRAME AMPERE RATING SHOWN)
60AT	CIRCUIT BREAKER, THERMOMAGNETIC, 600 VAC OR LESS, 3P (AMPERE RATING SHOWN)
600AT 1000AF	CIRCUIT BREAKER, THERMOMAGNETIC, 600 VAC OR LESS, 3P ADJUSTABLE TRIP (TRIP & FRAME AMPERE RATING SHOWN)
7A	MOTOR CIRCUIT PROTECTOR, 600V AC OR LESS, 3P UON (CONTINUOUS AMPERE RATING SHOWN)
3P 20A	CONTACTOR (NUMBER OF POLES AND AMPERE RATING SHOWN)
* **	MAGNETIC MOTOR STARTER * NEMA SIZE ** DESIGNATION: NONE – FULL VOLTAGE, NON–REVERSING FVR – FULL VOLTAGE, REVERSING RVNR – REDUCED VOLTAGE, NON–REVERSING RVR – REDUCED VOLTAGE, REVERSING
M	MANUAL MOTOR STARTER
	VARIABLE FREQUENCY DRIVE / INVERTER
750KVA 4.16/ 0.48KV	POWER TRANSFORMER (KVA RATING, VOLTAGES AND WINDINGS CONNECTIONS SHOWN)
Z=X% Ω	SERIES REACTOR (LINE OR LOAD RATING SHOWN)
(2) 4200/ 120V	VOLTAGE TRANSFORMER (QUANTITY AND VOLTAGE RATIO SHOWN)
(3) 800/5A	CURRENT TRANSFORMER (QUANTITY AND CURRENT RATIO SHOWN)
(3) 2200/5A SET AT 1200/5A	MULTI–RATIO CURRENT TRANSFORMER (QUANTITY, MAXIMUM CURRENT RATIO AND SETTING SHOWN)
800/5A	ZERO SEQUENCE CURRENT TRANSFORMER (CURRENT RATIO SHOWN)
	CAPACITOR
	GROUND CONNECTION
(3)	SURGE ARRESTER (QUANTITY SHOWN)
3P 400A	TRANSFER SWITCH (NUMBER OF POLES AND AMPERE RATING SHOWN)
125VDC	BATTERY (RATING SHOWN)
10	MOTOR, INDUCTION (HORSEPOWER SHOWN)

SYMBOL	DESCRIPTION
XXXKW XXXV 3–PHASE	GENERATOR (KW RATINGS, VOLTAGE AND PHASE SHOWN)
	THERMISTOR
	DIODE, SEMICONDUCTOR
RTD	RESISTANCE TEMPERATURE DETECTOR
	RESISTOR
	SPACE HEATER
500VA 480/120V	CONTROL POWER TRANSFORMER, (VA RATING VOLTAGES)
AS	AMMETER SWITCH
VS	VOLTMETER SWITCH
CS	CONTROL SWITCH
*	METER * DESIGNATION: AM – AMMETER VM – VOLTMETER PFM – POWER FACTOR WM – WATTMETER FMM – FREQUENCY METER WHM – WATTHOUR METER PM – POWER MONITORING DEVICE
*	PROTECTIVE RELAY OR DEVICE * DESIGNATION: 11 – MULTIFUNCTION PROTECTIVE RELAY 25 – SYNCHRONIZING OR SYNCHRONISM–CHECK RELAY 26 – APPARATUS THERMAL DEVICE 27 – UNDERVOLTAGE RELAY 32 – DIRECTIONAL POWER RELAY 37 – UNDERCURRENT OR UNDERPOWER RELAY 40 – FIELD RELAY 46 – REVERSE–PHASE OR PHASE–BALANCE CURRENT RELAY 49 – MACHINE OR TRANSFORMER THERMAL RELAY 50 – INSTANTANEOUS OVERCURRENT RELAY 50GS– INSTANTANEOUS GROUND FAULT RELAY 51 – AC TIME OVERCURRENT RELAY 51GS– AC TIME GROUND FAULT RELAY 51V – AC TIME OVERCURRENT RELAY (VOLTAGE RESTRAINT) 55 – POWER FACTOR RELAY 59 – OVERVOLTAGE RELAY 60 – VOLTAGE OR CURRENT BALANCE RELAY 63 – PRESSURE SWITCH 64 – GROUND DETECTOR RELAY 67 – AC DIRECTIONAL OVERCURRENT RELAY 81 – FREQUENCY RELAY 86 – LOCKOUT RELAY 87 – DIFFERENTIAL PROTECTIVE RELAY 87G – GENERATOR DIFFERENTIAL GROUND FAULT RELAY

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

ELECTRICAL SYMBOLS

ALABAMA LICENSED No. 34699-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON 7/11/25

JOB NO: 2024-0776-00
DATE: 07/19/2024

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WIRING

(J)	JUNCTION BOX
PB	PULL BOX
H	HANDHOLE
(PXX)	CONDUIT CONDUCTOR WIRE TAG. P–DENOTES POWER, AND C–DENOTES CONTROL
	COMMUNICATION
—(D)	DATA COMMUNICATION OUTLET
—(C)	CABLE TELEVISION OUTLET
	DATA COMMUNICATION FLOOR OUTLET
	TELEPHONE FLOOR RECEPTACLE
	WALL MOUNTED TELEPHONE
	WALL MOUNTED DATA
(S)	CEILING MOUNTED SPEAKER

LIGHTING

	EXIT SIGN WALL MOUNTED LIGHT
	ELECTRIC RESISTANCE HEATER
	FLUORESCENT EMERGENCY LIGHT FIXTURE
$	SINGLE POLE SWITCH
$3	THREE–WAY SWITCH
$T	TIMER OPERATED SWITCH
$F	FUSED SWITCH
$P	SWITCH WITH PILOT LIGHT
(P)	CEILING MOUNTED PULL SWITCH
$2	DOUBLE POLE SWITCH
$4	FOUR–WAY SWITCH
$K	KEY OPERATED SWITCH
(L)PS	LAMP HOLDER POLE SWITCH

LIGHTING (CONT)

$LM	LOW VOLTAGE MASTER SWITCH
$WP	WEATHER PROOF SWITCH
	INCANDESCENT CEILING MOUNTED LIGHT
	RECESSED FLUORESCENT 2X4 LIGHT FIXTURE
	RECESSED FLUORESCENT 1X4 LIGHT FIXTURE
	RECESSED FLUORESCENT 1X8 LIGHT FIXTURE
	SURFACE MOUNTED FLUORESCENT 2X4 LIGHT FIXTURE
	SURFACE MOUNTED FLUORESCENT 1X4 LIGHT FIXTURE
	SURFACE MOUNTED FLUORESCENT 1X8 LIGHT FIXTURE
	STREET LIGHT WITH BRACKET
	EXTERIOR BUILDING LIGHT
	EMERGENCY BATTERY POWERED LIGHTS
	2' X 2' LIGHT FIXTURE
	INDUSTRIAL OR STRIP FIXTURE
	HIGHMAST LIGHTING ASSEMBLY
	AREA LIGHTING ASSEMBLY

POWER

	CLOCK HANGER RECEPTACLE
	DUPLEX RECEPTACLE
	DUPLEX ON EMERGENCY POWER RECEPTACLE
	DUPLEX WITH GFI RECEPTACLE
	QUADRAPLEX RECEPTACLE
	SINGLE RECEPTACLE
S	SINGLE RECEPTACLE WITH SWITCH
	SPECIAL PURPOSE RECEPTACLE
S	DUPLEX RECEPTACLE WITH SWITCH
	FLUSH MOUNTED PANELBOARD CABINET
	SURFACE MOUNTED PANELBOARD CABINET
T	TRANSFORMER

SINGLE LINE (CONT)

	EARTH GROUND
	FUSED DISCONNECT SWITCH
	UNFUSED DISCONNECT SWITCH
(M)	METER
DP#_	DISTRIBUTION PANEL
LP#_	LIGHTING PANEL
PP#_	POWER PANEL

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REVISION

CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

ELECTRICAL SYMBOLS CONTINUED

ALABAMA LICENSED No. 34889-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON 7/11/25

JOB NO: 2024-0776-00
DATE: 07/19/2024

G-11

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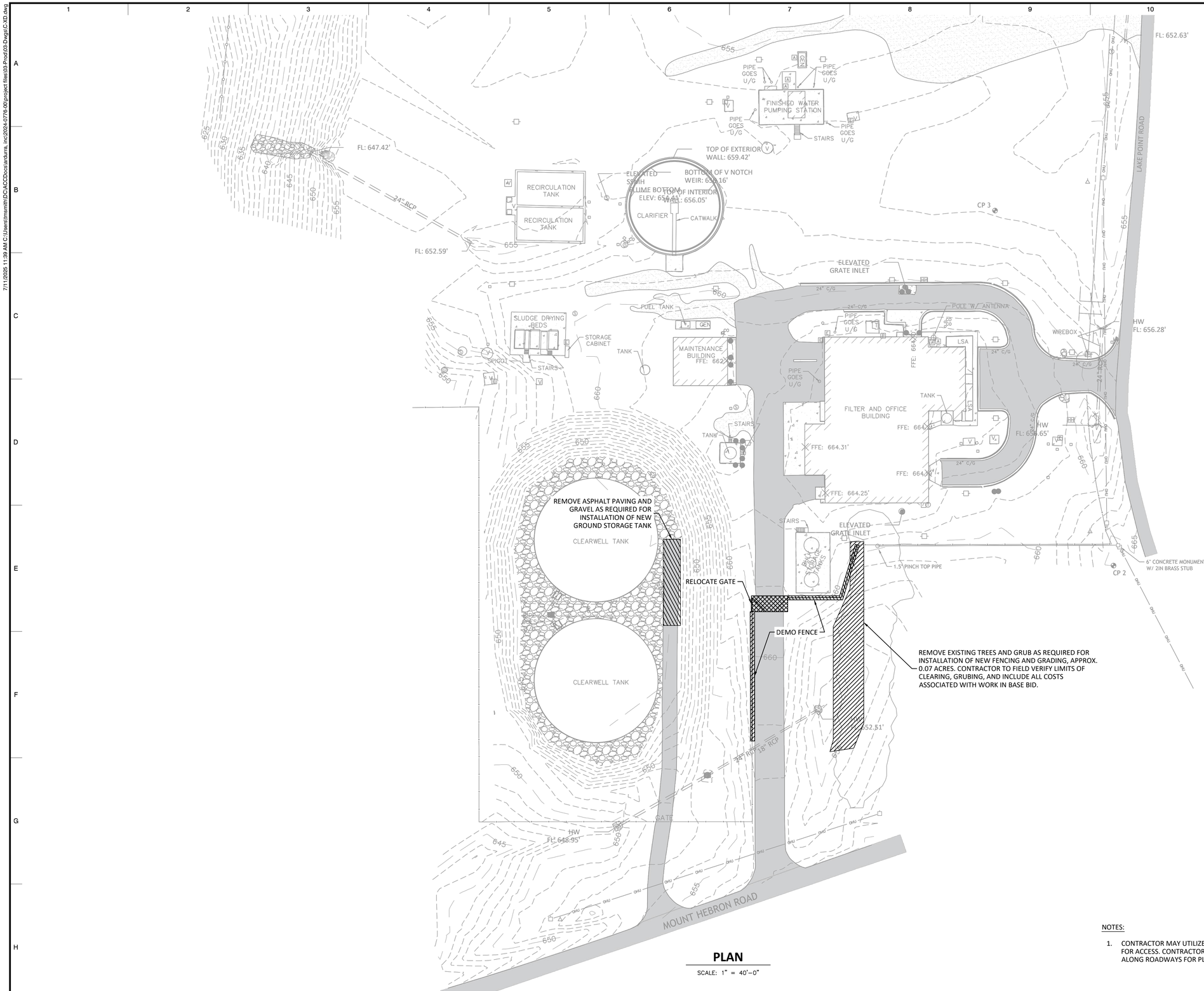

PLAN

SCALE: 1" = 40'-0"

NOTES:

1. CONTRACTOR MAY UTILIZE PLANT ENTRANCE AND EXITS FOR ACCESS. CONTRACTOR TO MAINTAIN CLEAR ACCESS ALONG ROADWAYS FOR PLANT OPERATIONS.

0 40 80
SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

EXISTING SITE AND DEMOLITION

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

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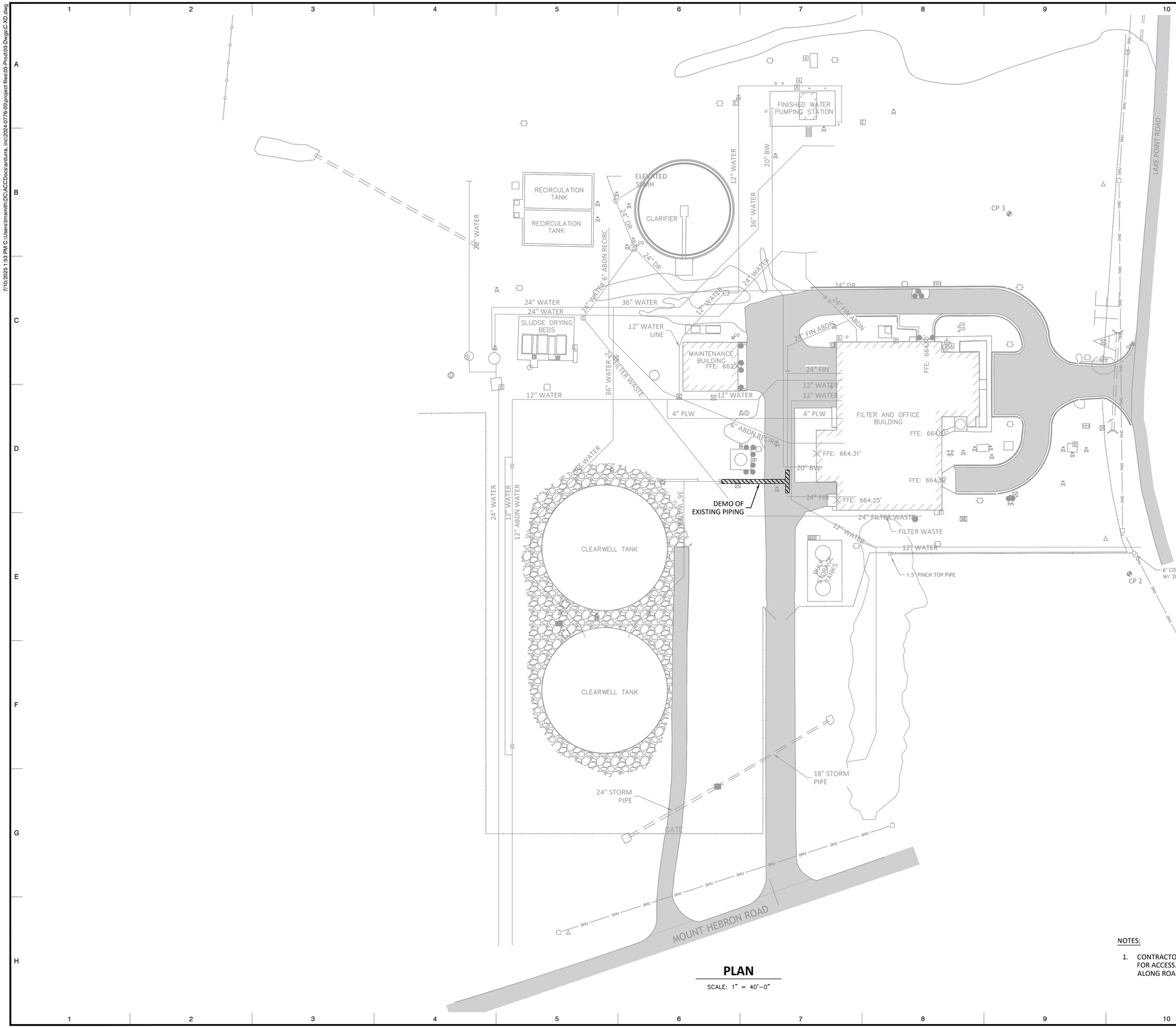

PLAN

SCALE: 1" = 40'-0"

NOTES:

1. CONTRACTOR MAY UTILIZE PLANT ENTRANCE AND EXITS FOR ACCESS. CONTRACTOR TO MAINTAIN CLEAR ACCESS ALONG ROADWAYS FOR PLANT OPERATIONS.

0 40 80
SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

EXISTING YARD PIPING AND DEMOLITION

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
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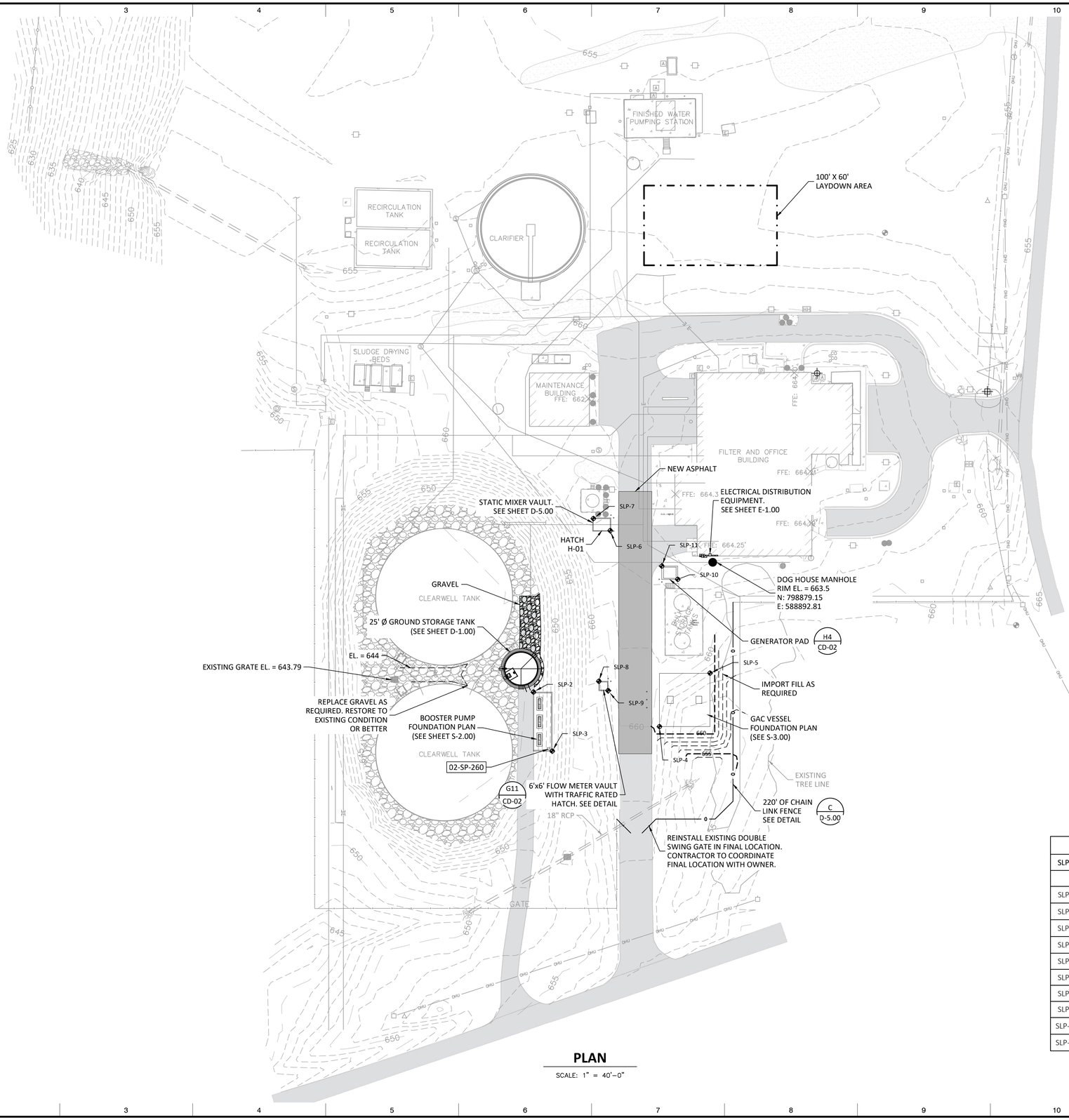

PLAN

SCALE: 1" = 40'-0"

STRUCTURAL LAYOUT POINT (SLP) TABLE			
SLP-#	DESCRIPTION	NORTHING	EASTING
SLP-2	COR EQUIP PAD	798781.64	588757.99
SLP-3	COR EQUIP PAD	798737.14	588772.11
SLP-4	COR EQUIP PAD	798755.61	588852.72
SLP-5	COR EQUIP PAD	798795.87	588890.74
SLP-6	INT VAULT COR	798903.08	588815.74
SLP-7	INT VAULT COR	798912.08	588803.08
SLP-8	INT VAULT COR	798789.66	588807.18
SLP-9	INT VAULT COR	798782.66	588814.18
SLP-10	COR EQUIP PAD	798866.39	588866.53
SLP-11	COR EQUIP PAD	798876.39	588854.53

0 40 80
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SITE PLAN

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07/11/2025

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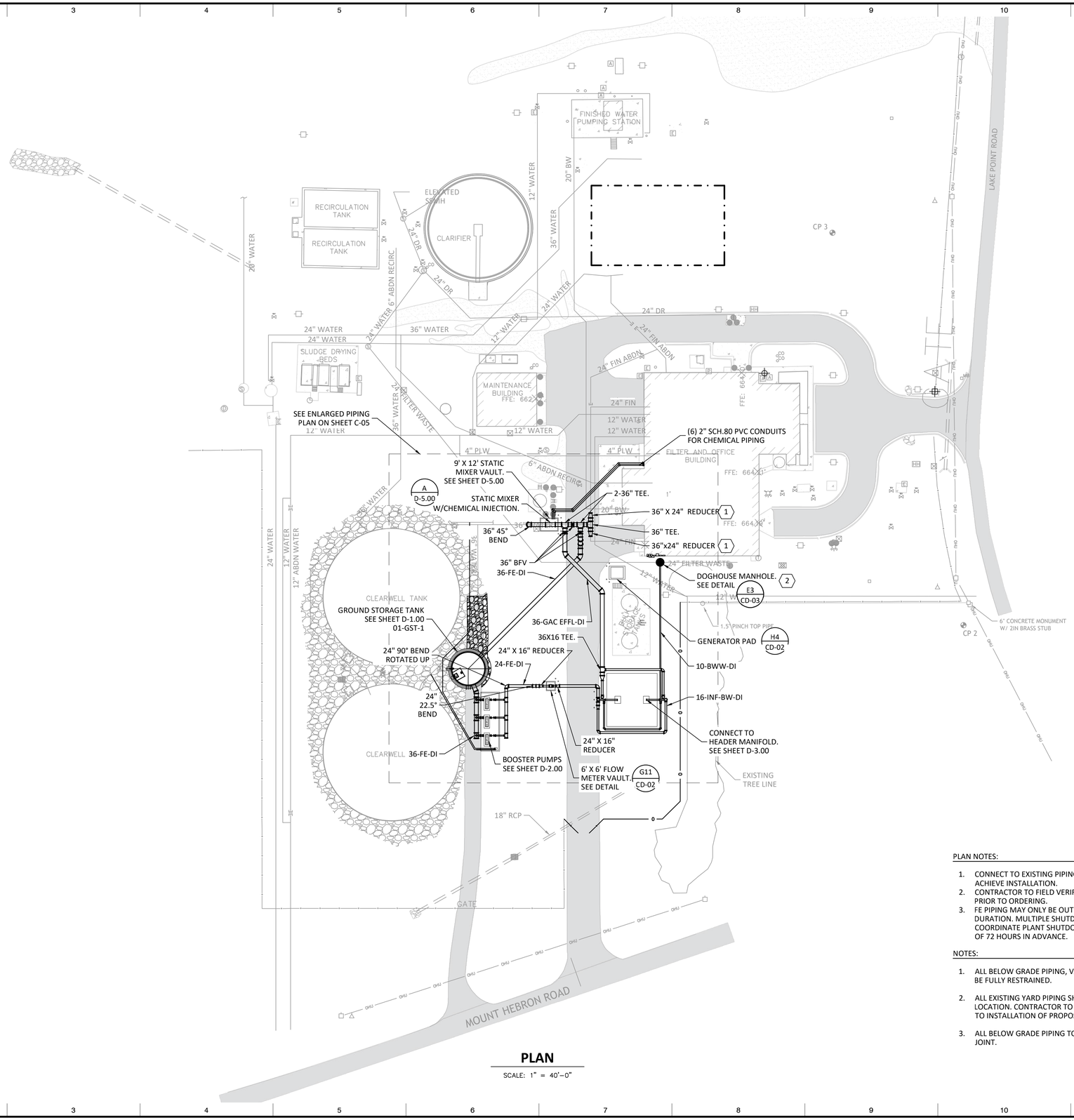

PLAN

SCALE: 1" = 40'-0"

PLAN NOTES: (X)

1. CONNECT TO EXISTING PIPING. FITTING AS REQUIRED TO ACHIEVE INSTALLATION.
2. CONTRACTOR TO FIELD VERIFY REQUIRED DH MH INVERT PRIOR TO ORDERING.
3. FE PIPING MAY ONLY BE OUT OF SERVICE FOR 8 HOUR DURATION. MULTIPLE SHUTDOWNS MAY BE REQUIRED. COORDINATE PLANT SHUTDOWNS WITH OWNER A MINIMUM OF 72 HOURS IN ADVANCE.

NOTES:

1. ALL BELOW GRADE PIPING, VALVES, AND APPURTENANCES TO BE FULLY RESTRAINED.
2. ALL EXISTING YARD PIPING SHOWN IN APPROXIMATE LOCATION. CONTRACTOR TO FIELD VERIFY AND LOCATE PRIOR TO INSTALLATION OF PROPOSED PIPING AND EQUIPMENT.
3. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

0 40 80
SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

OVERALL YARD PIPING PLAN

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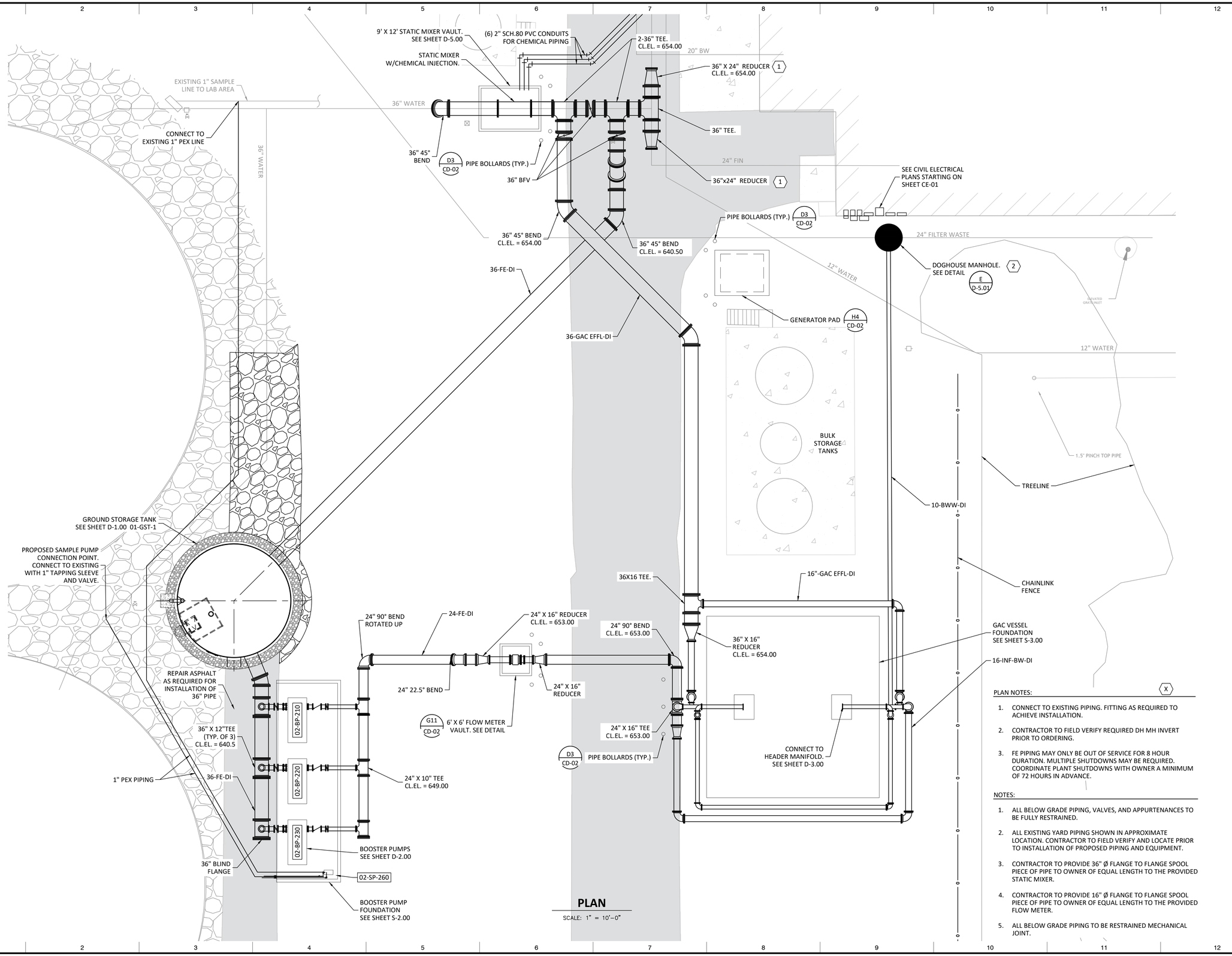

PLAN

SCALE: 1" = 10'-0"

PLAN NOTES: (X)

1. CONNECT TO EXISTING PIPING. FITTING AS REQUIRED TO ACHIEVE INSTALLATION.
2. CONTRACTOR TO FIELD VERIFY REQUIRED DH MH INVERT PRIOR TO ORDERING.
3. FE PIPING MAY ONLY BE OUT OF SERVICE FOR 8 HOUR DURATION. MULTIPLE SHUTDOWNS MAY BE REQUIRED. COORDINATE PLANT SHUTDOWNS WITH OWNER A MINIMUM OF 72 HOURS IN ADVANCE.

NOTES:

1. ALL BELOW GRADE PIPING, VALVES, AND APPURTENANCES TO BE FULLY RESTRAINED.
2. ALL EXISTING YARD PIPING SHOWN IN APPROXIMATE LOCATION. CONTRACTOR TO FIELD VERIFY AND LOCATE PRIOR TO INSTALLATION OF PROPOSED PIPING AND EQUIPMENT.
3. CONTRACTOR TO PROVIDE 36" Ø FLANGE TO FLANGE SPOOL PIECE OF PIPE TO OWNER OF EQUAL LENGTH TO THE PROVIDED STATIC MIXER.
4. CONTRACTOR TO PROVIDE 16" Ø FLANGE TO FLANGE SPOOL PIECE OF PIPE TO OWNER OF EQUAL LENGTH TO THE PROVIDED FLOW METER.
5. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

ENLARGED YARD PIPING PLAN

ALABAMA LICENSED No. 36223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

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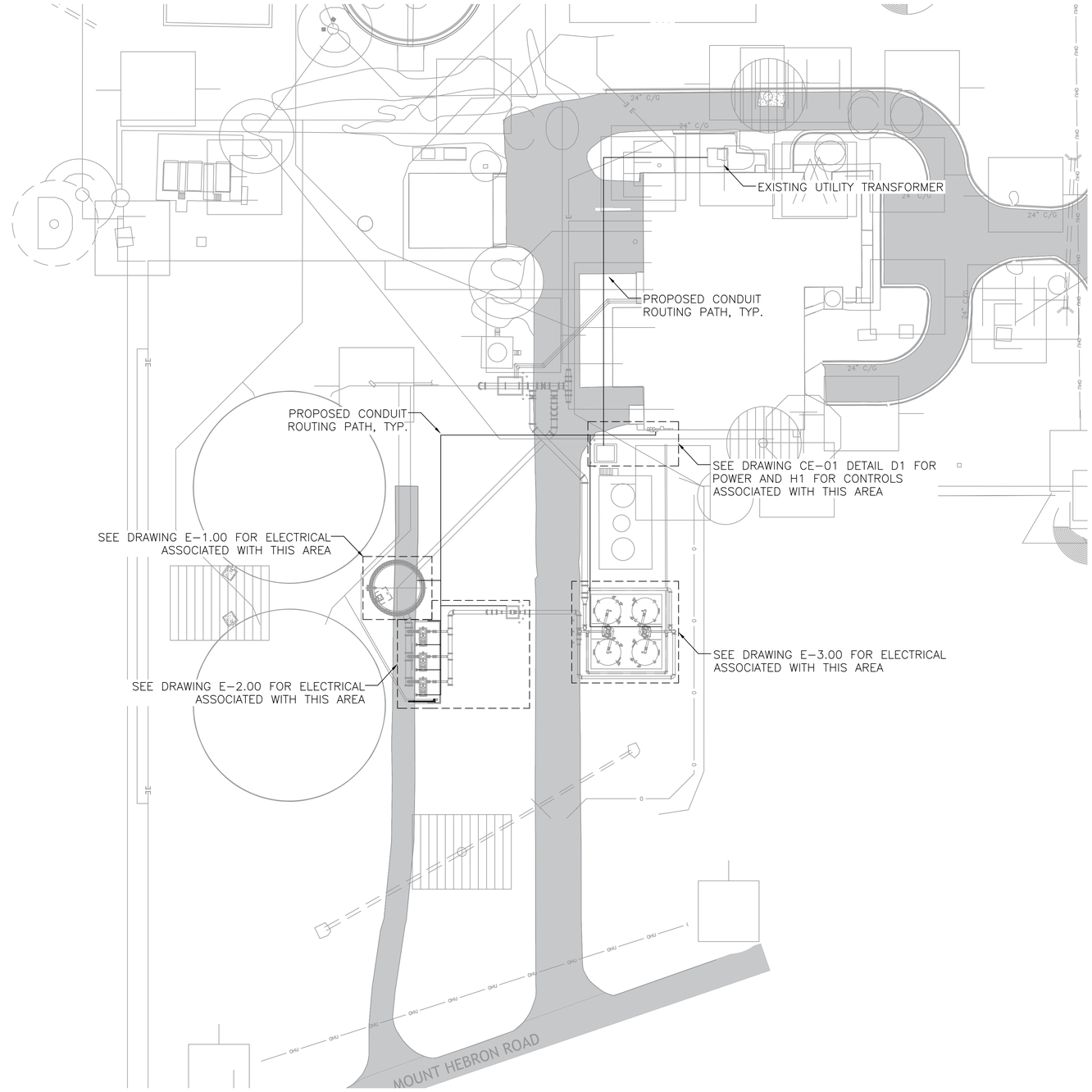

OVERALL ELECTRICAL SITE PLAN

SCALE: 1" = 40'

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

OVERALL ELECTRICAL SITE PLAN

ALABAMA LICENSED NO. 34099-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO:	2024-0776-00
DATE:	07/19/2024

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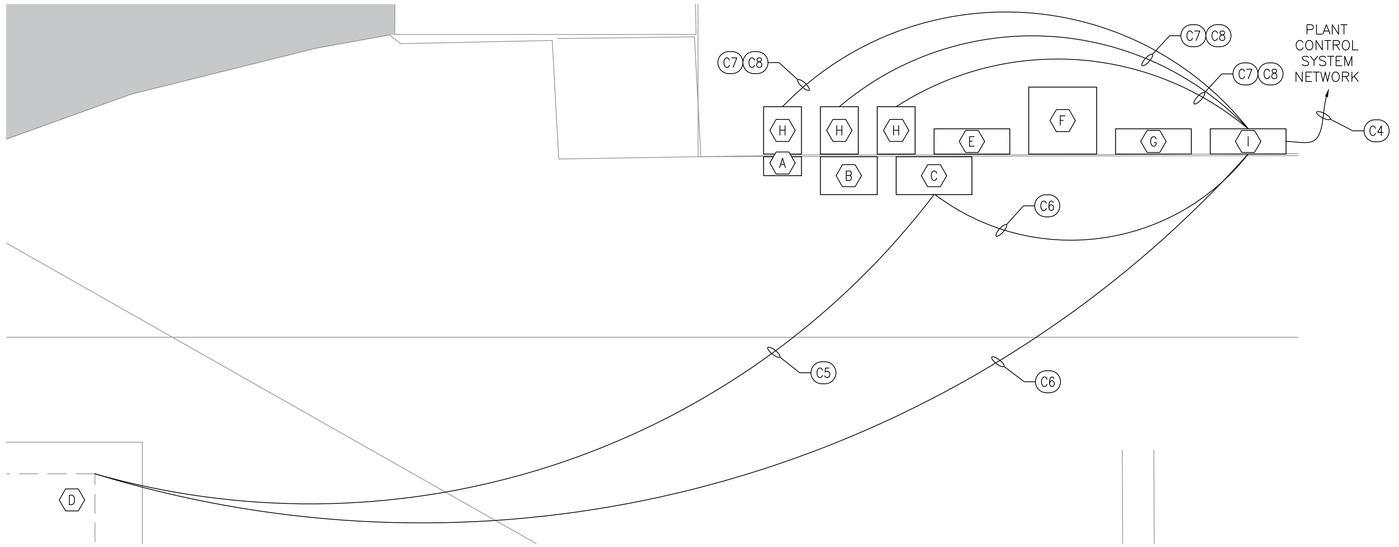
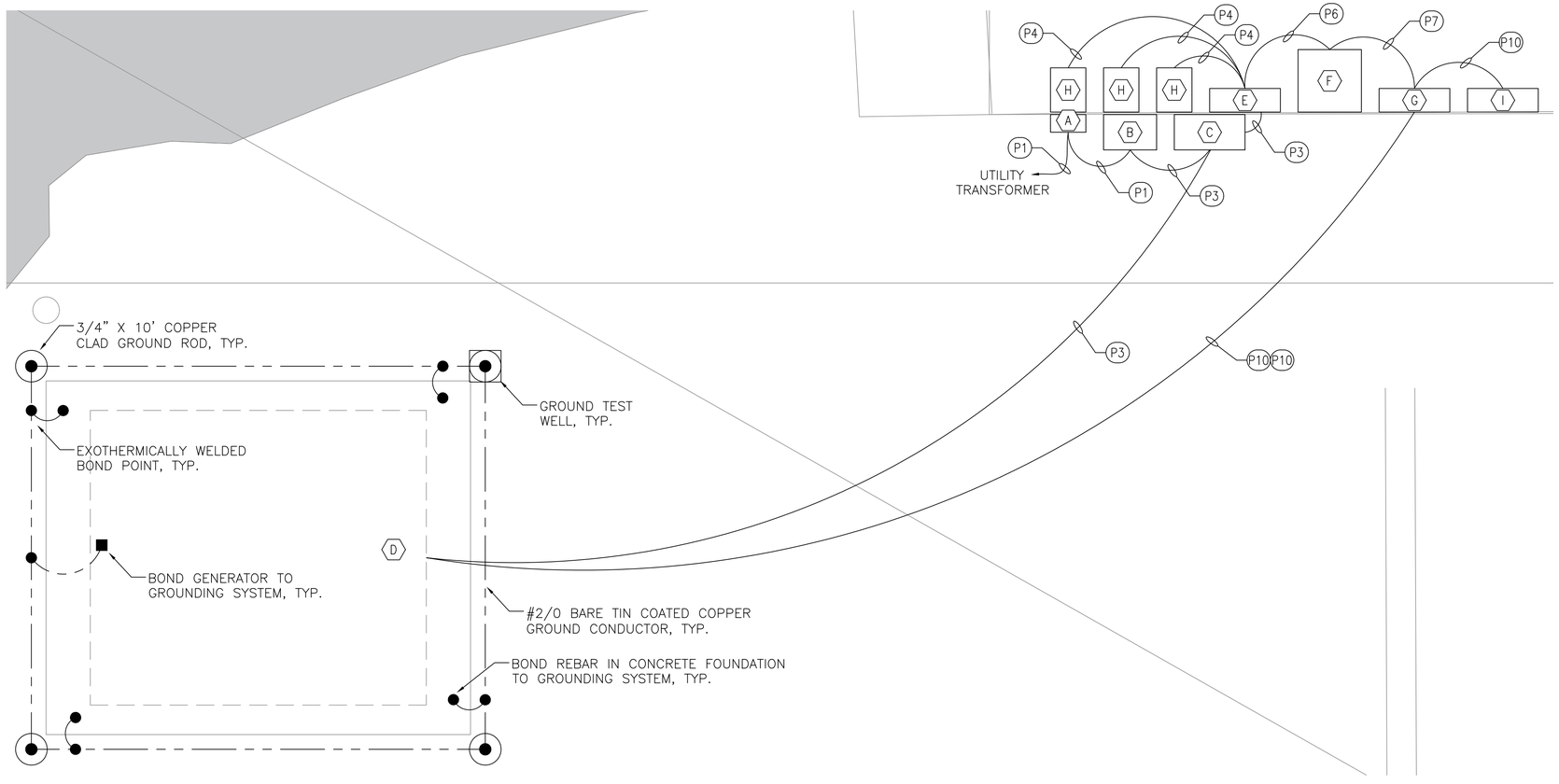


ELECTRICAL DISTRIBUTION EQUIPMENT CONTROL SITE PLAN

SCALE: 1/2" = 1'

KEY NOTES:

- (A) UTILITY METER
- (B) MAIN CIRCUIT BREAKER (MCB)
- (C) AUTOMATIC TRANSFER SWITCH (ATS)
- (D) STANDBY GENERATOR
- (E) BOOSTER PUMP EQUIPMENT DISTRIBUTION PANEL
- (F) PANEL LV TRANSFORMER
- (G) PANEL LV
- (H) WALL MOUNT VFD (TYP. OF 3)
- (I) BOOSTER PUMP RTU



ELECTRICAL DISTRIBUTION EQUIPMENT POWER SITE PLAN

SCALE: 1/2" = 1'

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

ELECTRICAL DISTRIBUTION EQUIPMENT

ALABAMA LICENSED PROFESSIONAL ENGINEER
No. 34899-E
DANIEL COLE STEVENSON
7/11/25

JOB NO: 2024-0776-00
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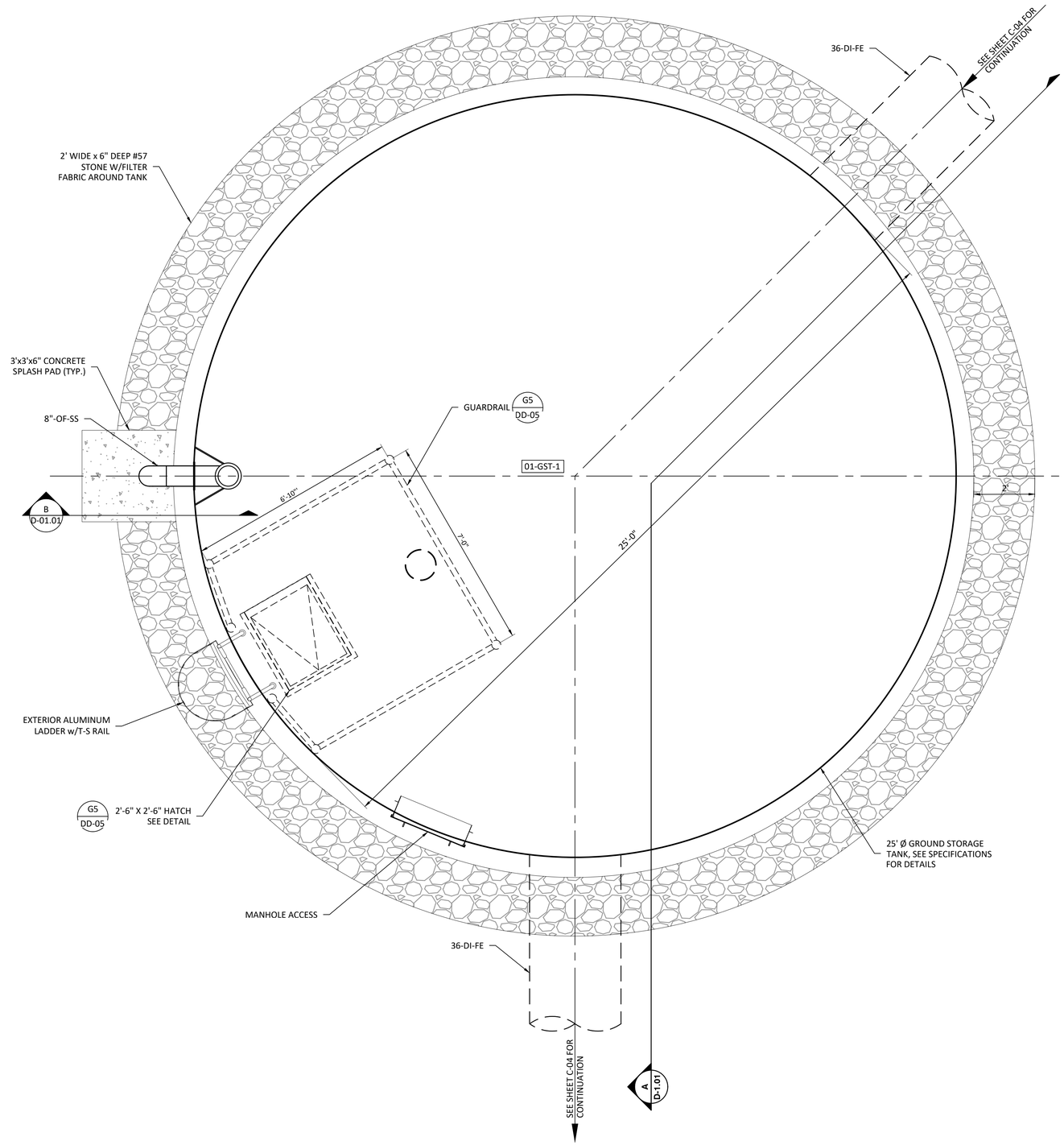

PLAN

SCALE: 1/2" = 1'-0"

NOTE:

1. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

N

0 4 8

SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GROUND STORAGE TANK PLAN

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN

07/11/2025

JOB NO: 2024-0776-00
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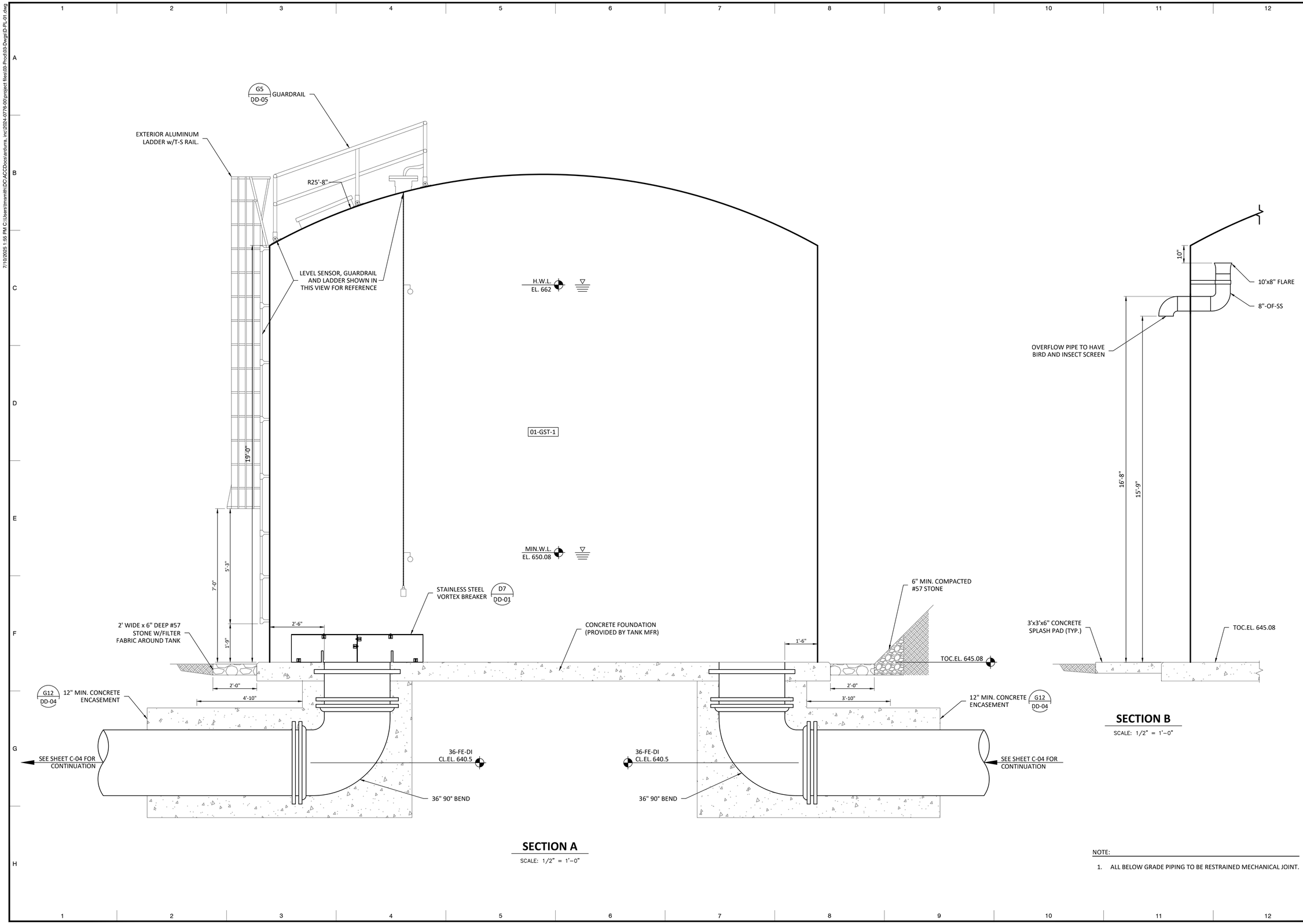

SECTION A

SCALE: 1/2" = 1'-0"

SECTION B

SCALE: 1/2" = 1'-0"

NOTE:

1. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

0 4 8

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GROUND STORAGE TANK SECTIONS

ALABAMA LICENSED No. 36223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO:	2024-0776-00
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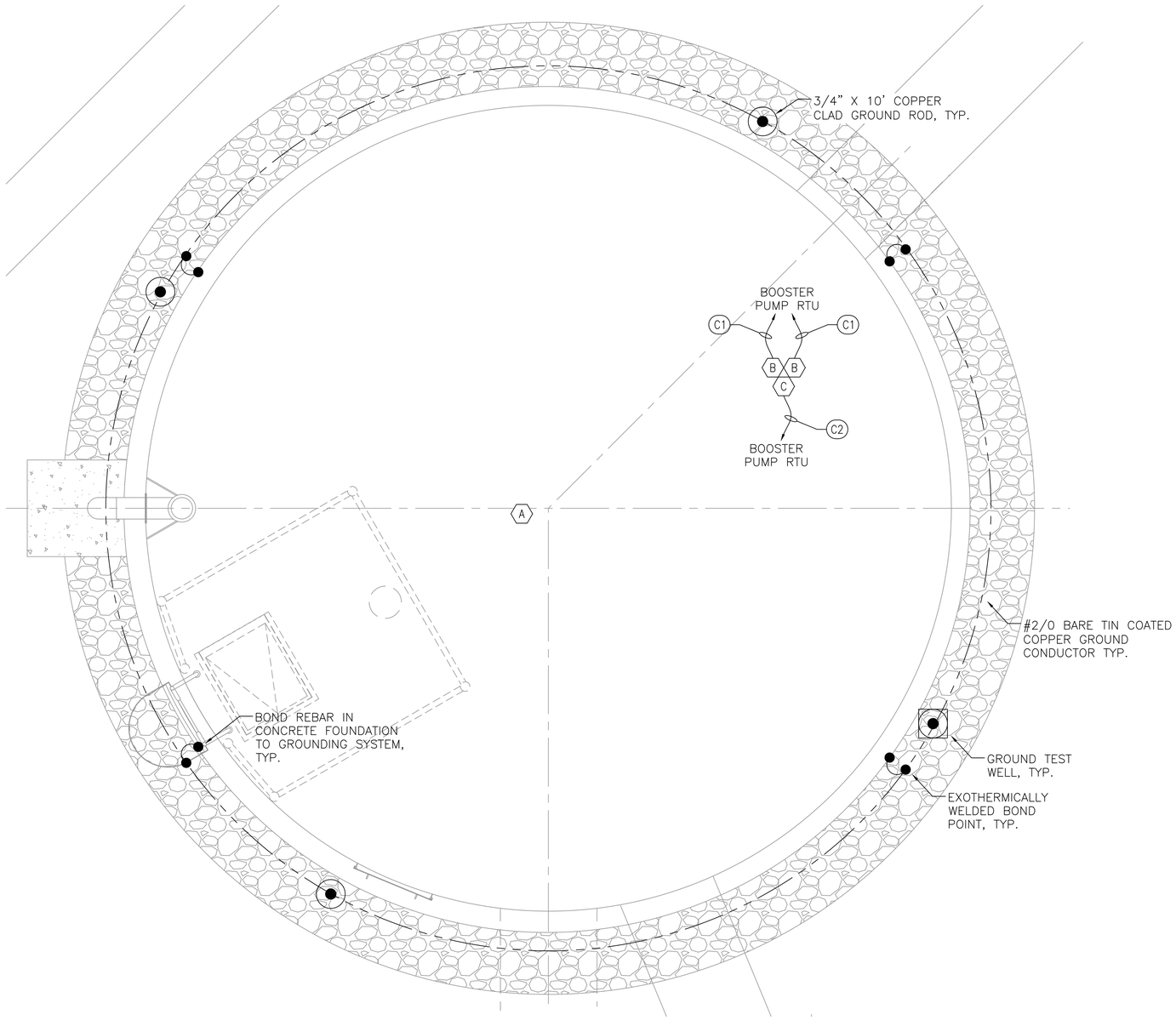
KEY NOTES:

A STORAGE TANK

B FLOAT SWITCH, TYP. OF 2

C SUBMERSIBLE LEVEL TRANSDUCER



STORAGE TANK ELECTRICAL PLAN

SCALE: 1/2" = 1'

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GROUND STORAGE TANK ELECTRICAL PLAN

ALABAMA LICENSED No. 34099-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO:	2024-0776-00
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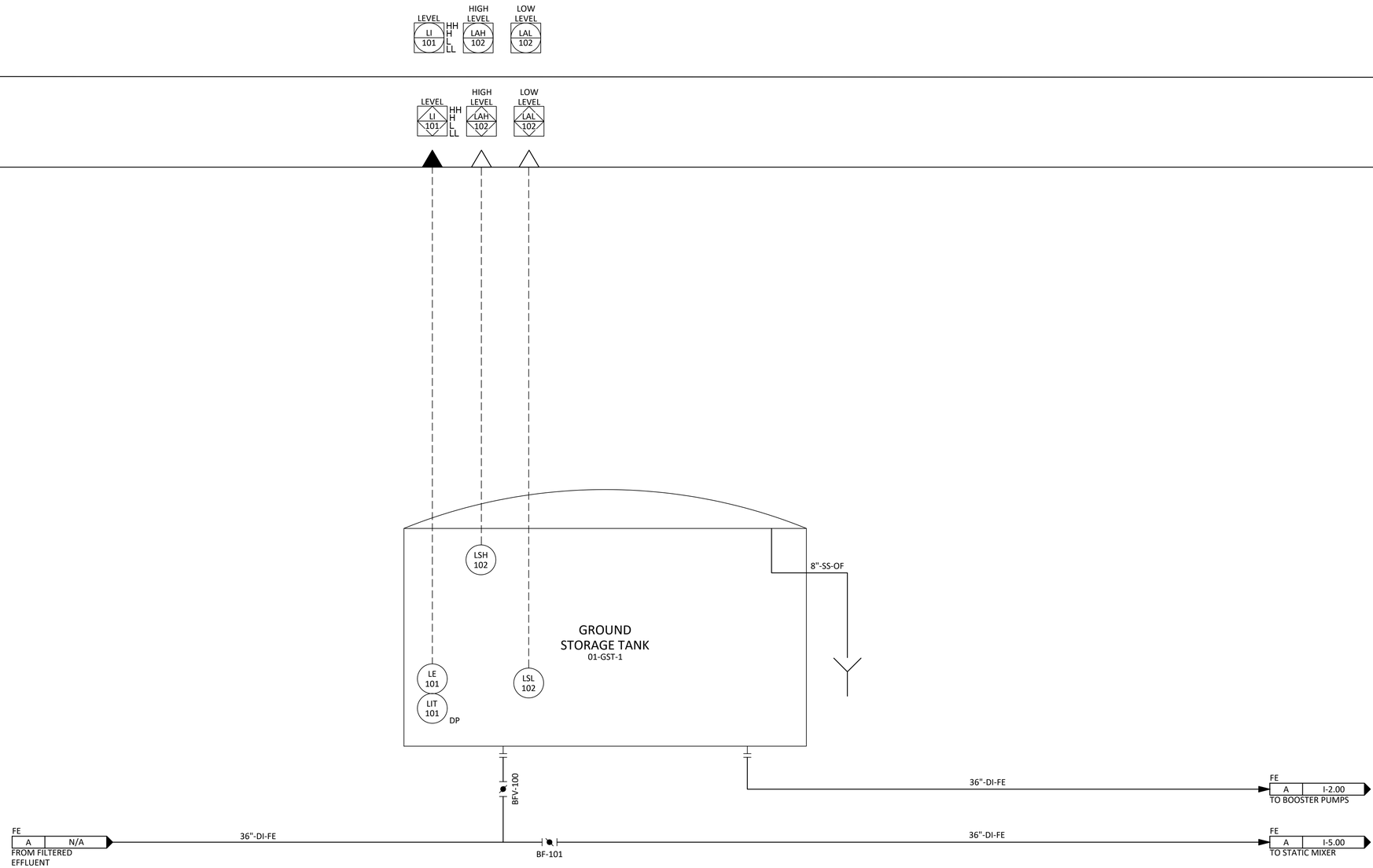
SCADA/HMI

02-BPRTU-1

FIELD PANELS

PROCESS



GENERAL NOTES

1. SEE LEGEND AND ABBREVIATIONS ON DRAWING G-06 AND G-07.
2. LOCAL CONTROL DEVICES SUCH AS INDICATING LIGHTS AND SWITCHES, LOCATED ON MCCs OR AT EQUIPMENT, MAY NOT BE INDICATED ON THE P&ID.
3. PROVIDE SURGE PROTECTION ON ANALOG CIRCUITS THAT RUN OUTDOORS.
4. IN CASE OF ANY DISCREPANCIES OR VARIANCES BETWEEN THE P&IDs AND THE MECHANICAL DRAWINGS, THE MECHANICAL DRAWINGS SHALL PREVAIL. THIS ALSO APPLIES TO VENDOR PACKAGE EQUIPMENT.

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GROUND STORAGE TANK PROCESS AND INSTRUMENTATION DIAGRAM

ALABAMA LICENSED P.E. NO. 34890-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

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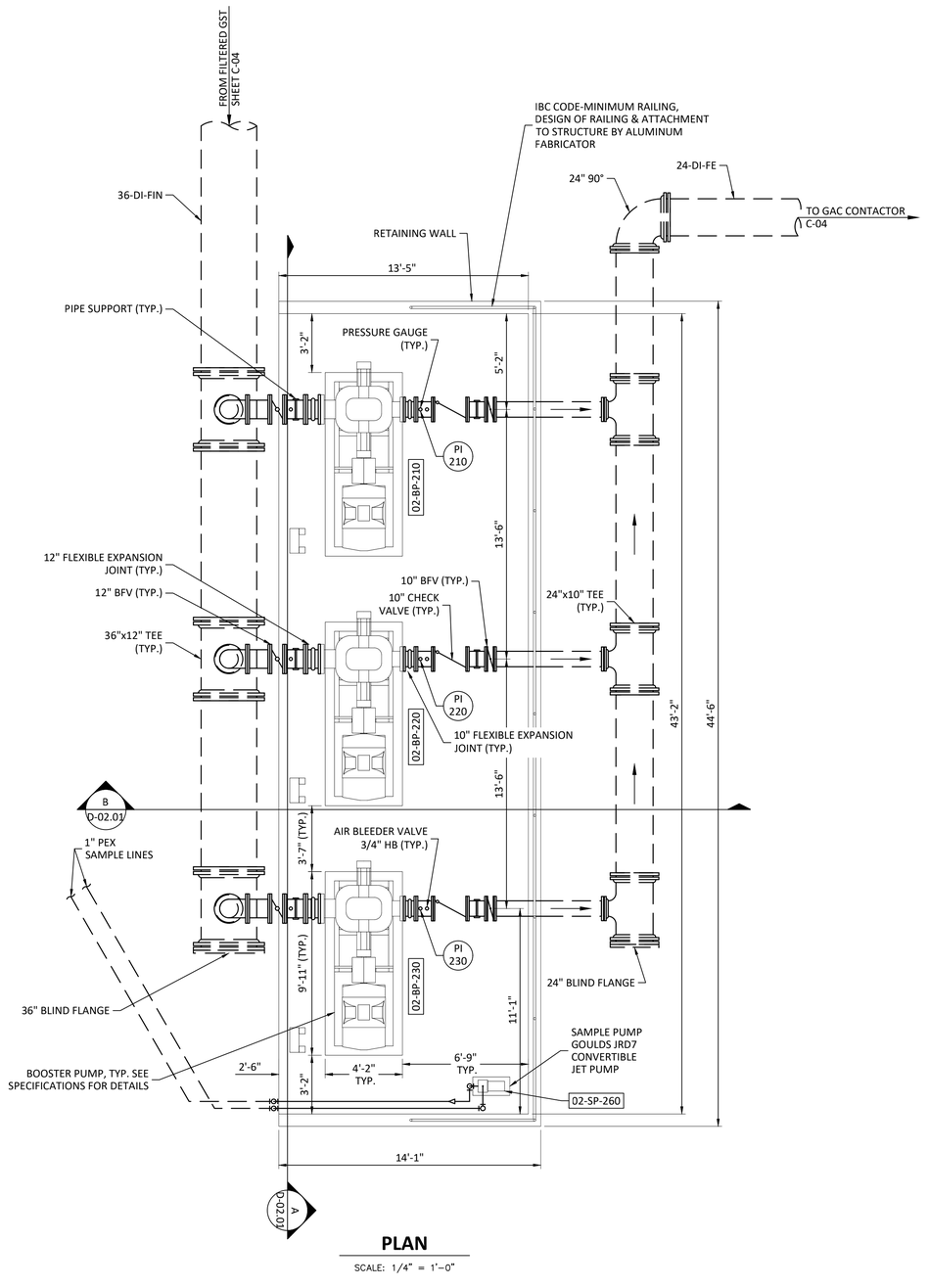

PLAN

SCALE: 1/4" = 1'-0"

NOTE:

1. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

BOOSTER PUMPS

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

D-2.00

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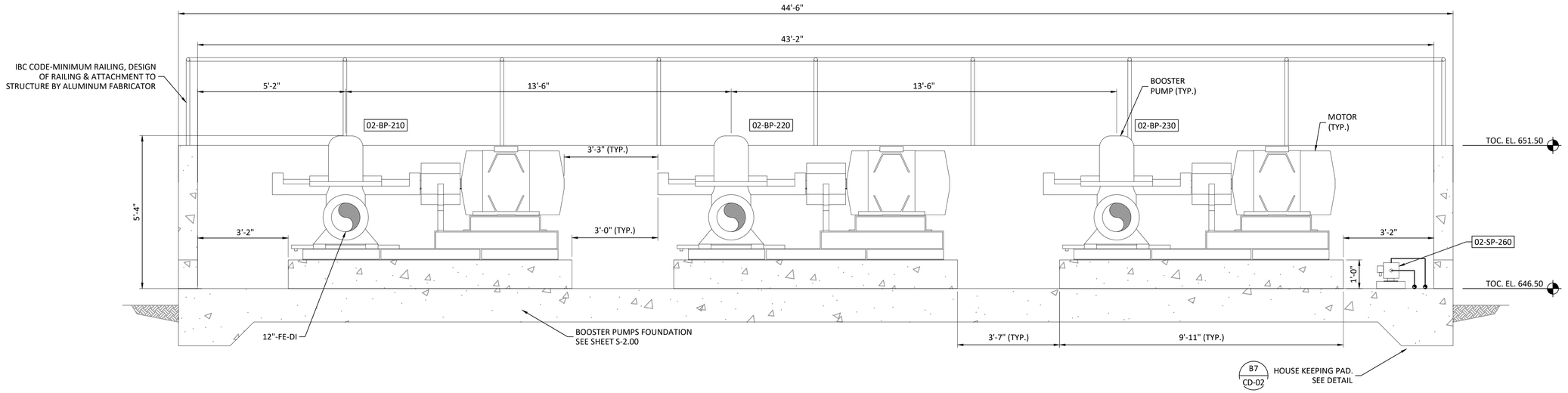
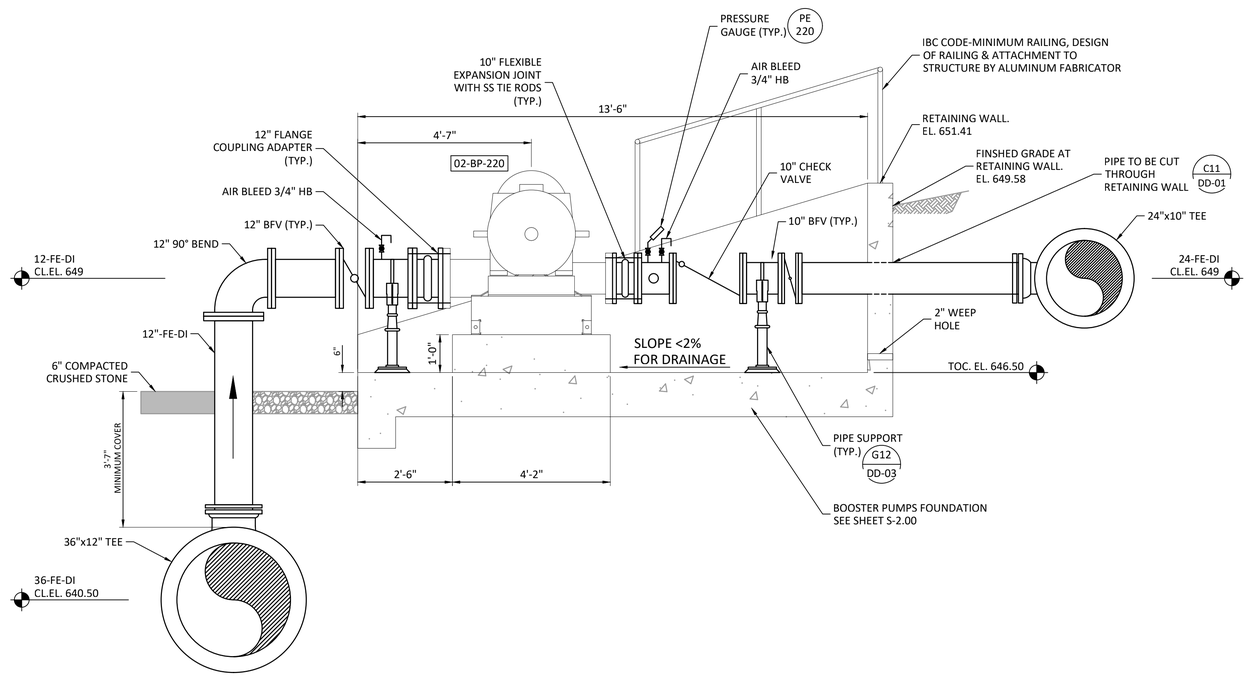


SECTION A

SCALE: 1/2" = 1'-0"



SECTION B

SCALE: 1/2" = 1'-0"

NOTE:

1. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

0 2 4
SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

BOOSTER PUMPS SECTIONS

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

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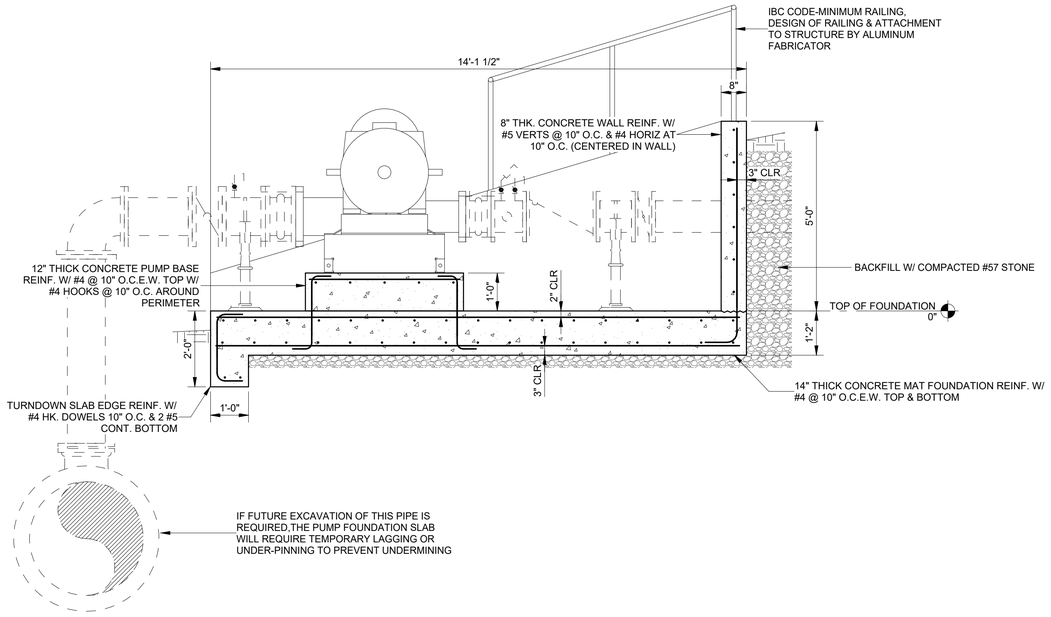
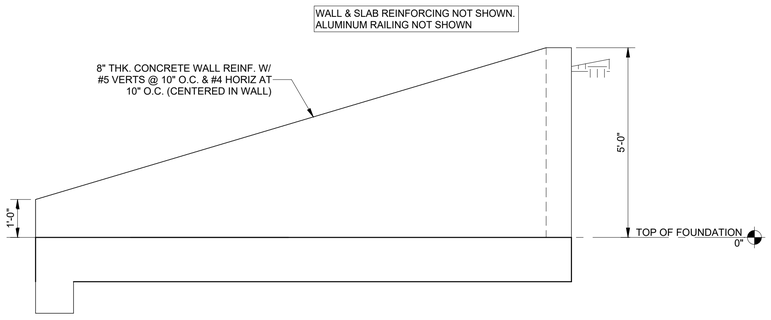


(BOOSTER PUMP PAD SECTION)

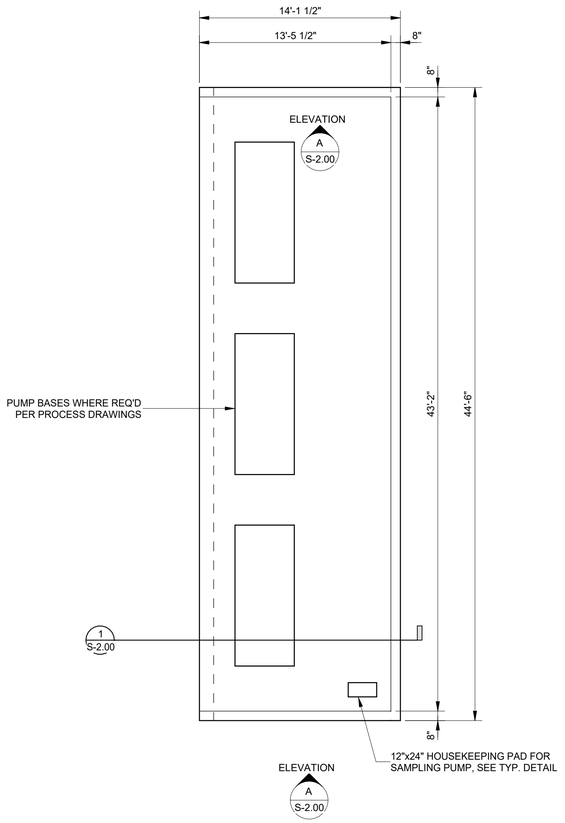
1 / S-2.00 SECTION

1/2" = 1'-0"



A / S-2.00 ELEVATION

1/2" = 1'-0"



BOOSTER PUMP FOUNDATION PLAN

3/16" = 1'-0"

SCALE: AS INDICATED

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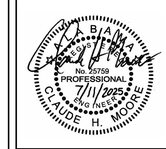
CENTRAL ELMORE WTP UPGRADE

BOOSTER PUMPS FOUNDATION PLAN & SECTIONS



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Echols, Lindsey & Moore
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Suite 21
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Phone: 256.864.2542
Project No. 24185

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KEY NOTES:

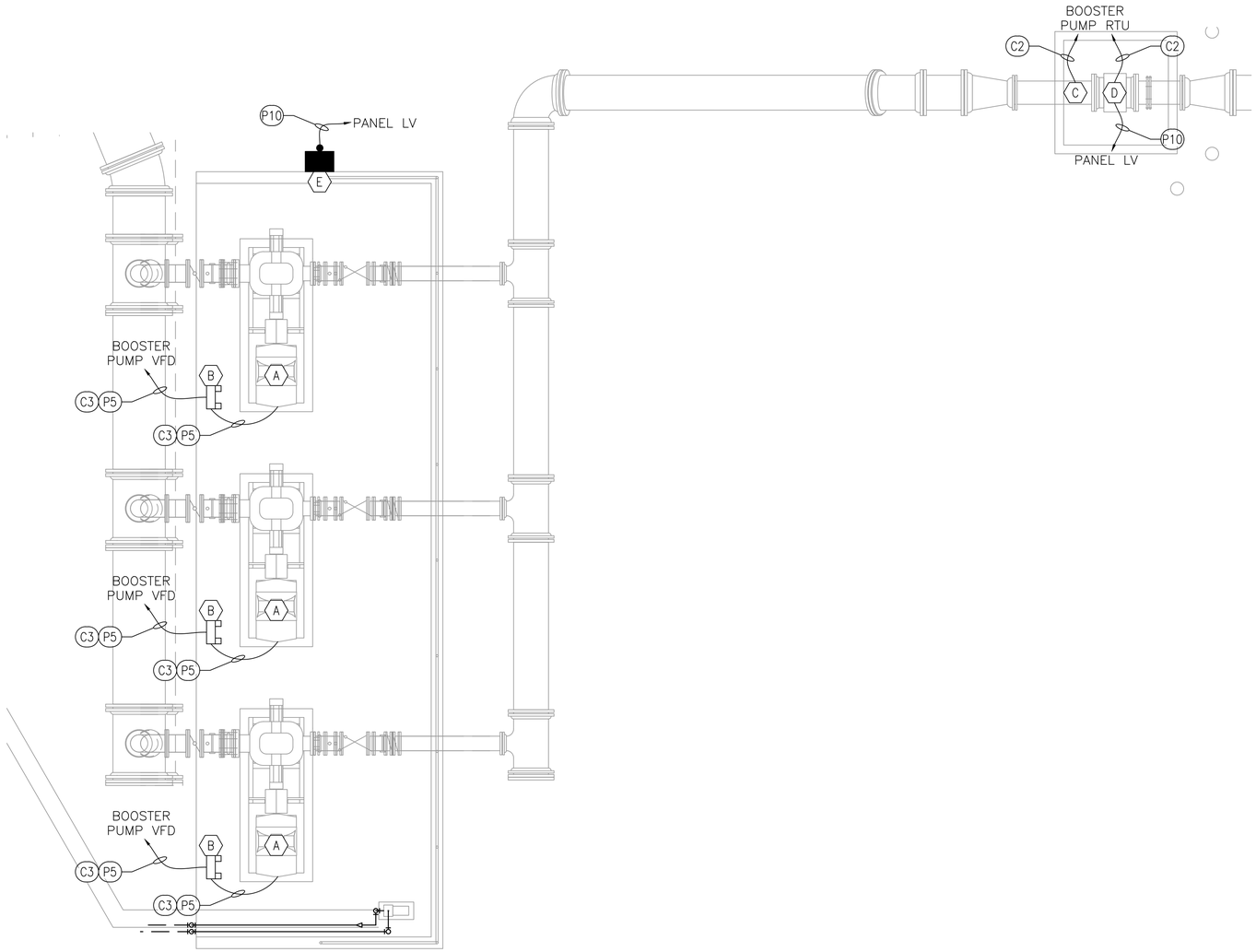
(A) BOOSTER PUMP, TYP. OF 3

(B) DISCONNECT SWITCH, TYP OF 3

(C) PRESSURE TRANSDUCER

(D) FLOW METER

(E) AREA LIGHT. SHALL BE AN LSI SMA-LED-28L-ACR-3-UNV-DIM-40-BRZ-PM FIXTURE (OR APPROVED EQUAL) PROVIDED WITH A 10' POLE, INTEGRATED RECEPTACLE, AND SWITCH. SEE DRAWING ED-20 FOR DETAIL.



BOOSTER PUMP ELECTRICAL PLAN

SCALE: 1/4" = 1'

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

BOOSTER PUMPS ELECTRICAL PLAN

ALABAMA LICENSED No. 34089-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON 7/11/25

JOB NO: 2024-0776-00
DATE: 07/19/2024

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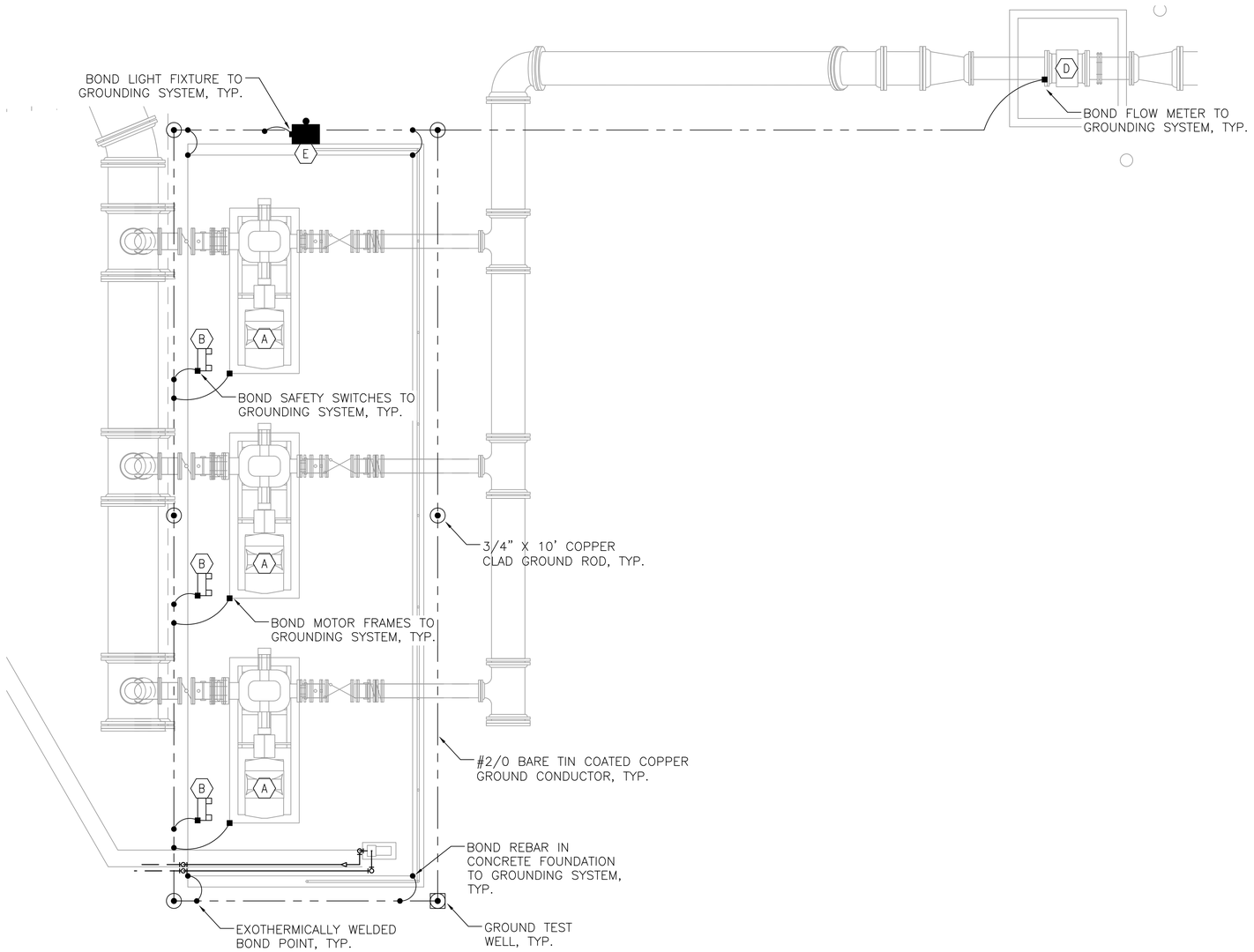
KEY NOTES:

- (A) BOOSTER PUMP, TYP. OF 3
- (B) DISCONNECT SWITCH, TYP OF 3
- (C) PRESSURE TRANSDUCER
- (D) FLOW METER
- (E) AREA LIGHT



BOOSTER PUMP GROUNDING PLAN

SCALE: 1/4" = 1'

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

BOOSTER PUMPS GROUNDING PLAN

ALABAMA LICENSED PROFESSIONAL ENGINEER
No. 34689-E
7/11/25
DANIEL COLE STEVENSON

JOB NO:	2024-0776-00
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SCADA/HMI

DESIRED TANK LEVEL — LC 200

IN REMOTE — YI 210 | RUNNING — YIR 210 | FAULT — UA 210 | SPEED FDBK — SI 210

IN REMOTE — YI 220 | RUNNING — YIR 220 | FAULT — UA 220 | SPEED FDBK — SI 220

IN REMOTE — YI 230 | RUNNING — YIR 230 | FAULT — UA 230 | SPEED FDBK — SI 230

FLOW — FI 250

LEAD PUMP START LEVEL — LC 204A | LEAD PUMP STOP LEVEL — LC 204B | LAG PUMP START LEVEL — LC 204C | LAG PUMP STOP LEVEL — LC 204D

02-BPRTU-1

IN REMOTE — YI 210 | RUNNING — YIR 210 | FAULT — UA 210 | START/STOP — UCS 210 | SPEED FDBK — SI 210 | SPEED CMD — SC 210A

IN REMOTE — YI 220 | RUNNING — YIR 220 | FAULT — UA 220 | START/STOP — UCS 220 | SPEED FDBK — SI 220 | SPEED CMD — SC 220A

IN REMOTE — YI 230 | RUNNING — YIR 230 | FAULT — UA 230 | START/STOP — UCS 230 | SPEED FDBK — SI 230 | SPEED CMD — SC 230A

FLOW — FI 250

MAIN PANELS

FIELD PANELS

480 V — 02-VFD-210 — LOR — HS 210, SC 210, YIR 210, UA 210, SS — HS 210, SI 210

480 V — 02-VFD-220 — LOR — HS 220, SC 220, YIR 220, UA 220, SS — HS 220, SI 220

480 V — 02-VFD-230 — LOR — HS 230, SC 230, YIR 230, UA 230, SS — HS 230, SI 230

120 V — FIT 250, FE 250 — M — VALVE VAULT

PROCESS

FE A I-1.00 — FROM STORAGE TANK — 36"-DI-FE

ARV — BFV-210A — 02-BP-210 — PI 210 — ARV — CKV-210 — 10"-DI-FE — BFV-210B

BOOSTER PUMP PUMP 1 4200 @ 60 TDH

24"-DI-FE — 16"-DI-FE — 16"-DI-FE — 24"-DI-FE — FE A I-3.00 — TO GAC VESSELS

ARV — BFV-220A — 02-BP-220 — PI 220 — ARV — CKV-220 — 10"-DI-FE — BFV-220B

BOOSTER PUMP PUMP 2 4200 @ 60 TDH

ARV — BFV-230A — 02-BP-230 — PI 230 — ARV — CKV-230 — 10"-DI-FE — BFV-230B

BOOSTER PUMP PUMP 3 4200 @ 60 TDH

SMP A N/A — FROM EXISTING SAMPLE LINE — 1"-PEX-SMP — BV-260A — 1 1/4"-PEX-SMP — 120 V — 02-SP-260 — SAMPLE PUMP 1 — BV-260B — 1"-PEX-SMP — 1"-PEX-SMP — A N/A — SAMPLE LINE TO LAB AREA

GENERAL NOTES

1. SEE LEGEND AND ABBREVIATIONS ON DRAWING G-06 AND G-07.
2. LOCAL CONTROL DEVICES SUCH AS INDICATING LIGHTS AND SWITCHES, LOCATED ON MCCs OR AT EQUIPMENT, MAY NOT BE INDICATED ON THE P&ID.
3. PROVIDE SURGE PROTECTION ON ANALOG CIRCUITS THAT RUN OUTDOORS.
4. IN CASE OF ANY DISCREPANCIES OR VARIANCES BETWEEN THE P&IDs AND THE MECHANICAL DRAWINGS, THE MECHANICAL DRAWINGS SHALL PREVAIL. THIS ALSO APPLIES TO VENDOR PACKAGE EQUIPMENT.

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

BOOSTER PUMPS PROCESS AND INSTRUMENTATION DIAGRAM

ALABAMA LICENSED No. 34699-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON 7/11/2025

JOB NO: 2024-0776-00
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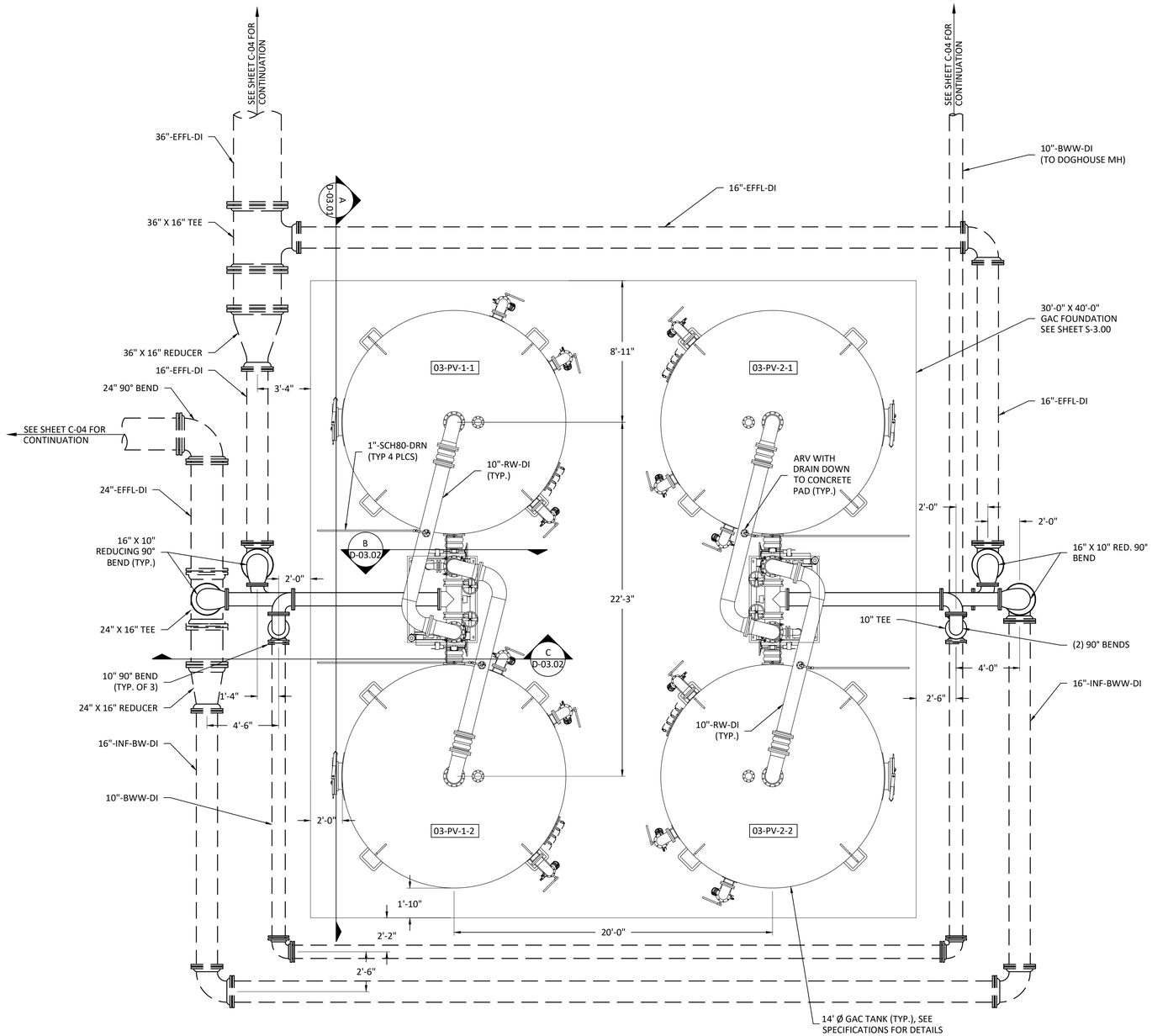

PLAN

SCALE: 1/4" = 1'-0"

NOTE:

1. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GAC VESSELS PLAN

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

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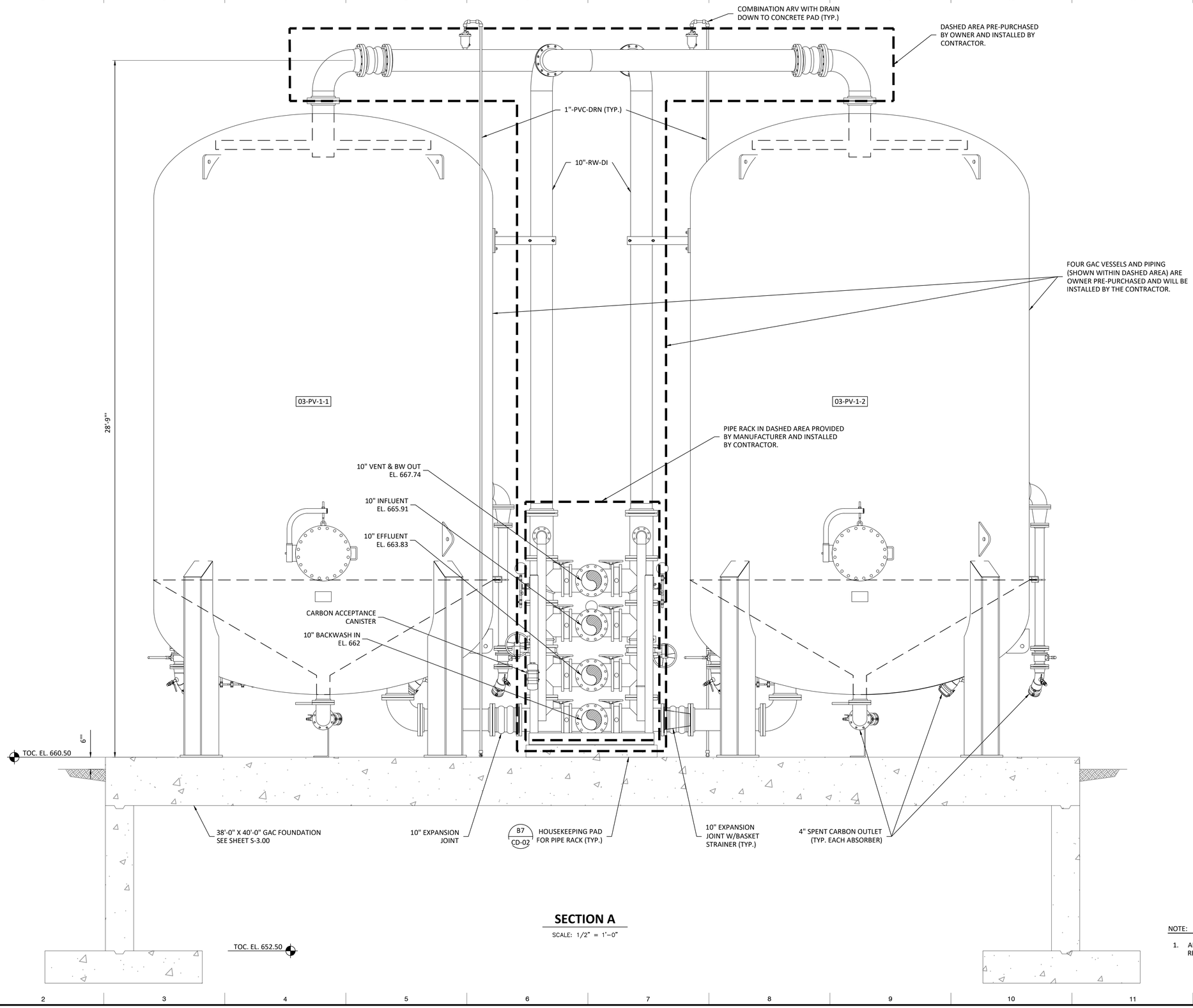

SECTION A

SCALE: 1/2" = 1'-0"

NOTE:

1. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

0 2 4
SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GAC VESSELS SECTION

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

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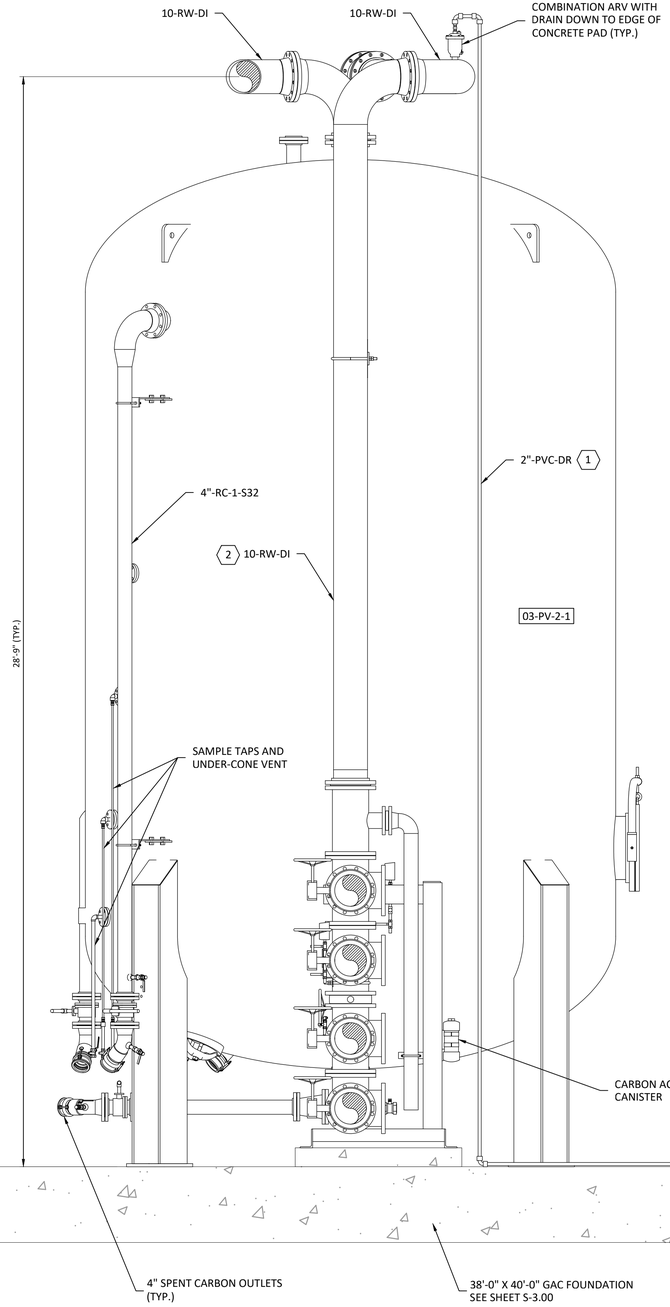
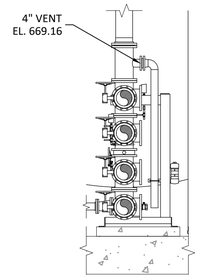


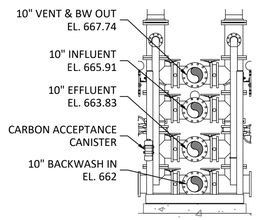
SECTION B

SCALE: 1/2" = 1'-0"



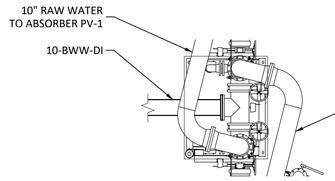
PIPE RACK LEFT

SCALE: 1/4" = 1'-0"



PIPE RACK FRONT

SCALE: 1/4" = 1'-0"



PIPE RACK PLAN

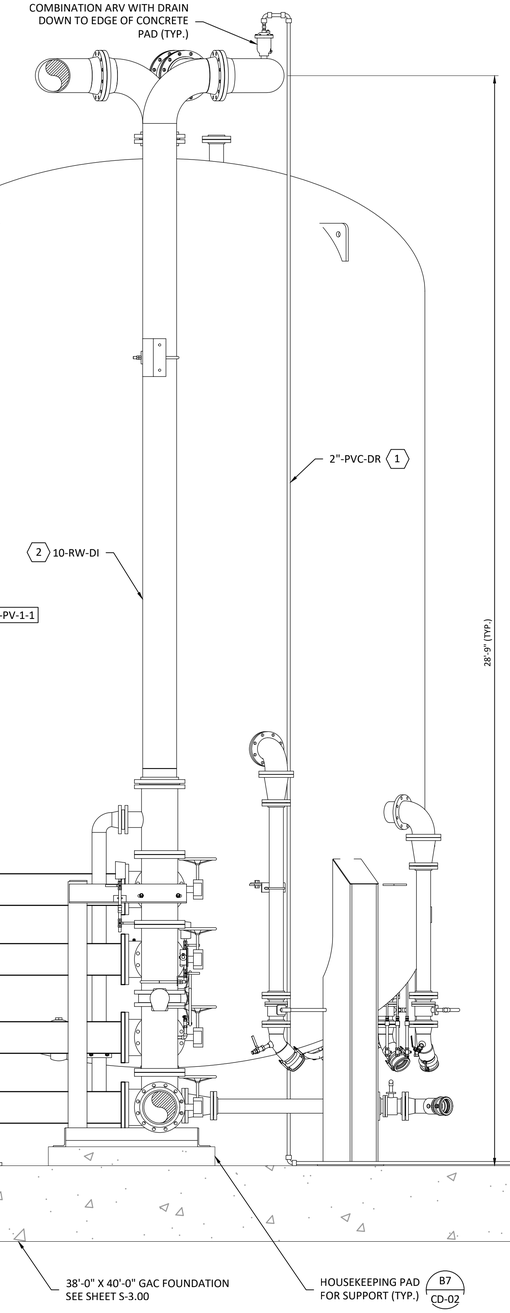
SCALE: 1/4" = 1'-0"

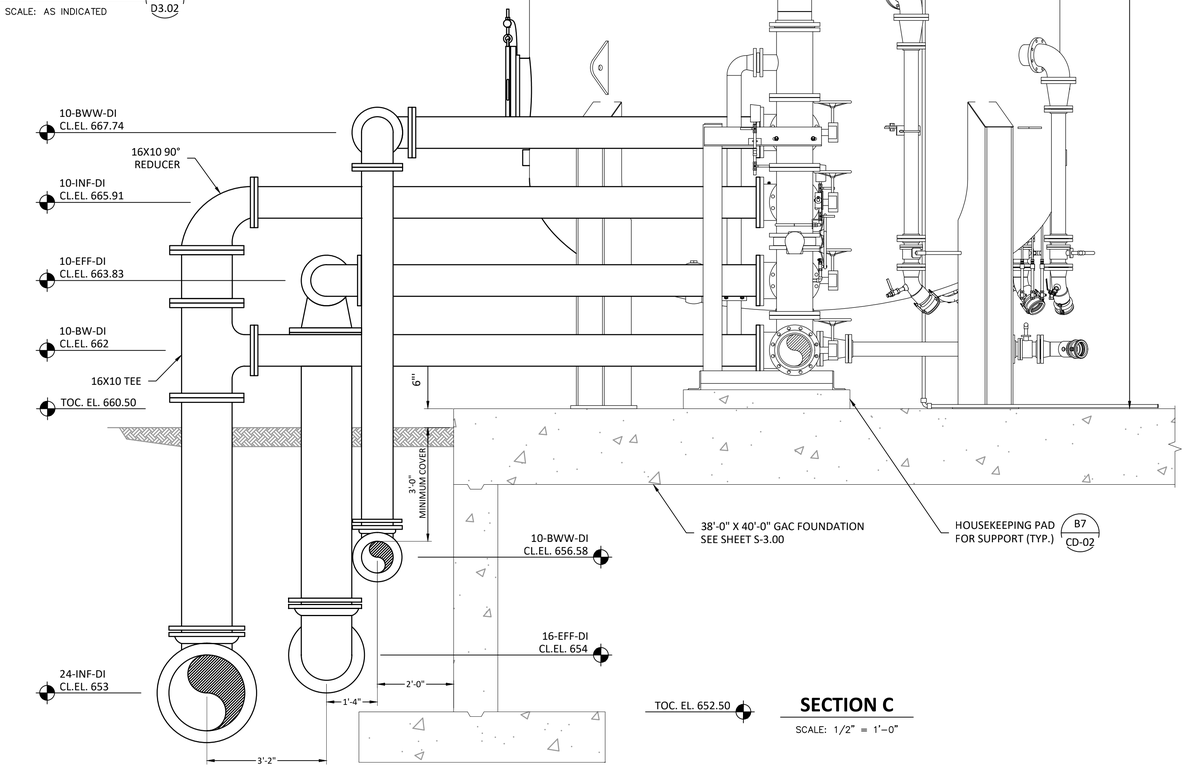
NOTE:

1. ORIENTATION OF THE PIPE RACK PLAN SHOWN IS FOR GAC VESSELS 03-PV-1-1 AND 03-PV-1-2, FOR GAC VESSELS 03-PV-2-1 AND 03-PV-2-2 ROTATE 180°.

PIPE RACK DETAIL (D / D3.02)

SCALE: AS INDICATED





SECTION C

SCALE: 1/2" = 1'-0"

PLAN NOTES :

1. CONTRACTOR TO PROVIDE PIPE AND HARDWARE FOR DRAIN PIPE TO BE SECURED TO GAC TANK.
2. CONTRACTOR TO SECURE PIPE TO GAC TANK AS INDICATED BY MANUFACTURER WITH BRACKETS PROVIDED BY MANUFACTURER.

NOTES:

1. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

SCALE: FEET
0 2 4

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GAC VESSELS SECTIONS AND DETAILS

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

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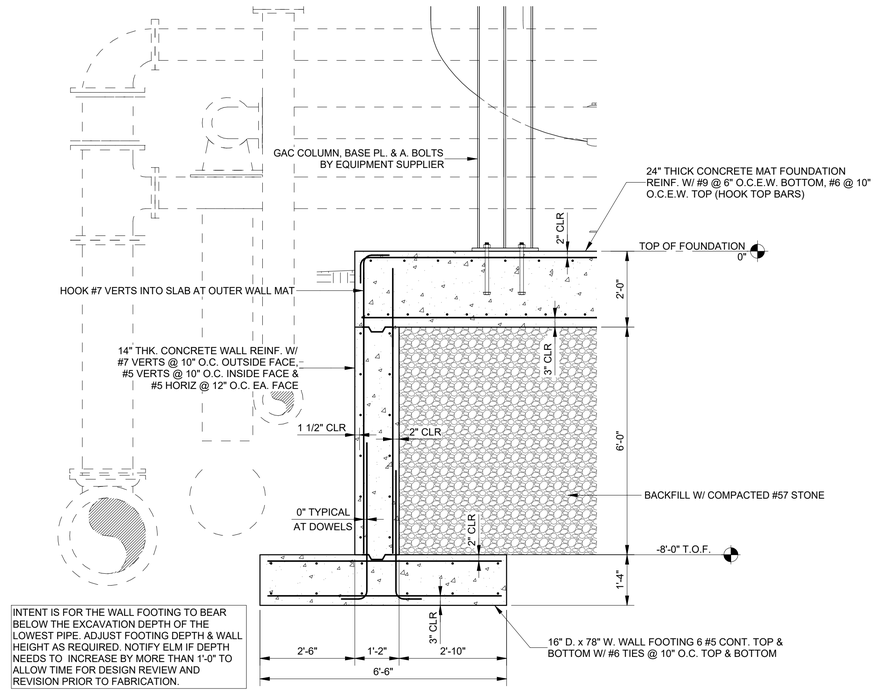
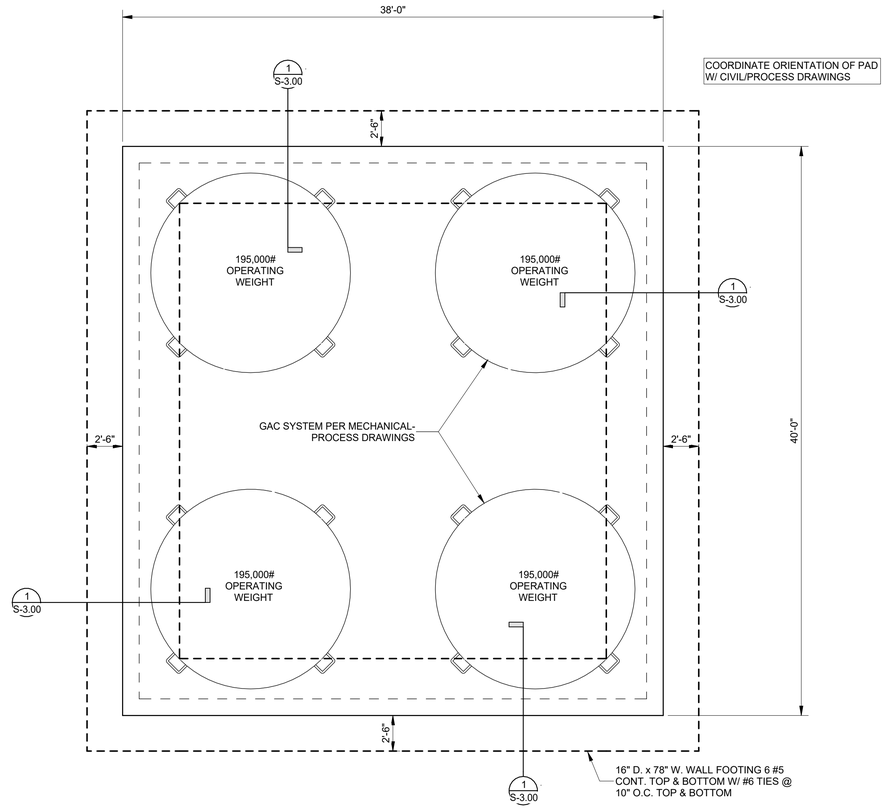


INTENT IS FOR THE WALL FOOTING TO BEAR BELOW THE EXCAVATION DEPTH OF THE LOWEST PIPE. ADJUST FOOTING DEPTH & WALL HEIGHT AS REQUIRED. NOTIFY ELM IF DEPTH NEEDS TO INCREASE BY MORE THAN 1'-0" TO ALLOW TIME FOR DESIGN REVIEW AND REVISION PRIOR TO FABRICATION.

(GAC FOUNDATION SECTION)

1 / S-3.00 SECTION

1/2" = 1'-0"



GAC FOUNDATION PLAN

3/16" = 1'-0"

SCALE: AS INDICATED

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CENTRAL ELMORE WTP UPGRADE

GAC FOUNDATION PLAN & SECTION

BAM
No. 25759
PROFESSIONAL
7/11/2025
ENGINEER
CLAUDE H. MOORE

JOB NO: 2024-0776-00
DATE: 7/11/25

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Phone: 256.864.2542
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Structural Engineers, Inc.
Project No. 24185

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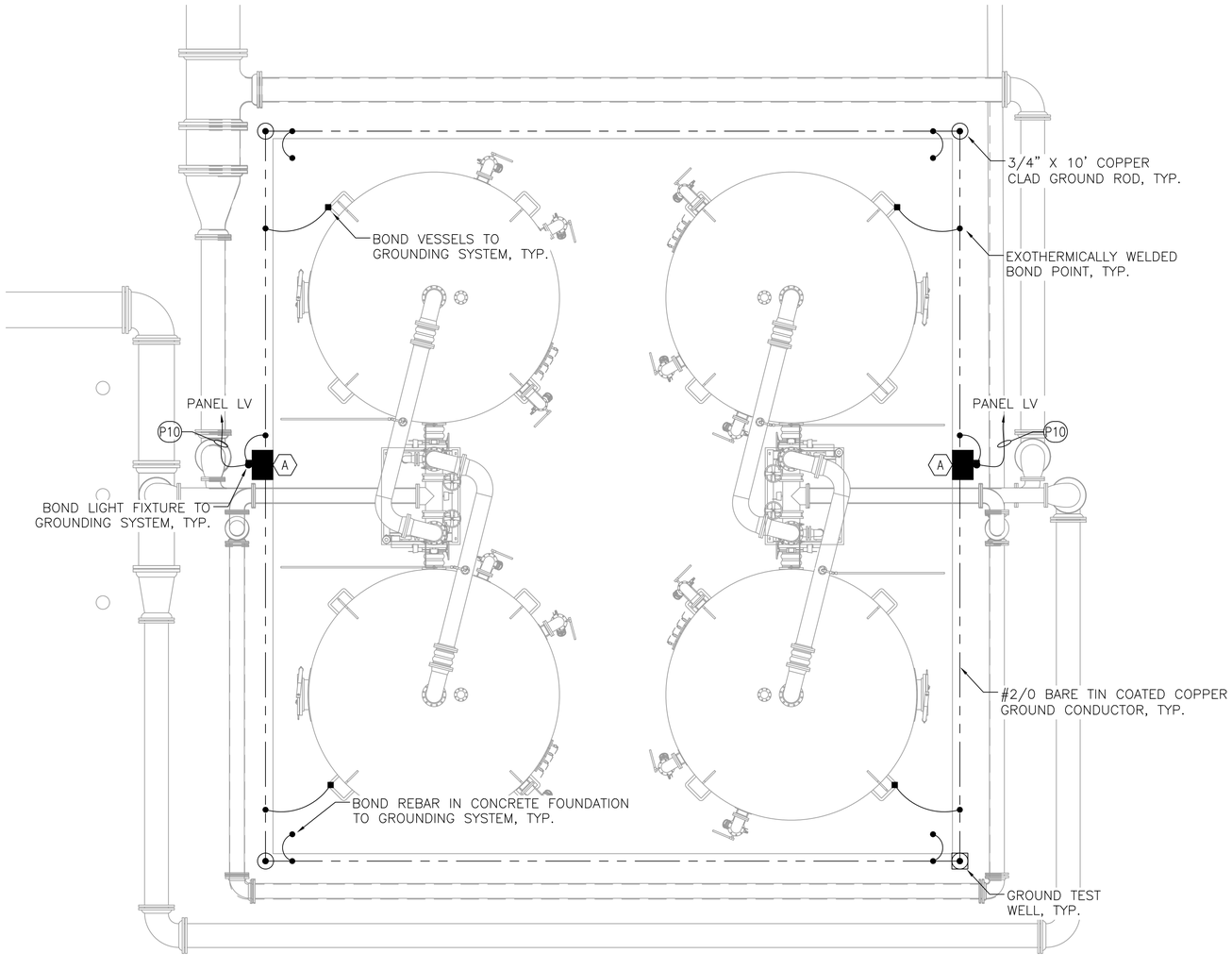
KEY NOTES:

(A) AREA LIGHT, TYPICAL OF 2. SHALL BE AN LSI SMA-LED-28L-ACR-3-UNV-DIM-40-BRZ-PM FIXTURE (OR APPROVED EQUAL) PROVIDED WITH A 10' POLE, INTEGRATED RECEPTACLE, AND SWITCH. SEE DRAWING ED-20 FOR DETAIL.



GAC ELECTRICAL PLAN

SCALE: 1/4" = 1'

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NO.	DATE	REVISION	BY
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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GAC ELECTRICAL PLAN

ALABAMA LICENSED No. 34699-E PROFESSIONAL ENGINEER 7/11/25 DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

E-3.00

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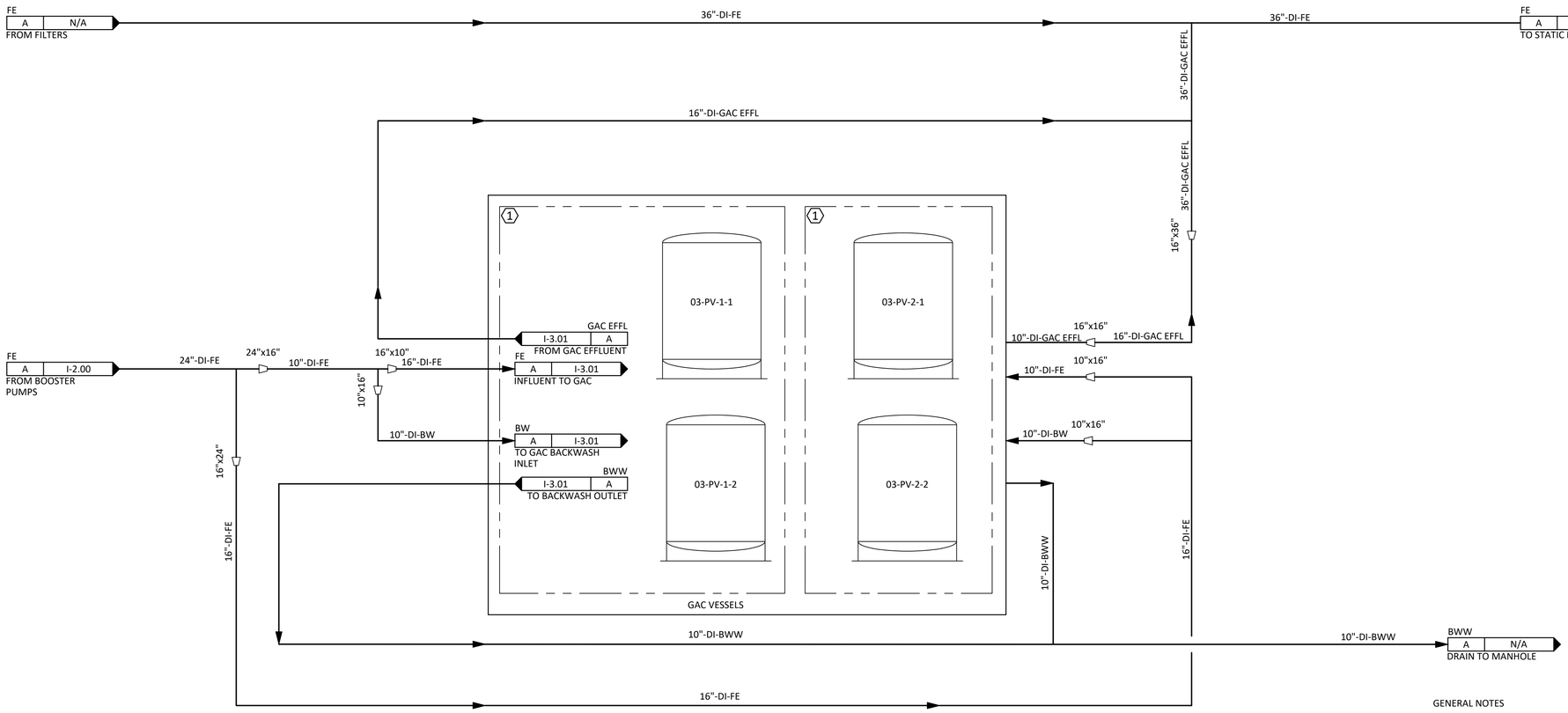
SCADA/HMI

PLCA

MAIN PANELS

FIELD PANELS

PROCESS



GENERAL NOTES

1. SEE LEGEND AND ABBREVIATIONS ON DRAWING G-06 AND G-07.
2. LOCAL CONTROL DEVICES SUCH AS INDICATING LIGHTS AND SWITCHES, LOCATED ON MCCs OR AT EQUIPMENT, MAY NOT BE INDICATED ON THE P&ID.
3. PROVIDE SURGE PROTECTION ON ANALOG CIRCUITS THAT RUN OUTDOORS.
4. IN CASE OF ANY DISCREPANCIES OR VARIANCES BETWEEN THE P&IDs AND THE MECHANICAL DRAWINGS, THE MECHANICAL DRAWINGS SHALL PREVAIL. THIS ALSO APPLIES TO VENDOR PACKAGE EQUIPMENT.

KEYED NOTES

1 PROVIDED BY VENDOR. REFER TO P&ID SHEET I-3.01.

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

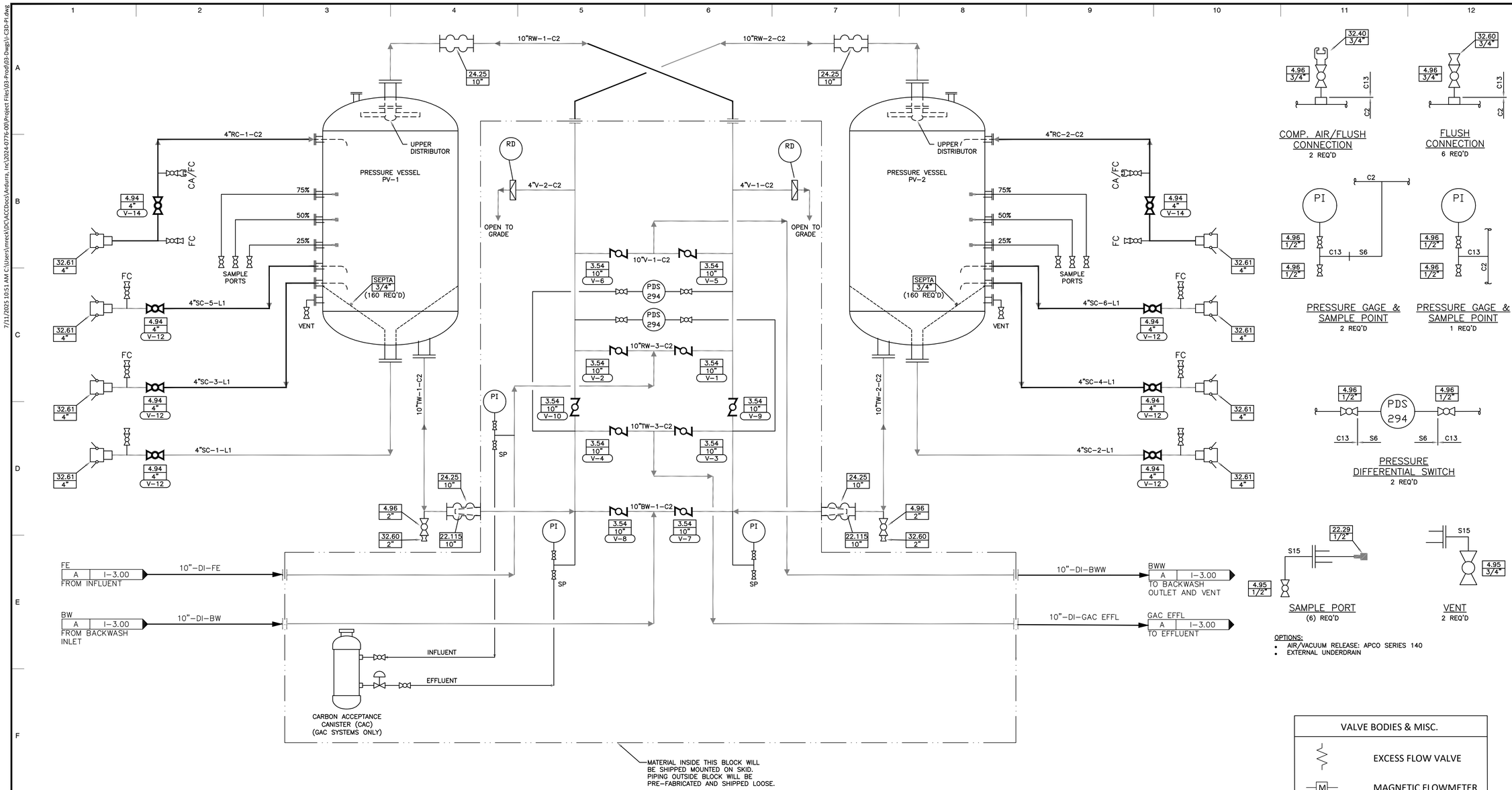
GAC VESSELS PROCESS AND INSTRUMENTATION DIAGRAM 1 OF 2

ALABAMA LICENSED No. 34899-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

I-3.00

100% ISSUE FOR BID
07/11/2025



OPTIONS:
- AIR/VACUUM RELEASE: APCO SERIES 140
- EXTERNAL UNDERDRAIN

VALVE BODIES & MISC.	
	EXCESS FLOW VALVE
M	MAGNETIC FLOWMETER
	VORTEX FLOWMETER
MF	MASS FLOWMETER
	ROTAMETER
	CHEMICAL SEAL
	THERMOWELL
	CAMLOCK FITTING
	RUPTURE DISC
	EXPANSION JOINT
	PNEUMATIC ACTUATOR & POSITIONER

GENERAL NOTES

1. VENDOR PROVIDED P&ID FOR INFORMATION ONLY. NO INSTRUMENTATION OR CONTROLS ARE ASSOCIATED WITH THIS PACKAGE.
2. IN CASE OF ANY DISCREPANCIES OR VARIANCES BETWEEN THE P&IDs AND THE MECHANICAL DRAWINGS, THE MECHANICAL DRAWINGS SHALL PREVAIL.

MEDIA	SPECIALTIES	DESIGN CONDITIONS	LEGEND	VESSELS	UTILITY REQUIREMENTS
MEDIA: GAC QUANTITY PER VESSEL: 60,000 LBS. OF GAC SERVICE: POTABLE WATER (NSF/ANSI 61 CERTIFIED)	PRESSURE INDICATOR: 0-160 PSIG, WIKA 232.XX RUPTURE DISK: 125 PSIG BURST PRESSURE (CCC SPEC. ISO44) PRESSURE DIFFERENTIAL SWITCH: ORANGE RESEARCH, 0-20-0 PSIG	FLOW RATE: 2600GPM (SERIES) 5200GPM (PARALLEL) INFLUENT PRESSURE: 100 PSIG MAX. INFLUENT TEMP.: 120°F MAX. BACKWASH RATE: T.B.D. GPM @ 55°F. ELECTRIC POWER:120 V, 60~ SINGLE PHASE, 15 AMP	BW - BACKWASH WATER FC - FLUSH CONNECTION RC - REACT.(OR VIRGIN) CARBON RW - RAW WATER SC - SPENT CARBON SLURRY SP - SAMPLE PORT TW - TREATED WATER V - VENT	14'-0" O.D. x 17'-0" S.S. ASME 2:1 ELLIPTICAL TOP AND BOTTOM HEADS. CARBON STEEL CONSTRUCTION. ASME SECT. VIII, DIV. 1 125 PSIG @ 140°F DESIGN. LINING TO BE FORCE CURED PER NSF/ANSI 61 PLASITE 4110, BLOME TL-22S AR OR REACTAMINE 760 SEPTA: ORTHOS C2 OR FEDERAL SCREEN	AIR, CARBON TRANSFER - 100 SCFM @ 30 PSIG MIN. PLANT WATER - 100 GPM @ 30 PSIG MIN. WIRING - MIN. AWG #16 TO PDS 294

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

GAC VESSELS PROCESS AND INSTRUMENTATION DIAGRAM 2 OF 2

ALABAMA LICENSED No. 34089-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON 7/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

I-3.01

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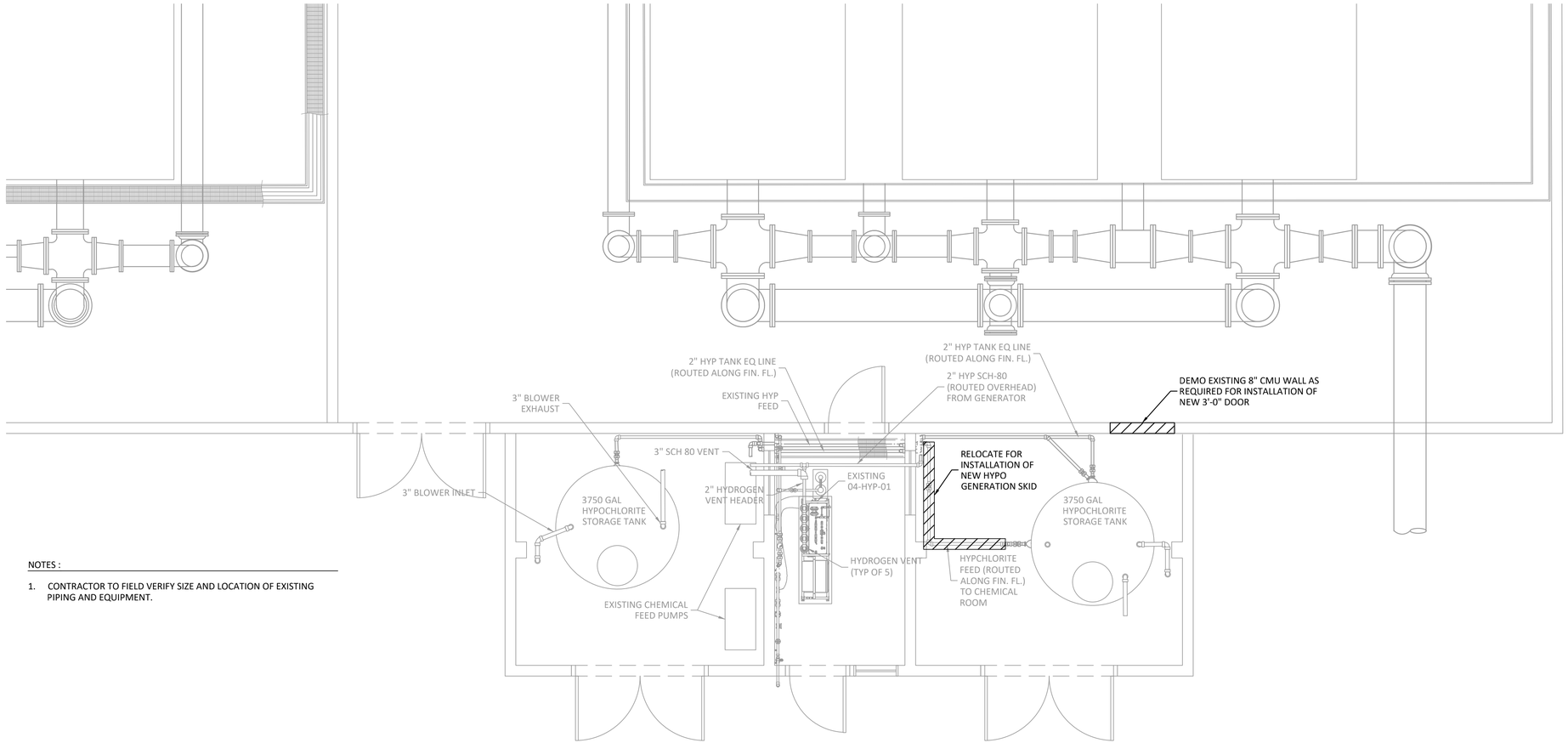

PLAN

SCALE: 1/4" = 1'-0"

NOTES :

1. CONTRACTOR TO FIELD VERIFY SIZE AND LOCATION OF EXISTING PIPING AND EQUIPMENT.

NOTE:

1. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.

0 48 96

SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

EXISTING SODIUM HYPOCHLORITE GENERATION AND DEMOLITION PLAN

ALABAMA LICENSED No. 36223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

D-4.00

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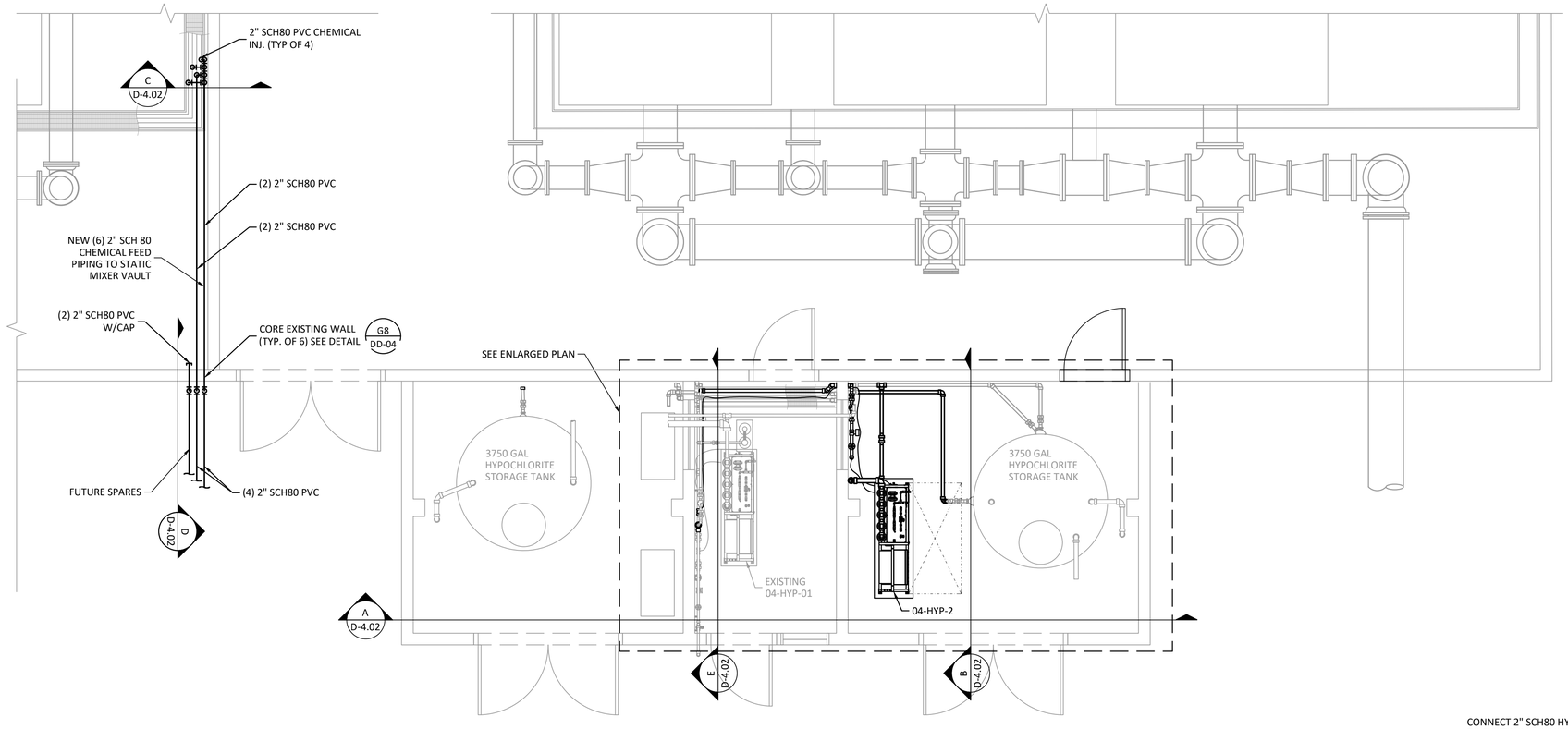
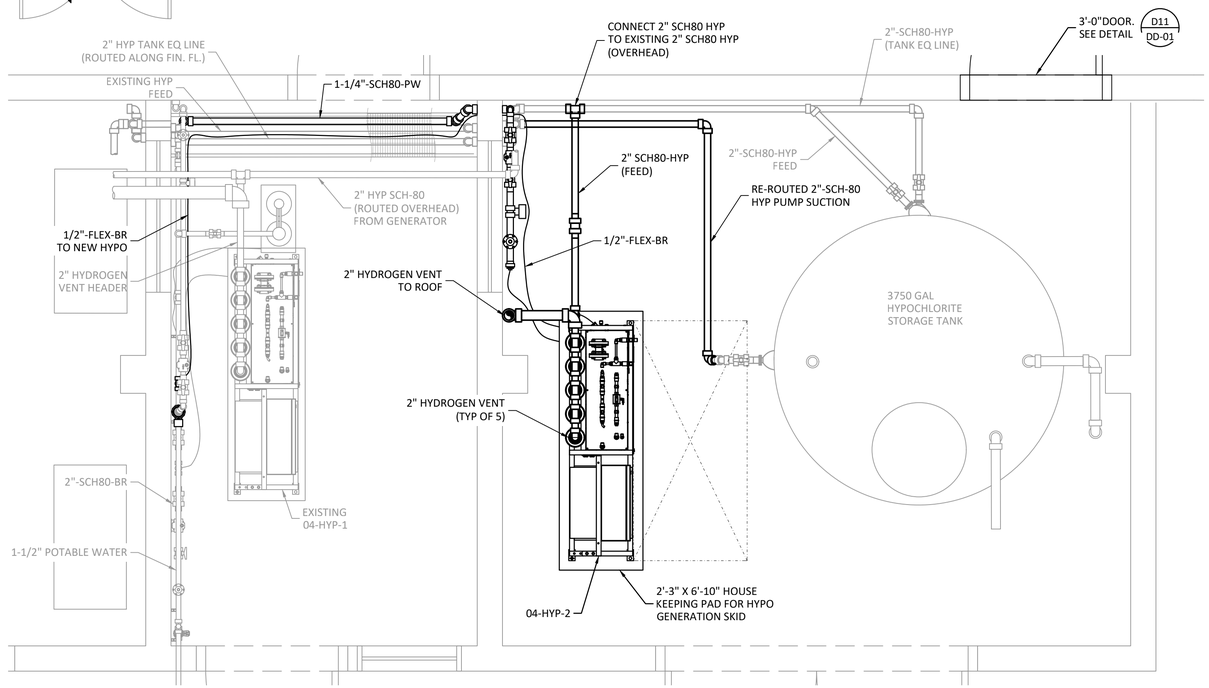


PLAN

SCALE: 1/4" = 1'-0"



ENLARGED PLAN

SCALE: 1/2" = 1'-0"

SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

SODIUM HYPOCHLORITE GENERATION SYSTEM PLAN

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

D-4.01

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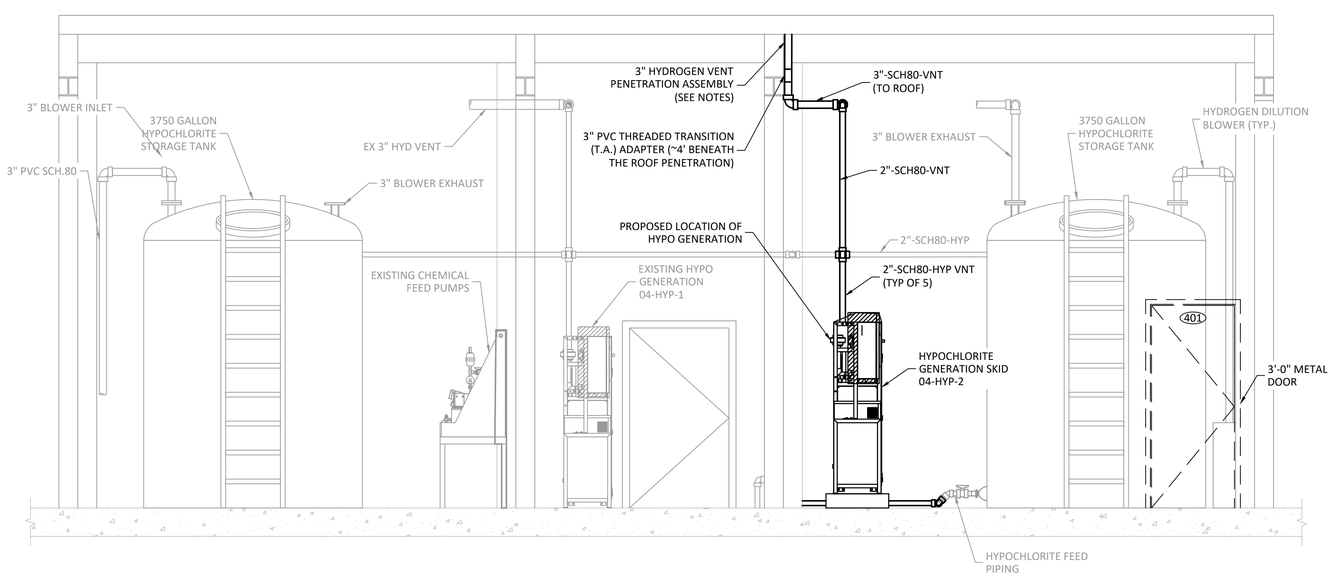
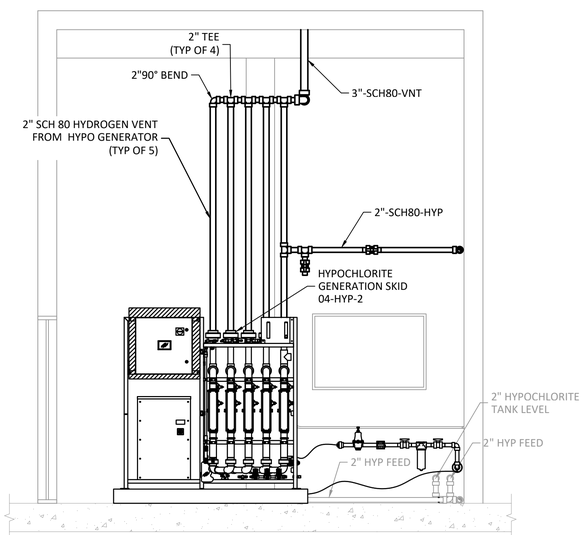


SECTION A

SCALE: 3/8" = 1'-0"

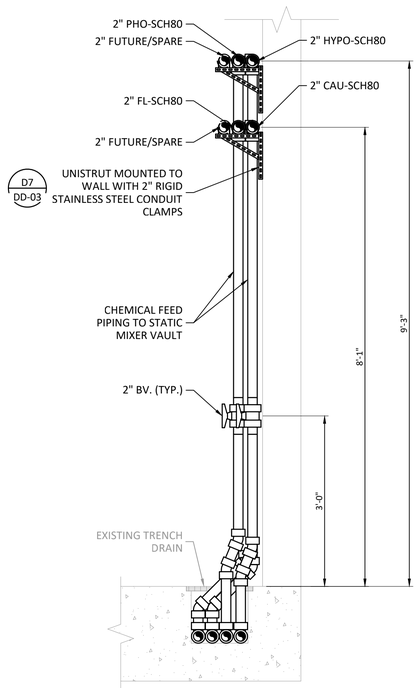
HYDROGEN VENT PENETRATION ASSEMBLY NOTES:

1. PIPE: 3" DIAMETER 10S 316 S.S.. THREADED ON ONE END SUITABLE FOR CONNECTION TO PVC T.A.. ENSURE PIPE EXTENDS 5' MIN. ABOVE FINISHED ROOF SURFACE.
2. BOOT: 316 S.S. WITH INTEGRAL FLASHING, 0.125" MIN. INSTALL PER MANUFACTURERS INSTRUCTIONS.
3. SEALANT: APPLY NEUTRAL CURE SILICONE ADHESIVE SEALANT (HYDROGEN COMPATIBLE) AT BOOT PERMIMETER AND PIPE/CAP INTERFACE.
4. CAP: 316 S.S. VENT CAP WITH INTEGRAL INSECT SCREEN. SECURE TO PIPE VIA S.S. MECHANICAL CONNECTION.
5. PIPE SUPPORTS: USING SS HARDWARE, INSTALL 2-HOLE STAINLESS STEEL PIPE SUPPORTS, SUCH AS THOSE MANUFACTURERD BY EMPIRE INDUSTRIES, (2-HOLE SS PIPE STRAPS) WITHIN 12" EACH SIDE OF THE PVC TO S.S. TRANSITION. INSTALL A 2-HOLE SS PIPE STRAP APPROXIMATLY 24" BENEATH THE ROOF PENETRATION.
6. INSTALLATION MUST COMPLY WITH LOCAL BUILDING CODES, MANUFACTURER'S SPECIFICATIONS, AND BEST PRACTICES.



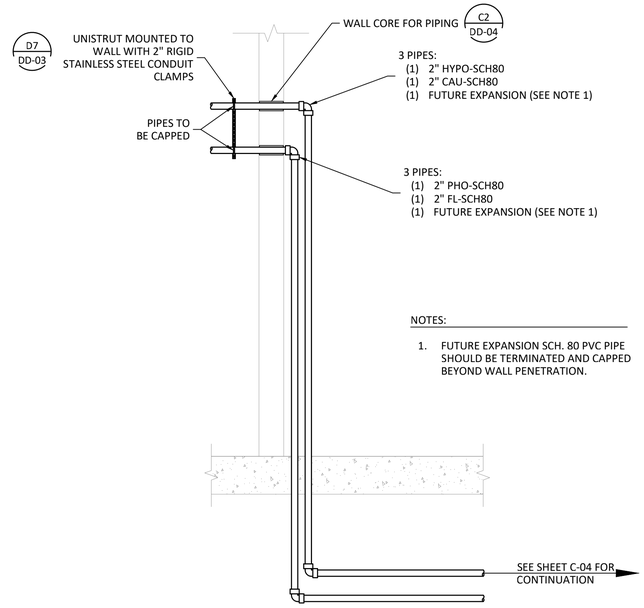
SECTION B

SCALE: 3/8" = 1'-0"



SECTION C

SCALE: 3/4" = 1'-0"

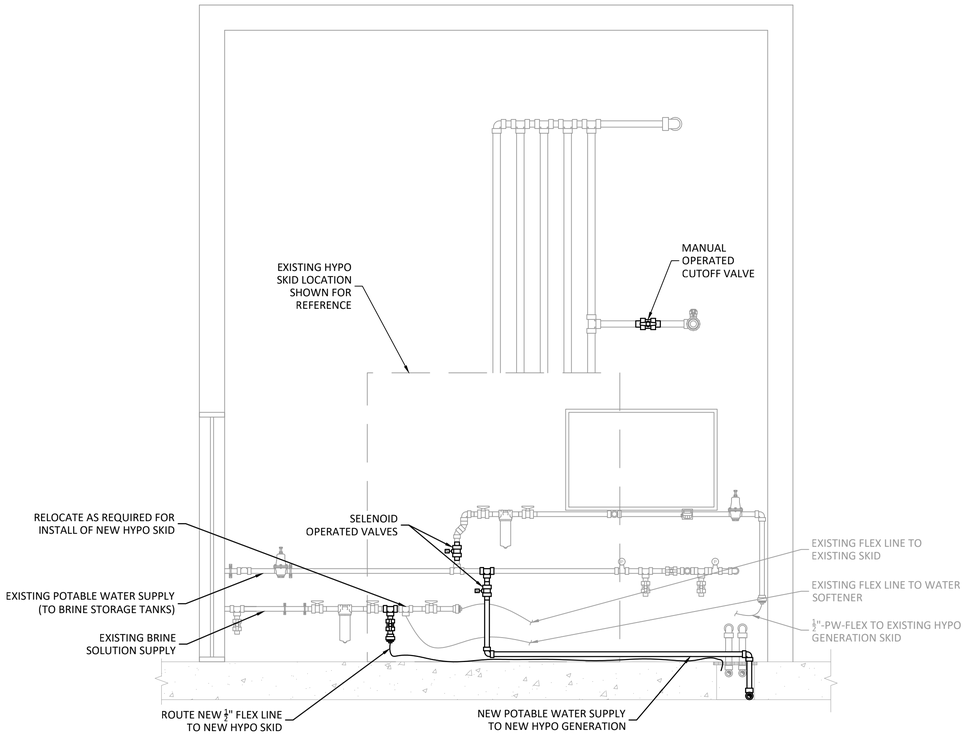


NOTES:

1. FUTURE EXPANSION SCH. 80 PVC PIPE SHOULD BE TERMINATED AND CAPPED BEYOND WALL PENETRATION.

SECTION D

SCALE: 1/2" = 1'-0"



SECTION E

SCALE: 1/2" = 1'-0"

0 ## ##
SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

SODIUM HYPOCHLORITE GENERATION SYSTEM SECTIONS AND DETAILS

ALABAMA LICENSED
No. 35223
PROFESSIONAL ENGINEER
SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

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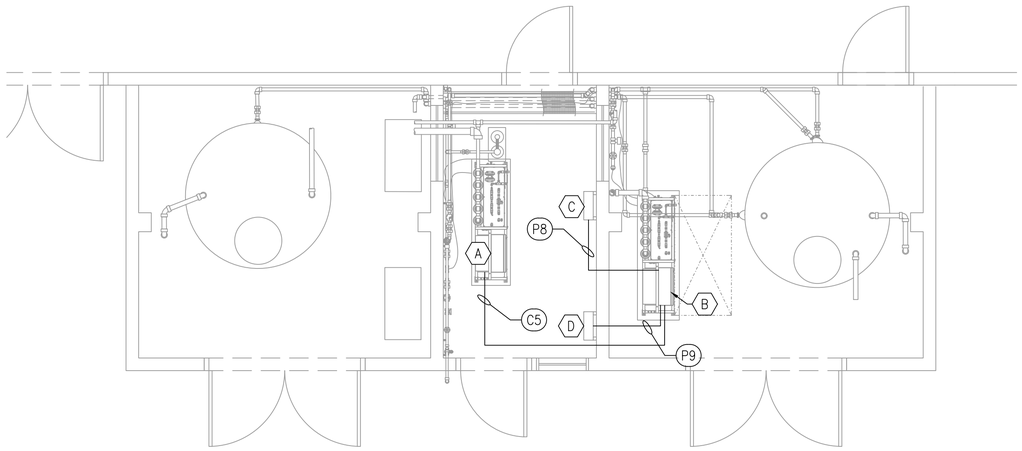
KEY NOTES:

(A) EXISTING HYPOCHLORITE GENERATION SYSTEM

(B) NEW HYPOCHLORITE GENERATION SYSTEM

(C) PP–HYPO POWER DISTRIBUTION PANEL (EXISTING)

(D) RP–HYPO POWER DISTRIBUTION PANEL (EXISTING)



HYPO SYSTEM ELECTRICAL SITE PLAN

SCALE: 1/4" = 1'

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

SODIUM HYPOCHLORITE GENERATE ELECTRICAL EQUIPMENT PLAN

ALABAMA LICENSED PROFESSIONAL ENGINEER
No. 34989-E
7/11/25
DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

E-4.00

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SCADA/HMI

MICROCLOR PLC

OPEN VALVE ZCO 403

OPEN VALVE ZCO 402

FIELD PANELS

FI 401

BV-401A

POTABLE WATER FILTER

BV-401B

PRV-401

1 1/4"-PVC80-PW

SV-402

PI 401A

BV-401D

PI 401B

PI 402A

PW N/A A TO BRINE STORAGE TANK

1 1/4"-PVC80-PW

SV-400

PRV-400

SV-403

BV-401C

BV-104E

2"-PVC80-PW

PW N/A A FROM POTABLE WATER

PRV-401B

BV-401F

WATER SOFTENER

1/2"-FLEX-PW

VNT N/A A TO VENT

2"-SCH80-VNT

HYP N/A A TO BULK HYPO STORAGE

2"-SCH80-HYP

2"-SCH80-HYP

HYP A I-5.00 TO BULK HYPO STORAGE

VNT A I-4.00 FROM SKID VENT

HYP A I-4.00 FROM HYPOCHLORITE SKID

BV-450

BV-460

2"-PVC80-VNT

VNT A N/A TO VENT

BR A I-4.00 TO BRINE FEED PUMP

PW A I-4.00 TO HYPOCHLORITE SKID

04-HYP-1

BR A N/A FROM BRINE STORAGE TANKS

1 1/4"-PVC80-BR

BLV-402A

BV-402B

BRINE FILTER

BV-402C

BV-402D

1/2"-FLEX-BR

1 1/4"-PVC80-PW

1 1/4"-PVC80-BR

2"-SCH80-VNT

2"-SCH80-HYP

PROCESS

BV-404A

1/2"-FLEX-BR

BR A I-4.00 TO BRINE FEED PUMP

VNT A I-4.00 FROM SKID VENT

FI 403A

PI 403A

BV-403A

BV-403B

PRV-403

1/2"-FLEX-PW

PW A I-4.00 TO HYPOCHLORITE SKID

HYP A I-4.00 FROM HYPOCHLORITE SKID

POTABLE WATER FILTER

04-HYP-2

GENERAL NOTES

1. SEE LEGEND AND ABBREVIATIONS ON DRAWING GP-06 AND GP-07.
2. LIGHTER LINE WEIGHTS INDICATE EQUIPMENT, INSTRUMENT, PIPING OR STRUCTURES THAT ARE EXISTING OR REUSED.
3. THIS DRAWING IS SHOWN FOR REFERENCE TO SHOW THE MODIFICATIONS WITHIN THIS PROJECT. OTHER EXISTING EQUIPMENT AND INSTRUMENTATION MAY NOT BE SHOWN.
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KEYED NOTE

1. EACH UNIT IS A PREPACKAGED SYSTEM. FOR ADDITIONAL INFORMATION REFER TO DRAWING I-4.01

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

SODIUM HYPOCHLORITE GENERATION PROCESS & INSTRUMENTATION DIAGRAM

ALABAMA LICENSED No. 34899-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

I-4.00

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SCADA/HMI

SYSTEM RUNNING YIR 420

SYSTEM RUNNING YIR 430

PLCA

SYSTEM RUNNING YIR 420

SYSTEM RUNNING YIR 430

MAIN PANELS

120 V — MICROCLOR PLC 1 — HS 420 LOR

120 V — MICROCLOR PLC 2 — HS 430 LOR

FIELD PANELS

2"-PVC80-VNT

2"-SCH80-HYP

VNT A I-4.00 TO VENT

HYP A I-4.00 TO BULK STORAGE

LS 421A LS 421B LS 421C LS 421D LS 421E

TS 421A TS 421B TS 421C TS 421D TS 421E

BV-422

BR A I-4.00 FROM BRINE SOLUTION — 1/2"-HDPE-BR — CKV-420A — CKV-420B

FP-420 BRINE FEED PUMP

FI 420B — CKV-420C — CV-420

480 V — Microclor Generator

PW A I-4.00 FROM POTABLE WATER — 1/2"-HDPE-PW — SV-420A — SV-420B — SV-420C

FIT 420A @ TI 420A

FI 420C

04-HYP-1

PROCESS

1

LS 431A LS 431B LS 431C LS 431D LS 431E

TS 431A TS 431B TS 431C TS 431D TS 431E

BV-433

BV-432

FI 430B — CK-430C — CV-430

BR A I-4.00 FROM BRINE SOLUTION — 1/2"-HDPE-BR — CKV-430A — CKV-430B

FP-430 BRINE FEED PUMP

480 V — Microclor Generator

SV-430A

FIT 430A @ TI 430A

PW A I-4.00 FROM POTABLE WATER — 1/2"-HDPE-PW — SV-430B

FI 430C

SV-430C

04-HYP-2

GENERAL NOTES

1. SEE LEGEND AND ABBREVIATIONS ON DRAWING G-06 AND G-07.
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KEYED NOTE

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NO.	DATE	REVISION	BY

CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

SODIUM HYPOCHLORITE GENERATION PROCESS & INSTRUMENTATION DIAGRAM

ALABAMA LICENSED No. 34099-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

I-4.01

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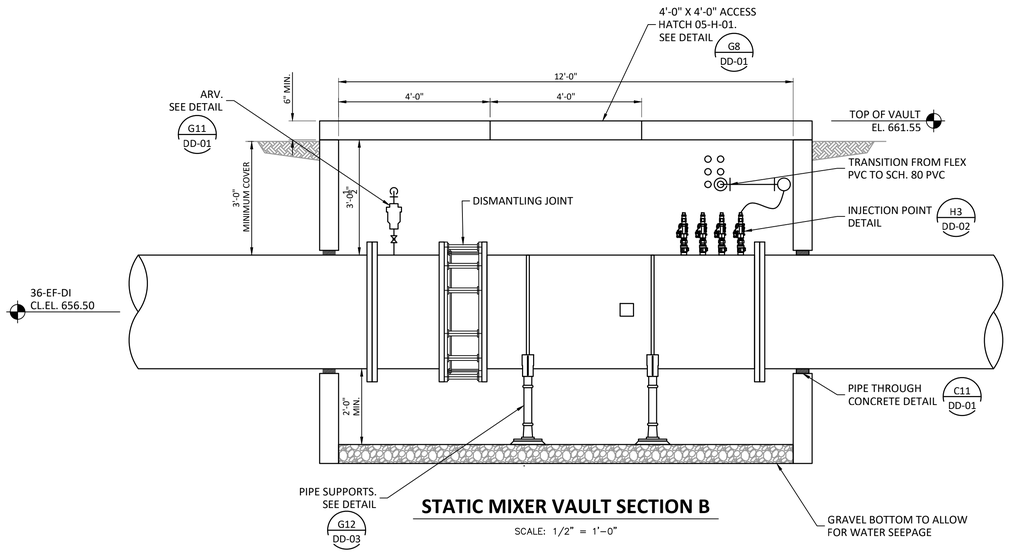
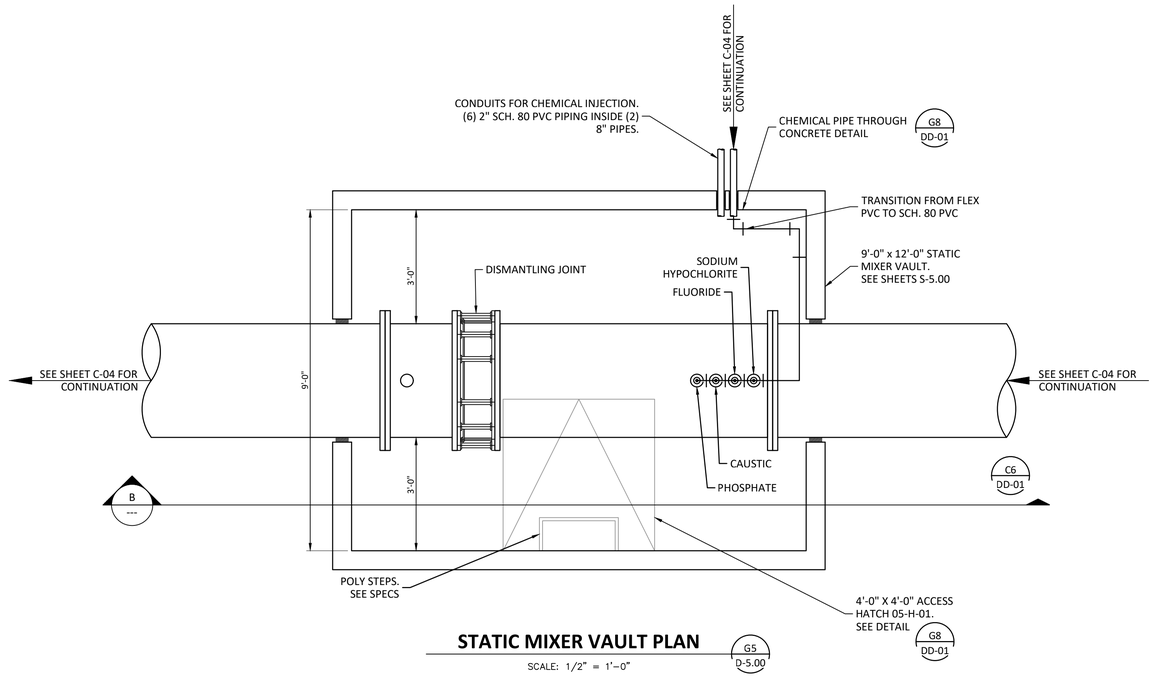


STATIC MIXER VAULT SECTION B

SCALE: 1/2" = 1'-0"



STATIC MIXER VAULT PLAN

G5
D-5.00

SCALE: 1/2" = 1'-0"

NOTES:

1. CONTRACTOR TO PROVIDE SPOOL PIECE OF PIPE TO OWNER OF EQUAL LENGTH TO THE PROVIDED STATIC MIXER.
2. ALL BELOW GRADE PIPING TO BE RESTRAINED MECHANICAL JOINT.
3. CONTRACTOR TO PROVIDE 36" Ø FLANGE TO FLANGE SPOOL PIECE OF PIPE TO OWNER OF EQUAL LENGTH TO THE PROVIDED STATIC MIXER.

0 ## ##
SCALE: FEET

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NO.	DATE	BY
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REVISION

CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

STATIC MIXER VAULT PLAN AND SECTION

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN

07/11/2025

JOB NO:	2024-0776-00
DATE:	07/19/2024

D-5.00

100% ISSUE FOR BID 07/11/2025

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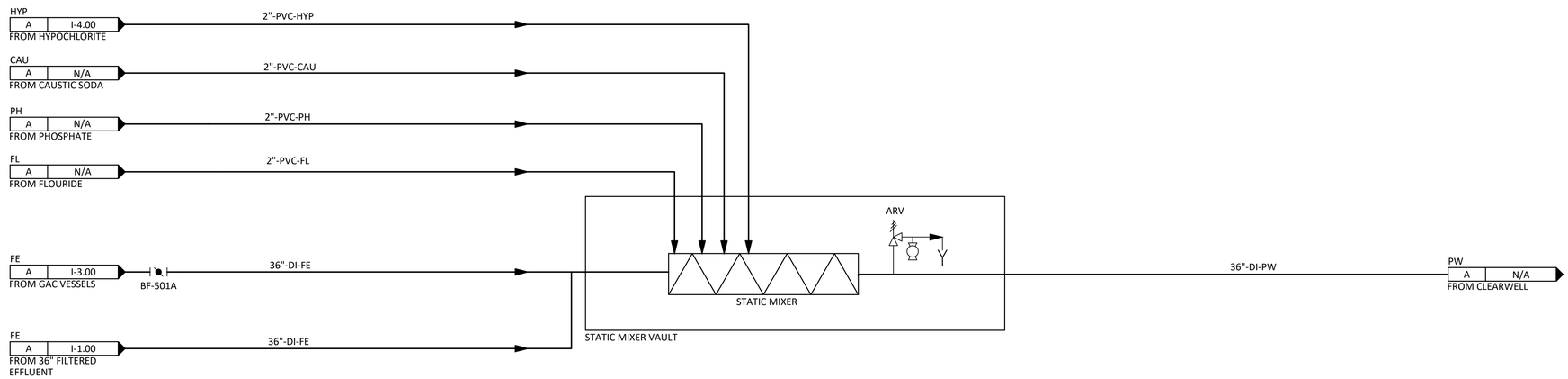
SCADA/HMI

PLCA

MAIN PANELS

FIELD PANELS

PROCESS



GENERAL NOTES

1. SEE LEGEND AND ABBREVIATIONS ON DRAWING G-06 AND G-07.
2. LOCAL CONTROL DEVICES SUCH AS INDICATING LIGHTS AND SWITCHES, LOCATED ON MCCs OR AT EQUIPMENT, MAY NOT BE INDICATED ON THE P&ID.
3. PROVIDE SURGE PROTECTION ON ANALOG CIRCUITS THAT RUN OUTDOORS.
4. IN CASE OF ANY DISCREPANCIES OR VARIANCES BETWEEN THE P&IDs AND THE MECHANICAL DRAWINGS, THE MECHANICAL DRAWINGS SHALL PREVAIL. THIS ALSO APPLIES TO VENDOR PACKAGE EQUIPMENT.

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

STATIC MIXER PROCESS AND INSTRUMENTATION DIAGRAM

ALABAMA LICENSED No. 34899-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON 7/11/25

JOB NO: 2024-0776-00
DATE: 07/19/2024

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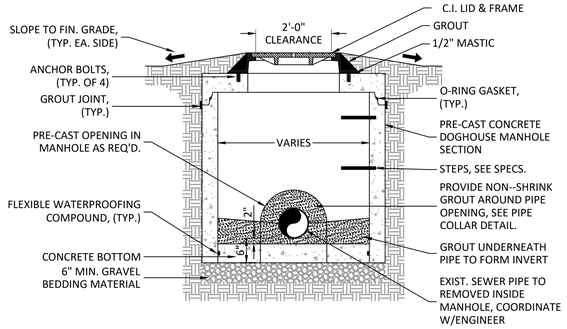
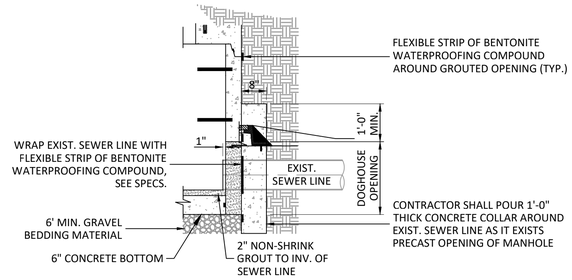


SECTION

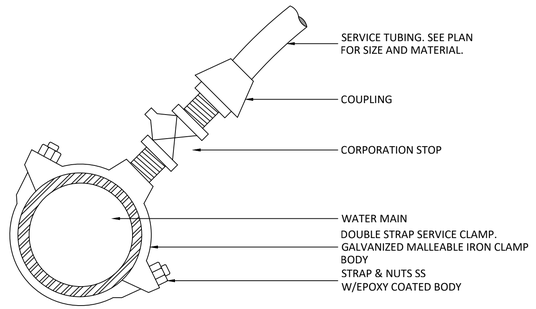


PIPE COLLAR SECTION

DOGHOUSE MANHOLE DETAIL

SCALE: NTS

C5 / CD-03



NOTES:

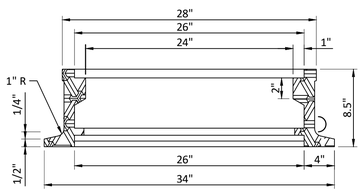
1. 2" TAPS SHALL BE SS FULL CIRCLE TAPPING SADDLES.
2. 2" SERVICE SHALL BE SCH 80 PVC

WATER SERVICE CONNECTION DETAIL

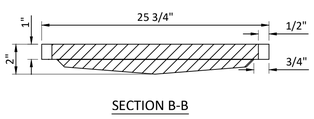
SCALE: NTS

C12 / CD-01

TOP OF COVER



SECTION A-A



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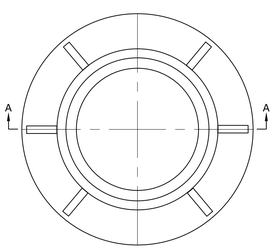
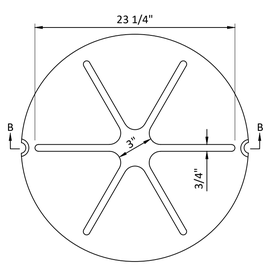


PLAN OF RING

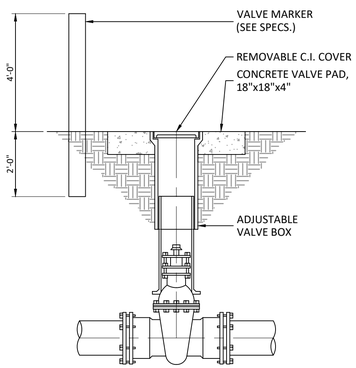


BOTTOM OF COVER

STANDARD MANHOLE COVER & RING DETAIL

SCALE: NTS

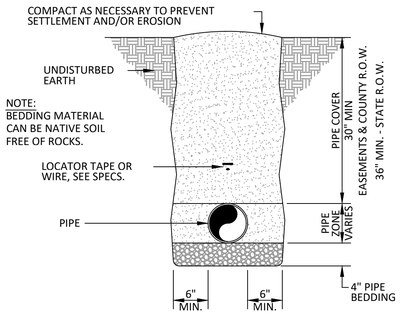
H4 / CD-03



TYP. BURIED VALVE & BOX

SCALE: NTS

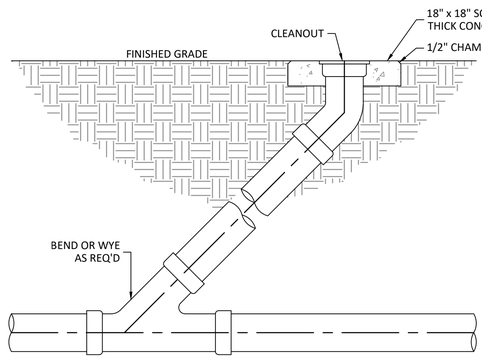
H8 / CD-01



TYP. WATER TRENCH DETAIL

SCALE: NTS

F12 / CD-01



TYP. LINE CLEANOUT DETAIL

SCALE: NTS

H11 / CD-01

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

CIVIL DETAILS SHEET 1 OF 3

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
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CD-01

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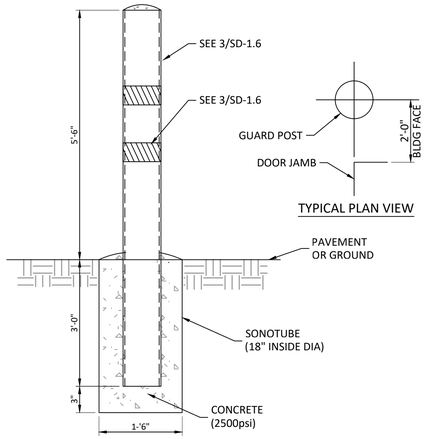


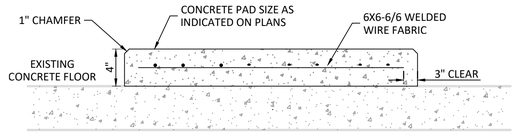
NOTES:

1. PROVIDE A SAFETY YELLOW SLEEVE COVER.
2. FOR STRIPING SEE 10/SD-1.6.

TYPICAL EMBEDED BOLLARD DETAIL

D2 / CD-02

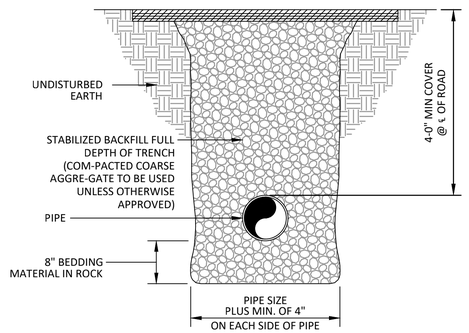
SCALE: NTS



HOUSEKEEPING PAD DETAIL

B7 / CD-02

SCALE: NTS



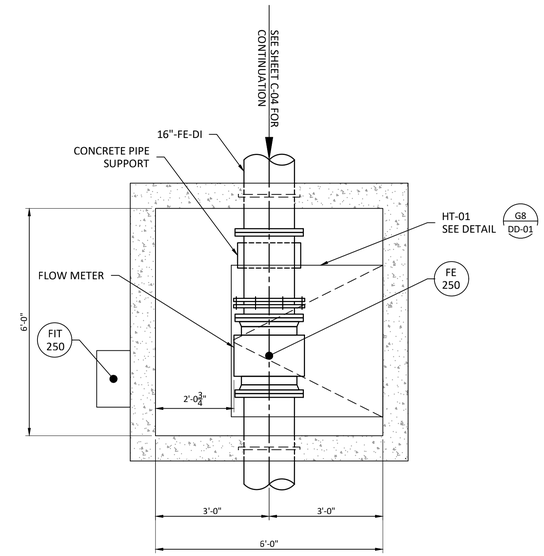
NOTES:

1. ONE HALF OF THE TRAVELED PORTION OF THE PAVING MUST BE OPENED TO TRAFFIC AT ALL TIMES.
2. OPEN CUTTING OF PAVEMENT SHALL BE DONE IN THE MANNER AND SEQUENCE AS FOLLOWS:
   A. OPEN TRENCH TO MINIMUM WIDTH REQUIRED, LAY PIPING.
   B. BACKFILL TRENCH TO SURFACE LEVEL PENDING REPLACING PAVEMENT AND ADDING LIMESTONE AS SHOWN.
   C. PLACE COMPACTED ASPHALT PAVEMENT TO MATCH EXISTING PAVING FOR TRENCH WIDTH PLUS 1'-0" ON EACH SIDE. SAW PAVING STRAIGHT & EVENLY BEFORE PLACEMENT OF ASPHALT PATCH.

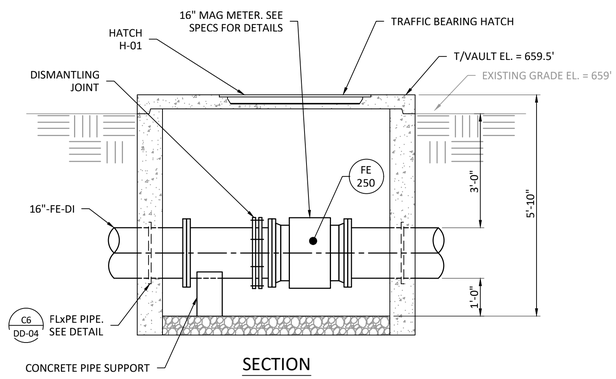
PAVED ROAD CROSSING DETAIL

F8 / CD-01

SCALE: NTS



PLAN



SECTION

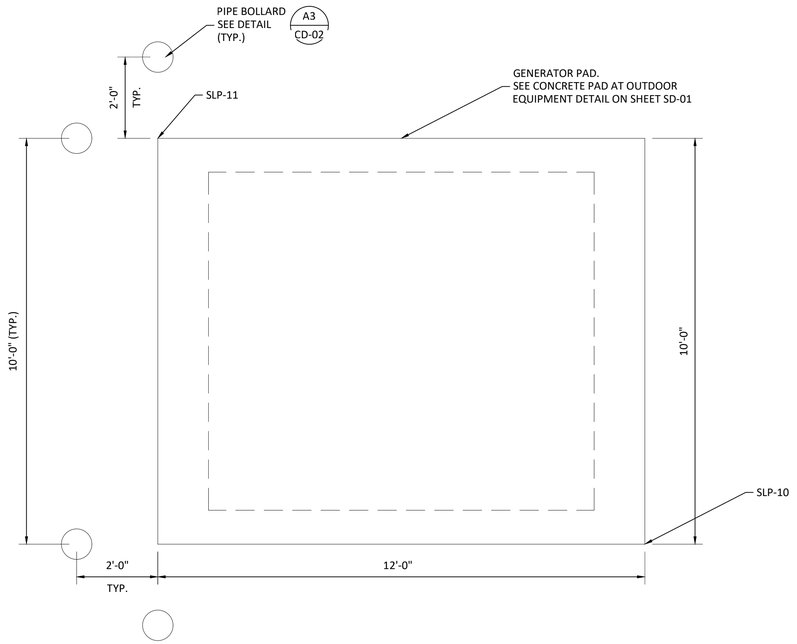
METER VAULT DETAIL

G11 / CD-02

SCALE: 1/2" = 1'-0"

NOTES:

1. CONTRACTOR TO PROVIDE SPOOL PIECE OF PIPE TO OWNER OF EQUAL LENGTH TO THE PROVIDED FLOW METER.



GENERATOR EQUIPMENT PAD DETAIL

H4 / CD-02

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

CIVIL DETAILS SHEET 2 OF 3

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

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CD-02

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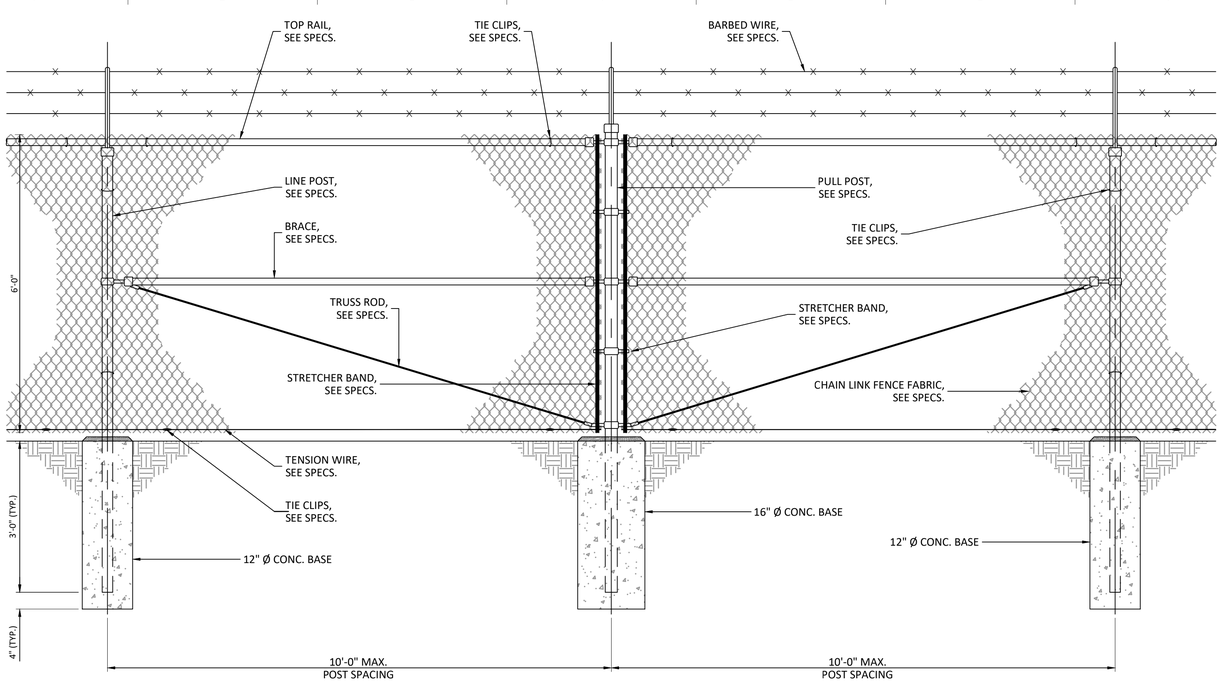
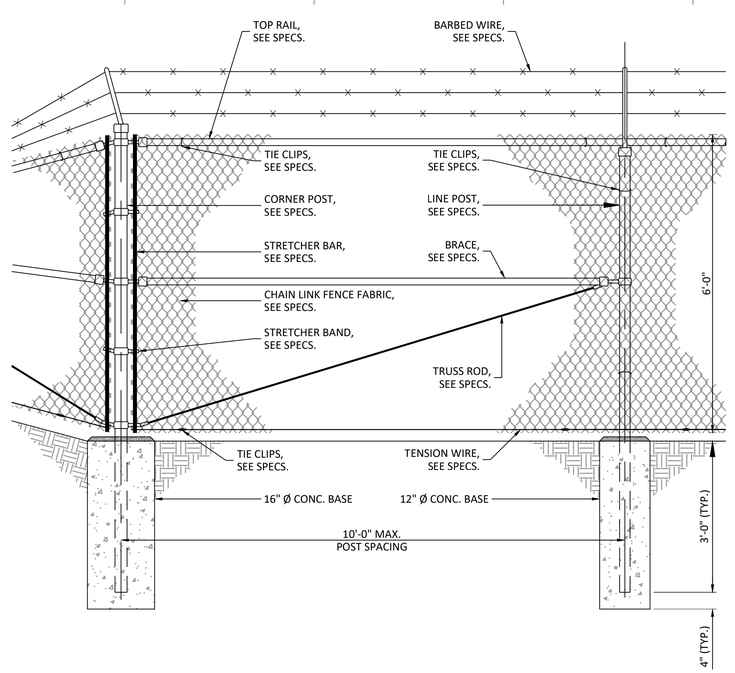


TYPICAL PULL POST

SCALE: NTS

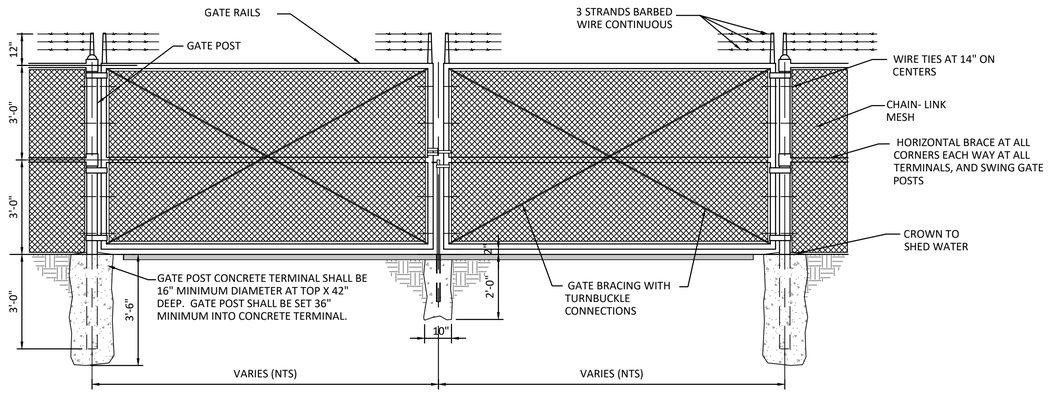
D5 CD-04



TYPICAL CORNER POST
CHAIN LINK FENCE DETAILS

SCALE: NTS

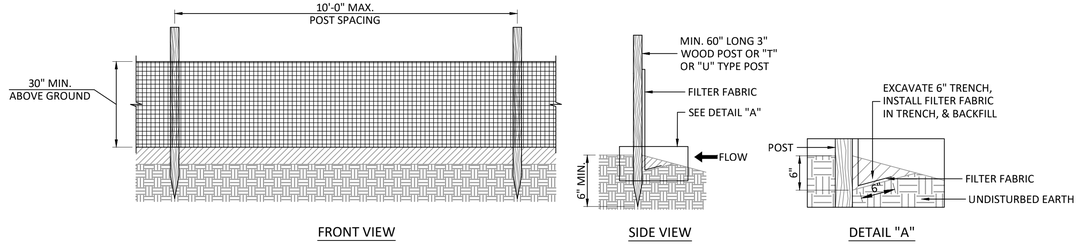
D11 CD-04



DOUBLE SWING GATE DETAIL

SCALE: NTS

G4 CD-04



FRONT VIEW | SIDE VIEW | DETAIL "A"

NOTE: THE FILTER FABRIC SHALL BE FASTENED TO UPSTREAM SIDE OF POST

SILT FENCE WITH FABRIC DETAIL

SCALE: NTS

F10 CD-04

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

CIVIL DETAILS SHEET 3 OF 3

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
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CD-03

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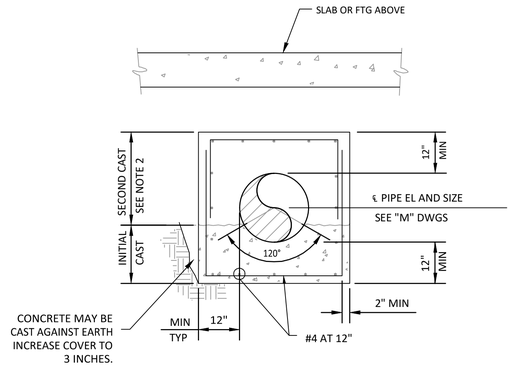


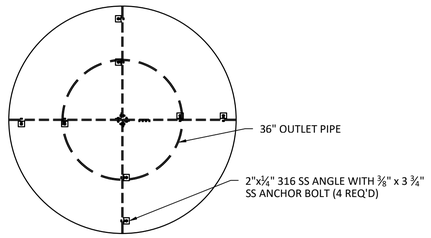
PIPE ENCASEMENT NOTES

1. ALL PIPE SHALL BE PRESSURE TESTED BEFORE CONCRETE ENCASEMENT
2. ALL BELOW GRADE PIPES SHALL BE SUPPORTED ON CONCRETE BLOCKS PRIOR TO CASTING OF CONCRETE BEDDING. SIZE AND SPACING OF CONCRETE BLOCK SUPPORTS SHALL BE PER PIPE MANUFACTURE
3. FOR ALL PIPES 12-INCH DIAMETER AND LARGER ENCASEMENT SHALL BE CAST IN TWO POURS AS SHOWN. INITIAL CAST SHALL BE CURED FOR 12 HR. BEFORE CASTING THE SECOND POUR.

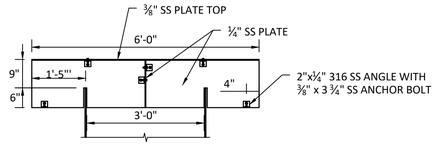
CONCRETE PIPE ENCASEMENT DETAIL

C3 / DD-01

SCALE: NTS



PLAN



SECTION

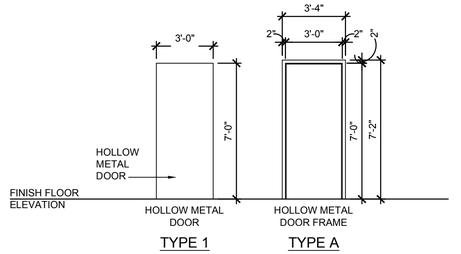
STAINLESS STEEL VORTEX BREAKER DETAIL

D7 / DD-01

SCALE: NTS

DOOR SCHEDULE					LABEL	FRAME SCHEDULE			
DOOR MARK	DIMENSIONS (WIDTHxHEIGHTxTHICKNESS)	ELEV.	MATERIAL TYPE	HARDWARE SET NO.		DIMENSIONS (WIDTHxHEIGHT)	ELEV.	MATERIAL TYPE	REMARKS
401	3'-0" x 7'-0" x 1 3/4"	1	HOLLOW METAL	1	-----	3'-4" x 7'-2"	A	HOLLOW METAL	SEE NOTE 1

NOTES:
1. DOOR DETAILS AND ALL REQUIRED STRUCTURAL FRAMING MEMBERS, FLASHING, TRIM, AND SEALANT TO BE MANUFACTURER'S STANDARD METHOD FOR METAL BUILDING SYSTEM SPECIFIED.

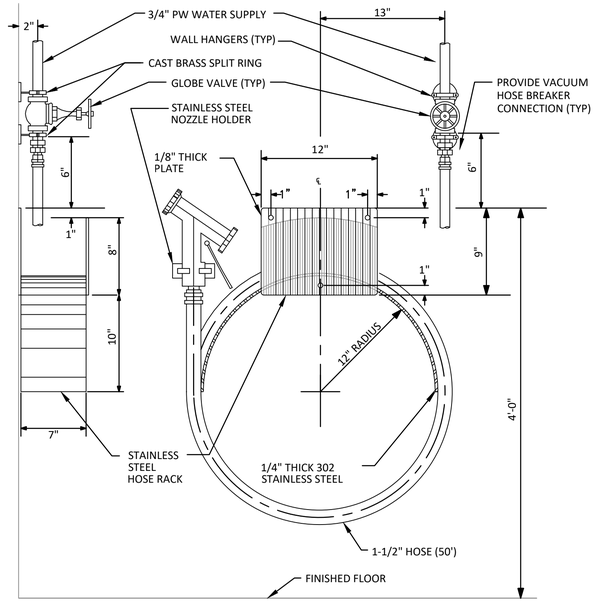


TYPE 1 TYPE A

DOOR SCHEDULE

C10 / DD-01

SCALE: NTS

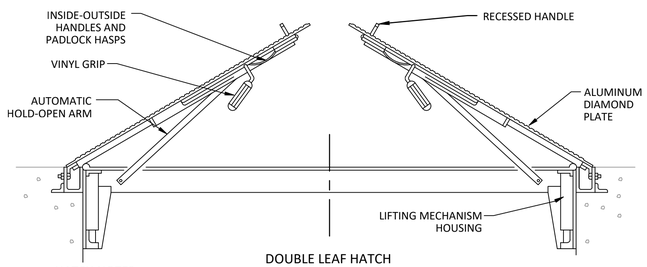


HOSE WASH STATION DETAIL

G3 / DD-01

SCALE: NTS

ACCESS HATCH SCHEDULE					
HATCH #	SIZE	MATERIAL	MANUFACTURER	CATALOG #	REMARKS
H-01	4'-0" X 4'-0"	STAINLESS STEEL	HALLIDAY	W254848	



DOUBLE LEAF HATCH

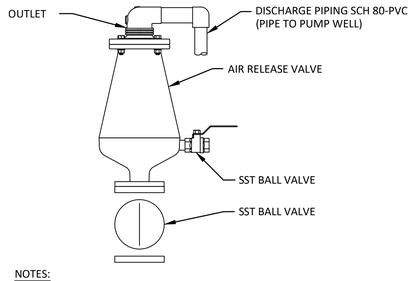
HATCH NOTES:

1. ALUMINUM HATCHES TO BE SUPPLIED WITH STAINLESS STEEL HARDWARE.
2. ALL HATCHES TO BE SUPPLIED WITH SAFETY CHAINS. CORNER POST WITH FLOOR INSERTS MUST ALSO BE PROVIDED FOR SINGLE LEAF HATCHES.
3. ALL HATCHES TO BE SUPPLIED WITH HIGH SECURITY DETENTION LOCKS.
4. HINGE PINS SHALL NOT BE ACCESSIBLE WHEN THE HATCH IS IN THE CLOSED POSITION.

TYPICAL HATCH DETAIL AND SCHEDULE DETAIL

G8 / DD-01

SCALE: NTS



NOTES:

1. ALL PIPE AND FITTINGS ON AIR ASSEMBLY VALVE SHALL BE 316 SST.
2. SEE SPECIFICATION SECTION 2.20 FOR ADDITIONAL REQUIREMENTS.
3. ALL PIPE AND FITINGS SHALL BE SAME NOMINAL SIZE AS THE ASSOCIATED AIR VALVE ASSEMBLY.
4. ARV'S SHALL BE LOW PRESSURE TYPE.

AIR RELEASE VALVE DETAIL

G11 / DD-01

SCALE: NTS

0 ## ##
SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS DETAILS SHEET 1 OF 5

ALABAMA LICENSED PROFESSIONAL ENGINEER No. 35223 SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

DD-01

100% ISSUE FOR BID
07/11/2025

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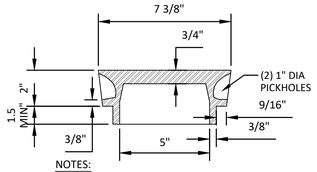
HEAVY DUTY RATING



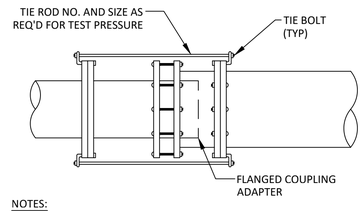
NOTES:

1. PAINT TOP OF THE COVER WITH ENAMEL PAINT (BLUE COLOR) FOR WATER.
2. FOR "REUSE" PAINT TOP PANTONE PURPLE.
3. LID WEIGHT: APPROX. 12 LBS.

WATER SYSTEM VALVE BOX COVER DETAIL

SCALE: NTS

C3 / DD-02



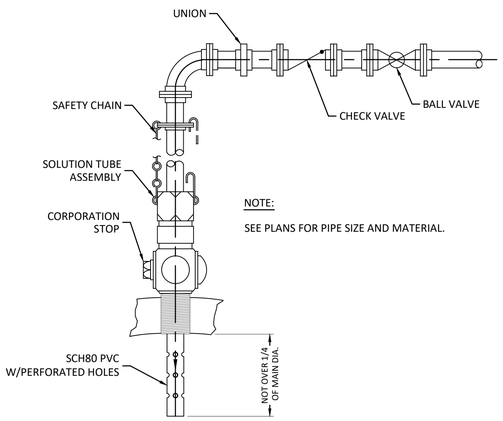
NOTES:

1. ALL FLANGED COUPLING ADAPTERS ON PUMP DISCHARGE PIPING SHALL BE RESTRAINED UNLESS APPROVED OTHERWISE BY ENGINEER IN WRITING.

316 SST RESTRAINED FLANGED COUPLING ADAPTER DETAIL

SCALE: NTS

E4 / DD-02



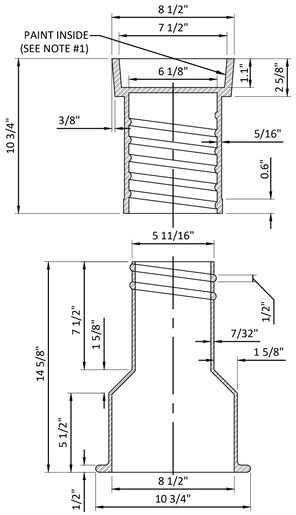
NOTE:

SEE PLANS FOR PIPE SIZE AND MATERIAL.

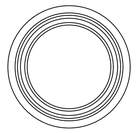
INJECTION POINT DETAIL

SCALE: NTS

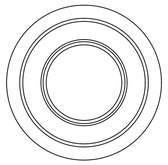
H3 / DD-02



HEAVY DUTY RATING



TOP SECTION VIEW
(23 LBS. APPROX.)



BOTTOM SECTION VIEW
(26 LBS. APPROX.)

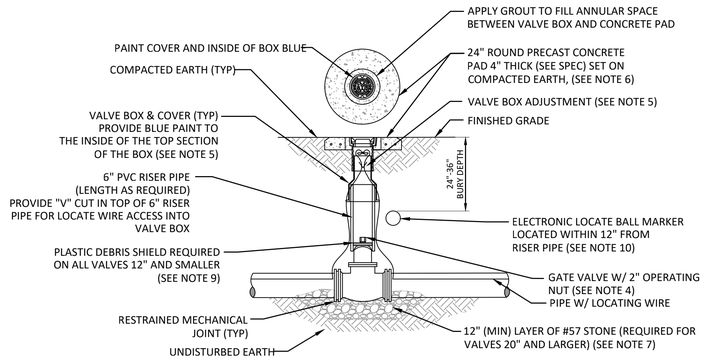
NOTES:

1. PAINT THE INSIDE OF THE TOP SECTION OF THE BOX WITH APPLICABLE COLOR (BLUE OR PURPLE)
2. HEAVY DUTY RATING (TOTAL WEIGHT APPROX. 50 LBS.).

WATER SYSTEM VALVE BOX DETAIL

SCALE: NTS

D6 / DD-02



NOTES:

1. FOR UNPAVED LOCATIONS, A PRECAST CONCRETE VALVE PAD SHALL BE PROVIDED AND INSTALLED FLUSH WITH GRADE. CONCRETE PAD IS NOT REQUIRED FOR VALVE LOCATED IN THE ROADWAY, UNLESS SHOWN OR NOTED OTHERWISE.
2. LOCATING WIRE IS REQUIRED ON ALL PRESSURE PIPING.
3. A "V" CUT SHALL BE CARVED IN THE CURB CLOSEST/ADJACENT/(ASPHALT IF NO CURB) TO ALL BELOW GRADE VALVES. THE "V" CUT IS TO BE PAINTED BLUE WATER/PURPLE RECLAIMED.
4. IN PAVED AREAS, INSTALL VALVE AT A DEPTH TO ALLOW A 12" MIN. DISTANCE BETWEEN THE VALVE COVER PLATE AND THE TOP OF THE VALVE OPERATING NUT. OUTSIDE OF PAVED AREAS (GRASS), INSTALL VALVE AT A DEPTH TO ALLOW A 6" MINIMUM DISTANCE BETWEEN THE VALVE COVER AND THE TOP OF THE VALVE OPERATING NUT. OPERATING NUT/STEM EXTENSION SHALL BE PROVIDED (WHERE APPLICABLE) SO THAT THE OPERATING NUT WILL BE NO MORE THAN 30 INCHES BELOW FINISHED GRADE.
5. FOR NEW CONSTRUCTION, THE VALVE BOX SHALL BE ADJUSTED TO MIDRANGE TO ALLOW FOR FUTURE BOX ADJUSTMENTS. ROUTE LOCATE WIRES THRU A "V" CUT IN THE TOP OF THE 6" PVC RISER PIPE FOR LOCATE WIRE ACCESS INTO VALVE BOX. THE LOCATE WIRES WITH A 24" LONG PIG-TAIL AT THE TOP SHALL BE CONNECTED TOGETHER WITH A WIRE NUT.
6. BRASS IDENTIFICATION TAG INDICATING "WATER", VALVE SIZE, DIRECTION AND TURNS TO OPEN & VALVE TYPE. PROVIDE A ¼" HOLE IN BRASS TAG AND ATTACH TAG (TWIST WIRE AROUND TAG) TO THE END OF THE LOCATE WIRE. TAGS ARE NOT REQUIRED ON VALVES INSTALLED ON FIRE HYDRANT BRANCH LINES.
7. IN LIEU OF PRECAST CONCRETE PAD, A 6" THICK X 24" (ROUND OR SQUARE) POURED CONCRETE PAD W/ 2-#4 REBAR AROUND PERIMETER, MAY BE USED.
8. GRAVEL SHALL BE PROVIDED UNDER ALL VALVES 20" AND LARGER. THE MINIMUM VERTICAL LIMIT OF GRAVEL IS 12" UNDER THE VALVE UP TO ⅓ THE OVERALL HEIGHT OF THE VALVE.
9. FOR VALVES 12 INCH AND SMALLER, PROVIDE A WHITE OR BLACK PLASTIC DEBRIS SHIELD WHICH INSTALLS BELOW THE OPERATING NUT. THIS SHIELD SHALL CENTER THE RISER PIPE BOX OVER THE OPERATING NUT AND MINIMIZE INFILTRATION. SHIELD SHALL BE BY AFC, BOXLOK OR APPROVED EQUAL.
10. ALL VALVES SHALL BE INSTALLED WITH AN ELECTRIC LOCATE MARKER. MARKER SHALL BE 4" DIA. COLOR CODED BALL MARKER (3M-1403XR FOR WATER AND 1408XR FOR RECLAIMED WATER).

WATER SYSTEM VALVE INSTALLATION DETAIL

SCALE: NTS

D6 / DD-02

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS DETAILS SHEET 2 OF 5

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

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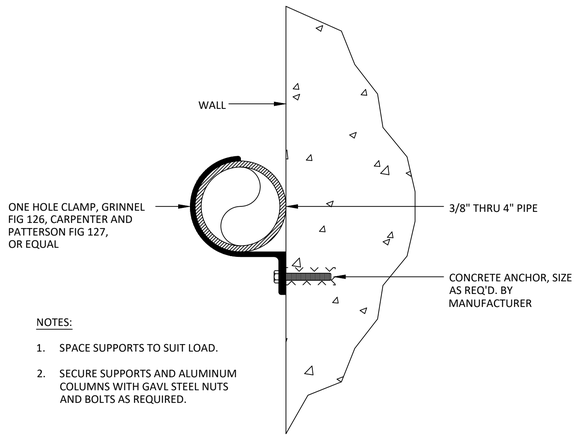


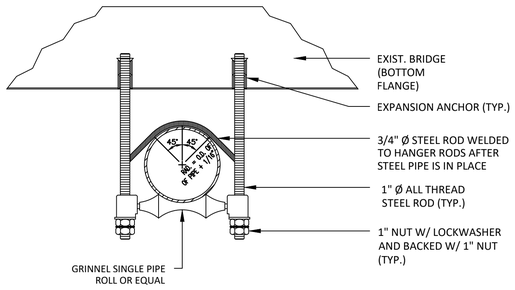
NOTES:

1. SPACE SUPPORTS TO SUIT LOAD.
2. SECURE SUPPORTS AND ALUMINUM COLUMNS WITH GAVL STEEL NUTS AND BOLTS AS REQUIRED.

3/8" THRU 4" PIPE SUPPORT DETAIL

C3 DD-03

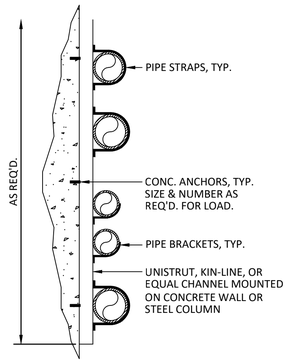
SCALE: NTS



PIPE HANGER DETAIL

C6 DD-03

SCALE: NTS



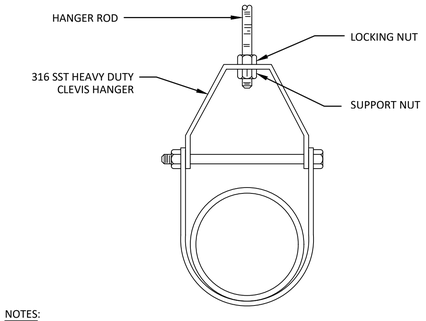
NOTES:

1. USE NEOPRENE SLEEVE ON COPPER AND PVC PIPING AT STRAPS AND BRACKETS.

STACKED PIPE WALL SYSTEM DETAIL

C9 DD-03

SCALE: NTS



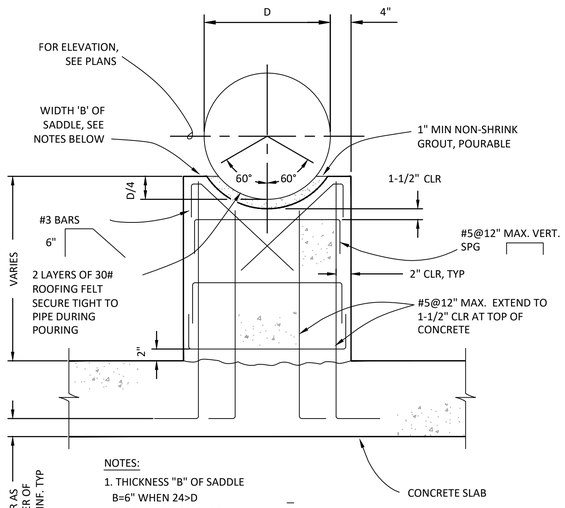
NOTES:

1. ALL HANGER COMPONENTS AND FASTENERS SHALL BE TYPE 316 STAINLESS STEEL.
2. CLEVIS HANGERS SHALL BE FIGURE 426 BY PHD MANUFACTURING, IN. OR ENGINEER APPROVED EQUAL.
3. COMPONENT DIMENSIONS AND ANCHORING SYSTEM SHALL BE AS MANUFACTURERS RECOMMENDATIONS.

ADJUSTABLE CLEVIS HANGER DETAIL

C12 DD-03

SCALE: NTS



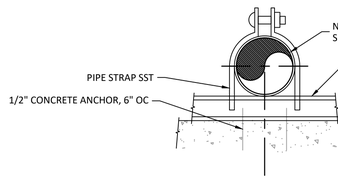
NOTES:

1. THICKNESS "B" OF SADDLE
   B=6" WHEN 24>D
   B=10" WHEN 42>D>24
   B=12" WHEN D>42
2. FOR "B"=10" OR THICKER, USE 2 LAYER OF REINF, TURN HORIZONTAL BARS 90 TO HOOK AROUND VERTS, 1 1/2" CLR OF CONCRETE
3. AT EXISTING SLAB, DRILL AND INSTALL 5/8" EXPANSION ANCHORS FOR VERTS AS SHOWN

CONCRETE PIPE SUPPORT DETAIL

G3 DD-03

SCALE: NTS



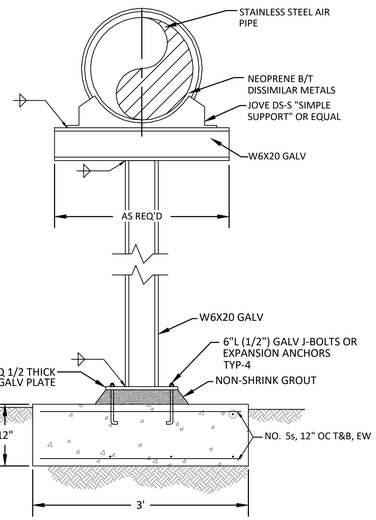
NOTES:

1. ALL MATERIALS TO BE 316 SST.

CHEMICAL PIPING SUPPORT DETAIL

D7 DD-03

SCALE: NTS



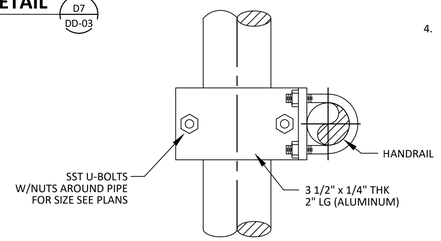
NOTES:

1. PIPE SUPPORTS SHALL BE SPACED AT 15' MAXIMUM.
2. VALVES AND OTHER APPURTENANCES SHALL BE NO FURTHER THAN 5' FROM NEAREST SUPPORT.
3. HEIGHTS OVER 10' SHALL REQUIRE LARGER MEMBERS AS APPROVED BY THE ENGINEER OR FABRICATOR.

PIPE SUPPORT DETAIL

H6 DD-03

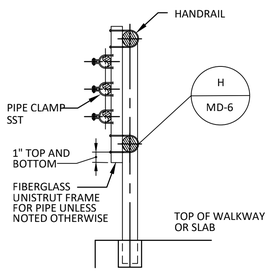
SCALE: NTS



HANDRAIL RESTRAINTS DETAIL

F9 DD-03

SCALE: NTS



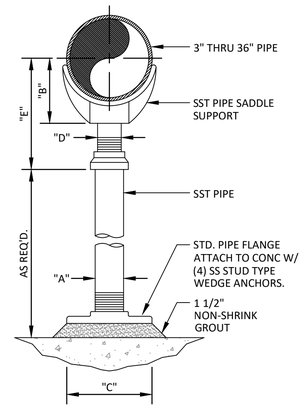
HANDRAIL PIPE SUPPORT DETAIL

H9 DD-03

SCALE: NTS

NOTES:

1. PROVIDE HALF ROUND RIGID INSULATION & INSULATION PROTECTION SHIELD.
2. PROVIDE NEOPRENE WAFFLE ISOLATION PAD UNDER SUPPORT FOOT WHEN PIPING IS ISOLATED OR SUPPORT IS ADJACENT TO MECHANICAL EQUIPMENT.
3. FOR BASE, HEIGHT, AND FLANGE DIMENSIONS, SEE TABLE.
4. PIPE SUPPORT TO BE PAINTED SAME AS PIPING.



DIMENSION TABLE						
PIPE SIZE	"A"	"B"	"C"	"D"	"E" MIN.	"E" MAX.
3"	2"	4 1/4"	8"	1 1/2"	8 1/2"	13 1/4"
4"	2"	4 1/2"	8"	1 1/2"	9 3/4"	14 1/2"
6"	3"	5 1/2"	9"	2 1/2"	10 1/2"	15 1/4"
8"	3"	6 7/8"	9"	2 1/2"	11 3/4"	16 1/2"
10"	3"	8 1/2"	9"	2 1/2"	13 1/2"	18 1/4"
12"	3"	9 15/16"	9"	2 1/2"	15"	19 3/4"
14"	4"	10 15/16"	11"	3"	16 1/4"	20 3/4"
16"	4"	12 3/8"	11"	3"	17 3/4"	22 1/4"
18"	6"	13 7/8"	13 1/2"	3 1/2"	19 1/2"	24"
20"	6"	15 3/8"	13 1/2"	3 1/2"	21"	25 1/2"
24"	6"	17 15/16"	13 1/2"	4"	23 3/4"	28 1/4"
30"	6"	21 5/16"	13 1/2"	4"	27"	31 1/2"
32"	6"	22 1/2"	13 1/2"	4"	28 1/4"	32 3/4"
36"	6"	24 1/2"	13 1/2"	4"	30 1/4"	34 3/4"

3" THRU 36" PIPE SUPPORT (SADDLE TYPE) DETAIL

G12 DD-03

SCALE: NTS

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SCALE: FEET

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No. 36223
PROFESSIONAL
ENGINEER
SHAKIL AMIN
07/11/2025

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS DETAILS SHEET 3 OF 5

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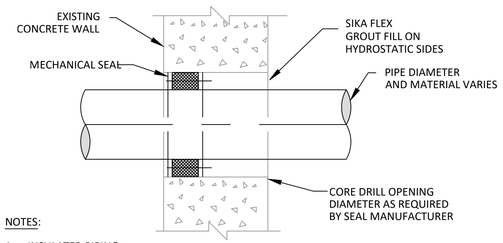


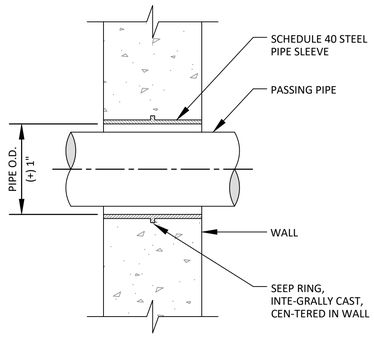
NOTES:

1. INSULATED PIPING:
   INTERRUPT INSULATION AT BOTH SIDES OF WALL. INSTALL INSULATION FLUSH WITH WALL AFTER WATER TIGHT INSTALLATION OF MECHANICAL SEAL.
2. SEALS FOR PROCESS AIR SHALL BE HEAT RESISTANT.

CORE DRILLED OPENING AND MECHANICAL SEAL
PENETRATION THROUGH EXISTING CONCRETE

DETAIL

SCALE: NTS — C2 / DD-04

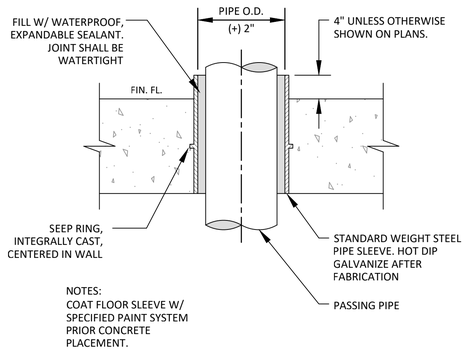


NOTES:

1. DO NOT USE WHERE SUBJECTED TO HYDROSTATIC PRESSURE.
2. PAINT ENTIRE SLEEVE W/ COAL TAR EPOXY ACCORDING TO MANUFACTURER'S PREPARATION AND APPLICATION RECOMMENDATIONS.
3. FILL ANNULAR SPACE BETWEEN PASSING PIPE AND SLEEVE WITH BACKER ROD AND WATERPROOF SILICONE SEALANT. JOINT SHALL BE WATERTIGHT.
4. PROVIDE ESCUTCHION PLATES TO COVER SLEEVE AT EXPOSED WALLS.

WALL PIPE SLEEVE DETAIL

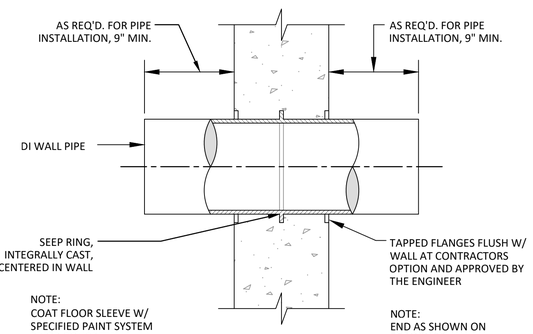
SCALE: NTS — C6 / DD-04



NOTES:
COAT FLOOR SLEEVE W/ SPECIFIED PAINT SYSTEM PRIOR CONCRETE PLACEMENT.

FLOOR PIPE SLEEVE DETAIL

SCALE: NTS — C10 / DD-04

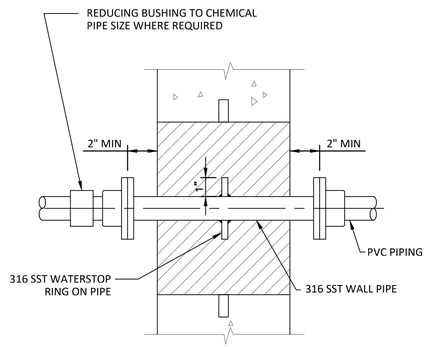


NOTE:
COAT FLOOR SLEEVE W/ SPECIFIED PAINT SYSTEM PRIOR CONCRETE PLACEMENT.

NOTE:
END AS SHOWN ON DRAWINGS.

DUCTILE IRON WALL PIPE DETAIL

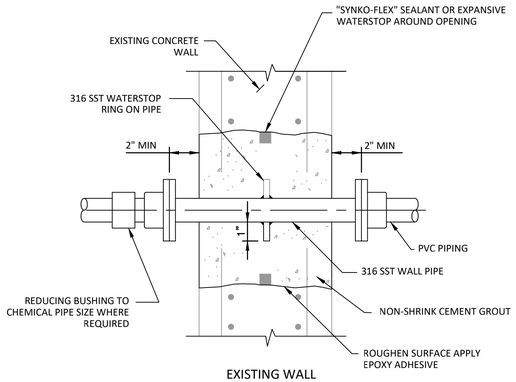
SCALE: NTS — G3 / DD-04



NEW WALL

NOTES:

1. ALL CHEMICAL PIPE WALL PENETRATIONS SHALL BE 2 INCH MINIMUM DIAMETER. IF CHEMICAL PIPE IS LARGER THAN 2 INCH, THE WALL PIPE SHALL BE THE SAME SIZE AS THE CHEMICAL PIPE.



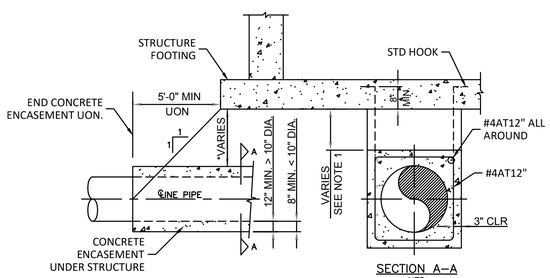
EXISTING WALL

NOTES:

1. CORE HOLE THROUGH WALL APPROX. SAME DIA. AS OD.D. OF WATERSTOP RING. CHIP CONC. BACK ADDL. 2" ALL ARND. LEAVING EXIST. REINF. EXPOSED.
2. ALL CHEMICAL PIPE WALL PENETRATIONS SHALL BE 2-INCH MINIMUM DIAMETER. IF CHEMICAL PIPE IS LARGER THAN 2-INCH, THE WALL PIPE SHALL BE THE SAME SIZE AS THE CHEMICAL PIPE.

CHEMICAL PIPE WALL PENETRATION DETAIL

SCALE: NTS — G8 / DD-04



NOTES:

1. EXTEND ENCASEMENT UP TO UNDERSIDE OF SLAB IF ANY POINT IS WITHIN 2'-0" OF SLAB UNLESS OTHERWISE NOTED
2. ENCASEMENT AT VERTICAL RUN OF PIPE SIMILAR TO HORIZONTAL RUN SHOWN.
3. ALL PIPING BELOW STRUCTURES AND FOOTING ARE TO BE ENCASED PER THIS DETAIL UON ON DRAWINGS.

PIPE ENCASEMENT DETAIL

SCALE: NTS — G12 / DD-04

SCALE: FEET

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS DETAILS SHEET 4 OF 5

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DD-04

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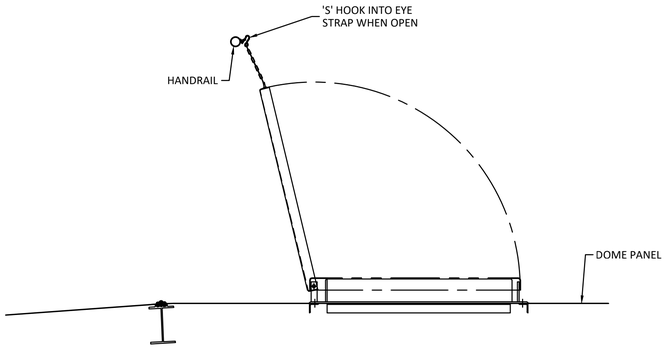
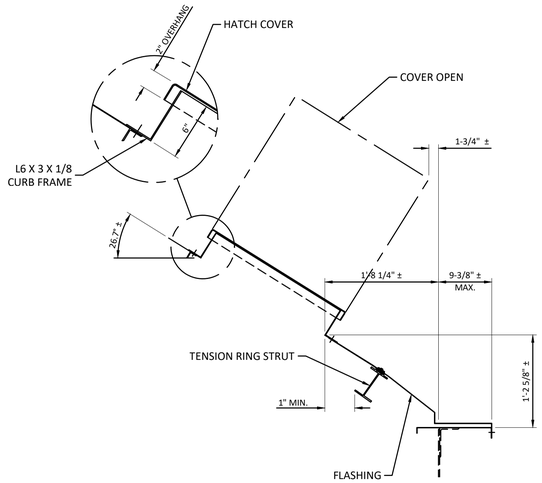
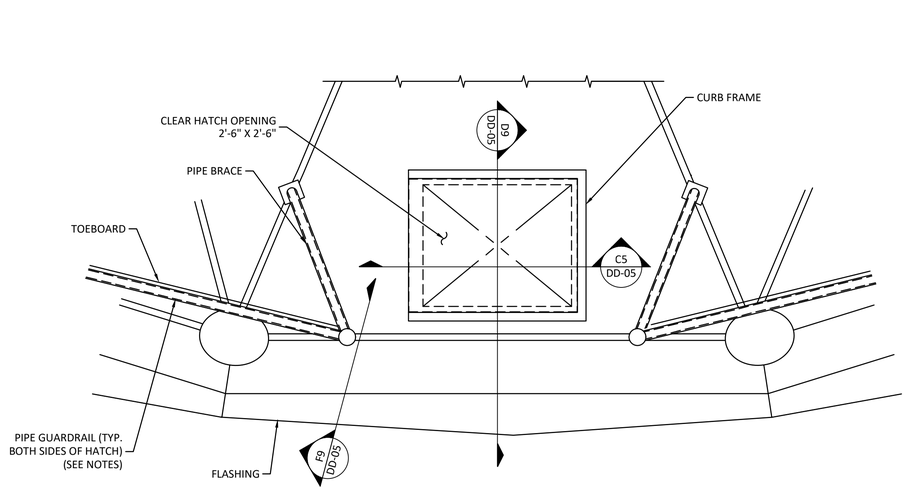


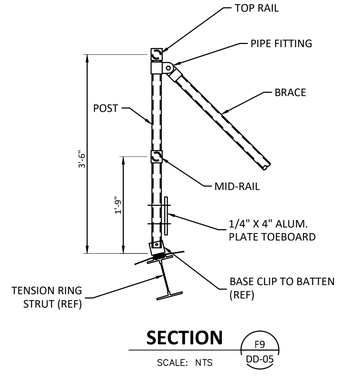
SECTION C5 / DD-05
SCALE: NTS



SECTION D9 / DD-05
SCALE: NTS



TANK HATCH PLAN G5 / DD-05
SCALE: NTS



SECTION F9 / DD-05
SCALE: NTS

NOTES:

1. HATCH FRAME AND COVER ARE ALL ALUMINUM CONSTRUCTION.
2. GUARDRAIL TO BE PROVIDED WHERE REQUIRED ON PLAN.

SCALE: FEET

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NO.	DATE	REVISION	BY
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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

PROCESS DETAILS SHEET 5 OF 5

ALABAMA LICENSED No. 35223 PROFESSIONAL ENGINEER SHAKIL AMIN
07/11/2025

JOB NO: 2024-0776-00
DATE: 07/19/2024

DD-05

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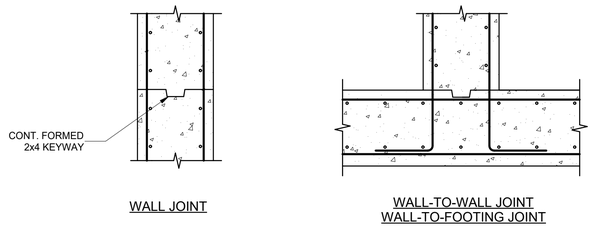


WALL JOINT

WALL-TO-WALL JOINT
WALL-TO-FOOTING JOINT

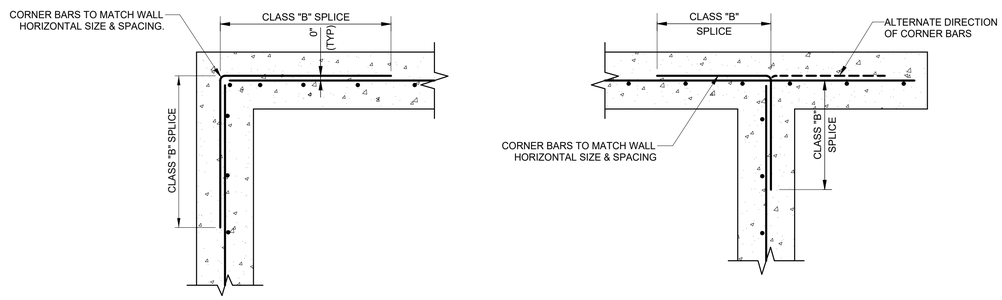
TYPICAL CONSTRUCTION JOINT DETAILS

NOTE: MAXIMUM HORIZONTAL SPACING OF CONSTRUCTION JOINTS SHALL NOT EXCEED 25'-0" OC.

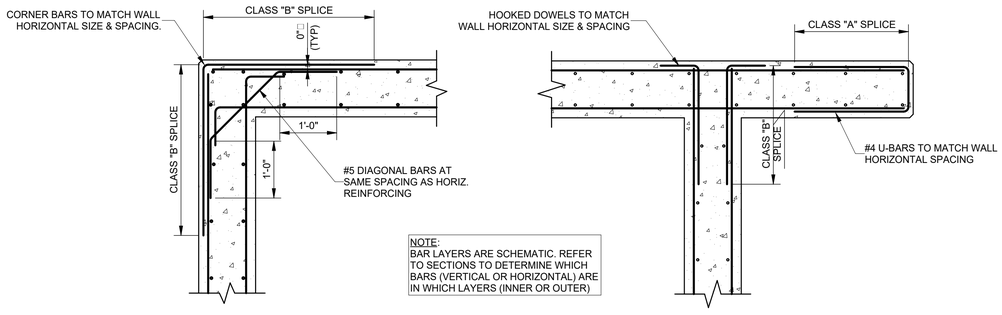
TENSION LAP SPLICE LENGTHS

BAR SIZE	f'_c = 4500 PSI			
	TOP BARS		OTHER BARS	
	CLASS "A"	CLASS "B"	CLASS "A"	CLASS "B"
#3	12"	14"	12"	12"
#4	14"	18"	12"	14"
#5	17"	23"	13"	17"
#6	21"	27"	16"	21"
#7	31"	40"	23"	31"
#8	35"	45"	27"	35"
#9	43"	56"	33"	43"
#10	53"	69"	41"	53"
#11	64"	83"	49"	64"

TOP BARS ARE HORIZONTAL REINFORCING WITH MORE THAN 12" OF CONCRETE CAST BELOW THE REINFORCING.

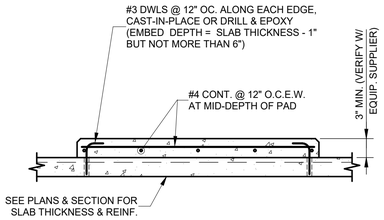


SINGLE-MAT REINFORCING



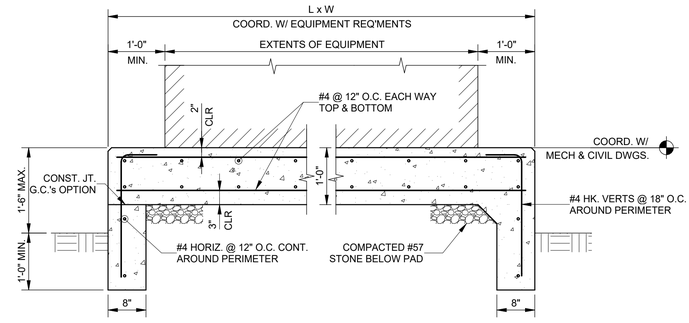
DOUBLE-MAT REINFORCING

TYPICAL CORNER, INTERSECTION & END DETAILS AT CONCRETE WALLS



VERIFY PAD SIZE AND LOCATION W/ EQUIPMENT REQUIREMENTS.

TYPICAL HOUSEKEEPING PAD DETAIL



CONCRETE PAD AT OUTDOOR EQUIPMENT

APPLY THIS DETAIL AT EQUIPMENT WHERE FOUNDATION SLAB OR CONCRETE BASE IS NOT SPECIFICALLY DETAILED

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Phone: 256.864.2542
Echols, Lindsey & Moore
Structural Engineers, Inc.
Project No. 24185

SCALE: AS INDICATED

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CENTRAL ELMORE WTP UPGRADE

STRUCTURAL TYPICAL DETAILS

JOB NO: 2024-0776-00
DATE: 7/11/25

SD-01

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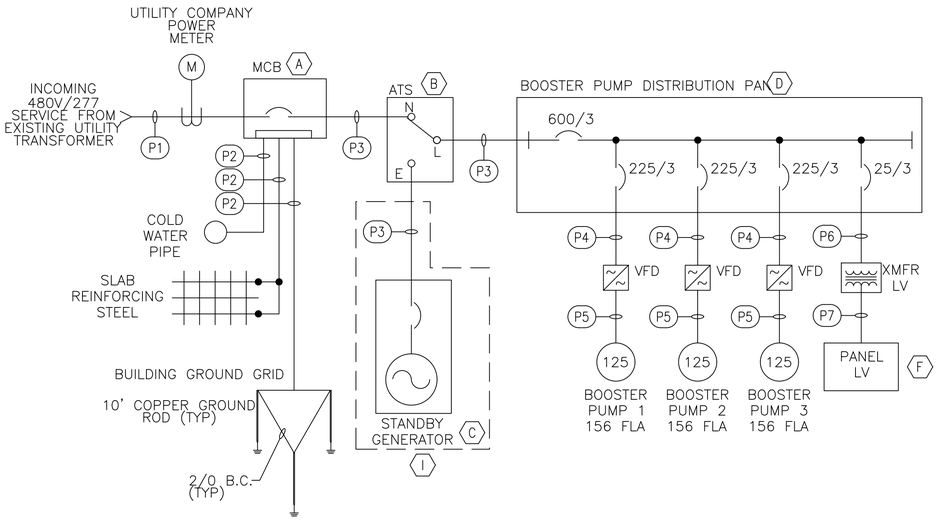
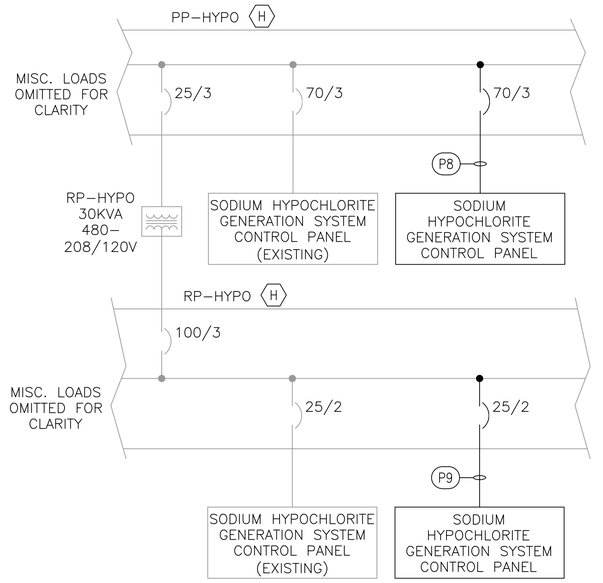
7/11/25



BOOSTER PUMP POWER SINGLE LINE DIAGRAM

SCALE: NONE



HYPO GEN SYSTEM POWER SINGLE LINE DIAGRAM

SCALE: NONE

GENERAL NOTES:

1. A NEW UTILITY SERVICE SHALL BE ESTABLISHED TO ACCOMMODATE THE NEW EQUIPMENT. THE CONTRACTOR SHALL COORDINATE INSTALLATION OF THE NEW SERVICE WITH THE UTILITY COMPANY AND SHALL PROVIDE ALL EQUIPMENT REQUIRED FOR THE NEW SERVICE NOT BEING SUPPLIED BY THE UTILITY COMPANY (SUCH AS THE METER BASE). COORDINATION SHALL INCLUDE DETAILS SUCH AS THE POLE MOUNT OR PAD MOUNT TRANSFORMERS, REQUIRED METER BASE, ETC...

KEY NOTES:

(A) MAIN CIRCUIT BREAKER (MCB). SHALL BE A 480V, 3 POLE, 600A FULLY RATED BREAKER IN A UL TYPE 4 CIRCUIT BREAKER DISCONNECT ENCLOSURE WITH GROUND AND NEUTRAL KITS. SHALL BE SE RATED.

(B) AUTOMATIC TRANSFER SWITCH (ATS). SHALL BE A 480V, 3 POLE 600A SWITCH IN A UL TYPE 4 ENCLOSURE.

(C) STANDBY GENERATOR. SHALL BE A 480V, 3ø, 250KW GENERATOR WITH MAIN BREAKER, SOUND ATTENUATED ENCLOSURE, AND SUB BASE FUEL TANK CAPABLE OF PROVIDING 48 HOURS OF CONTINUOUS RUNTIME FOR TWO (2) OF THE BOOSTER PUMPS. ***SHALL BE A BID ALTERNATE***

(D) BOOSTER PUMP EQUIPMENT DISTRIBUTION PANEL. SHALL BE A 480V, 3ø, 600A, 65KAIC, MLO DISTRIBUTION PANELBOARD WITH ALL NECESSARY CIRCUIT BREAKERS TO PROVIDE POWER FOR THE EQUIPMENT SHOWN.

(E) PANEL LV TRANSFORMER. SHALL BE A 480-208/120V, 15KVA NEMA 3R UNIT.

(F) PANEL LV. SHALL BE A 208/120V, 3ø, 100A DISTRIBUTION PANELBOARD WITH ALL CIRCUIT BREAKERS NECESSARY TO POWER THE EQUIPMENT SHOWN/NOTED.

(G) EXISTING PLANT CONTROL SYSTEM. SHALL BE MODIFIED TO INCORPORATE THE NEW BOOSTER PUMP SIGNALS INTO THE PLANT'S CONTROL SYSTEM, BOTH THE CLOSEST PLC (IF NECESSARY) AND THE OVERALL HMI APPLICATION. THE SYSTEM INTEGRATOR SHALL BE RESPONSIBLE FOR ALL MATERIALS AND LABOR ASSOCIATED WITH ANY PLC MODIFICATIONS, NETWORKING, SOFTWARE, AND GRAPHICAL UPDATES TO INCORPORATE AND REPRESENT THE NEW PLANT PROCESS AREA.

(H) EXISTING PLANT HYPO EQUIPMENT POWER DISTRIBUTION SYSTEM. NEW CIRCUIT BREAKERS (IF NECESSARY) SHALL BE PROVIDED TO SUPPLY POWER FOR THE NEW EQUIPMENT SHOWN.

(I) BID ALTERNATE. THE EMERGENCY GENERATOR AND FEEDER CONDUCTORS SHALL BE PROVIDED AS A BID ALTERNATE. THE ATS AND CONDUIT SHALL BE PROVIDED AND INSTALLED AS PART OF THE BASE BID.

PANEL: LV

3 PH		4 WIRE	VOLTAGE	L-L: 208		L-N: 120	MAIN:	100A MLO			
LOCATION: ELECTRICAL ROOM MCC				PHASE	PHASE	PHASE		MOUNTING: MCC			
CKT#	BKR.	POLE	DESCRIPTION	VOLT-AMP	A	B	C	VOLT-AMP	DESCRIPTION	POLE	BKR.	CKT#
1	20	1	GENERATOR BATTERY CHARGER	120	120			0	SPARE	1	20	2
3	20	1	GENERATOR BLOCK HEATER	2000		2000		0	SPARE	1	20	4
5	20	1	FLOW METER	120			120	0	SPARE	1	20	6
7	20	1	BOOSTER PUMP AREA LIGHT & REC.	380	380			0	SPARE	1	20	8
9	20	1	GAC AREA LIGHTS & REC.	760		760		0	SPARE	1	20	10
11	25	1	SAMPLE PUMP	1600			1600	0	SPARE	1	20	12
13	20	1	SPARE	0	0			0	SPARE	1	20	14
15	20	1	SPARE	0		0		0	SPARE	1	20	16
17	20	1	SPARE	0			0	0	SPARE	1	20	18
19	20	1	SPARE	0	0			0	SPARE	1	20	20
21	20	1	SPARE	0		0		0	SPARE	1	20	22
23	20	1	SPARE	0			0	0	SPARE	1	20	24
25	20	1	SPARE	0	0			0	SPARE	1	20	26
27	20	1	SPARE	0		0		0	SPARE	1	20	28
29	20	1	SPARE	0			0	0	SPARE	1	20	30
31	20	1	SPARE	0	0			0	SPARE	1	20	32
33	20	1	SPARE	0		0		0	SPARE	1	20	34
35	20	1	SPARE	0			0	0	SPARE	1	20	36
37	20	1	SPARE	0	0			0	SPARE	1	20	38
39	20	1	SPARE	0		0		0	SPARE	1	20	40
41	20	1	SPARE	0			0	0	SPARE	1	20	42
TOTAL LOAD(VA)/PHASE THIS PANEL:					500	2760	1720					

TOTAL CONNECTED LOAD(VA) THIS PANEL: 4980 — TOTAL CONNECTED LOAD (AMPS): 14

TOTAL DEMAND LOAD (VA) THIS PANEL: 3984 — TOTAL DEMAND LOADS (AMPS): 11

NOTES:
1.

PANEL LV

SCALE: NONE

(P1)	2 RUNS OF 3#350 KCMIL, 1#2/0 G EACH IN A 3" C
(P2)	1#2/0 G
(P3)	2 RUNS OF 3#350 KCMIL, 1#350KCMIL, 1#2/0 G EACH IN A 3" C
(P4)	3#3/0, 1#4 G IN A 2-1/2" C
(P5)	3#3/0, 1#4 G VFD RATED CABLE IN A 2-1/2" C
(P6)	3#12, 1#12 G IN A 3/4" C
(P7)	3#8, 1#8 N, 1#12 G IN A 1" C
(P8)	3#4, 1#8 G IN A 1-1/4" C
(P9)	2#10, 1#10 N, 1#12 G IN A 1" C
(P10)	3#12 IN A 3/4" C

POWER CONDUIT AND CONDUCTOR SCHEDULE

SCALE: NONE

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

POWER SINGLELINE DIAGRAMS

ALABAMA LICENSED No. 34899-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON 7/11/25

JOB NO: 2024-0776-00
DATE: 07/19/2024

ED-01

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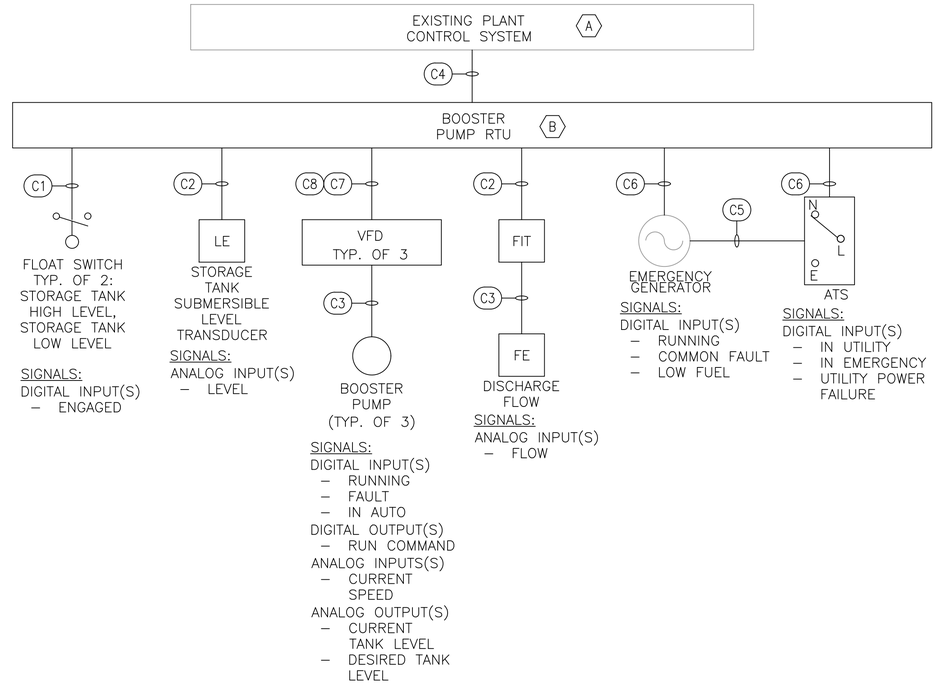
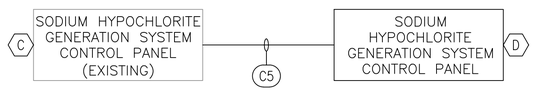


BOOSTER PUMP CONTROL SINGLE LINE DIAGRAM

SCALE: NONE



HYPO GEN SYSTEM CONTROL SINGLE LINE DIAGRAM

SCALE: NONE

GENERAL NOTES:

1. A NEW UTILITY SERVICE SHALL BE ESTABLISHED TO ACCOMMODATE THE NEW EQUIPMENT. THE CONTRACTOR SHALL COORDINATE INSTALLATION OF THE NEW SERVICE WITH THE UTILITY COMPANY AND SHALL PROVIDE ALL EQUIPMENT REQUIRED FOR THE NEW SERVICE NOT BEING SUPPLIED BY THE UTILITY COMPANY (SUCH AS THE METER BASE). COORDINATION SHALL INCLUDE DETAILS SUCH AS THE POLE MOUNT OR PAD MOUNT TRANSFORMERS, REQUIRED METER BASE, ETC...

KEY NOTES:

(A) EXISTING PLANT CONTROL SYSTEM. THE SYSTEM INTEGRATOR SHALL INTEGRATE ALL OF THE NEW PROCESS EQUIPMENT INTO THE PLANT CONTROL SYSTEM IN CONJUNCTION WITH THE PROJECT PLANS AND SPECIFICATIONS.

(B) BOOSTER PUMP RTU. SHALL CONTAIN ALL NECESSARY COMPONENTS (BREAKERS, FUSES, POWER SUPPLIES, PLCs, I/O, ETC...) TO MONITOR AND CONTROL THE NEW PROCESS EQUIPMENT AS DETAILED IN THE PROJECT PLANS AND SPECIFICATIONS.

(C) EXISTING HYPO GENERATION SYSTEM. SHALL BE MODIFIED (IF NECESSARY) AND PROGRAMMED BY THE NEW HYPO GENERATION SYSTEM SUPPLIER TO PROVIDE A RUNNING STATUS OUTPUT (VIA DRY CONTACTS) THAT SHALL BE UTILIZED BY THE NEW HYPO GENERATION SYSTEM TO PREVENT ITS OPERATION IN THE EVENT THAT THE EXISTING SYSTEM IS RUNNING. IN ADDITION, IT SHALL BE MODIFIED (IF NECESSARY) AND PROGRAMMED TO ACCEPT A PERMISSIVE SIGNAL (DRY CONTACT) FROM THE NEW HYPO GENERATION SYSTEM TO PREVENT OPERATION OF THE EXISTING SYSTEM WHENEVER THE NEW HYPO SYSTEM IS RUNNING.

(D) NEW HYPO GENERATION SYSTEM. SHALL INCLUDE A RUNNING STATUS OUTPUT (VIA DRY CONTACTS) THAT SHALL BE UTILIZED BY THE EXISTING HYPO GENERATION SYSTEM TO PREVENT ITS OPERATION IN THE EVENT THAT THE NEW SYSTEM IS RUNNING. IN ADDITION, IT SHALL INCLUDE THE ABILITY TO ACCEPT A PERMISSIVE SIGNAL (DRY CONTACT) FROM THE EXISTING HYPO GENERATION SYSTEM TO PREVENT OPERATION OF THE NEW SYSTEM WHENEVER THE EXISTING HYPO SYSTEM IS RUNNING.

C1	3#14 IN A 3/4" C
C2	2#18 TSP CABLE IN A 3/4" C
C3	MANUFACTURER CABLE, CONDUIT AS REQUIRED
C4	CAT6 CABLE, 1" C
C5	4#14 IN A 3/4" C
C6	6#14 IN A 3/4" C
C7	3 – 2#18 TSP CABLE IN A 1" C
C8	10#14 IN A 1" C

CONTROL CONDUIT AND CONDUCTOR SCHEDULE

SCALE: NONE

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

CONTROL SINGLELINE DIAGRAMS

ALABAMA LICENSED NO. 34899-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

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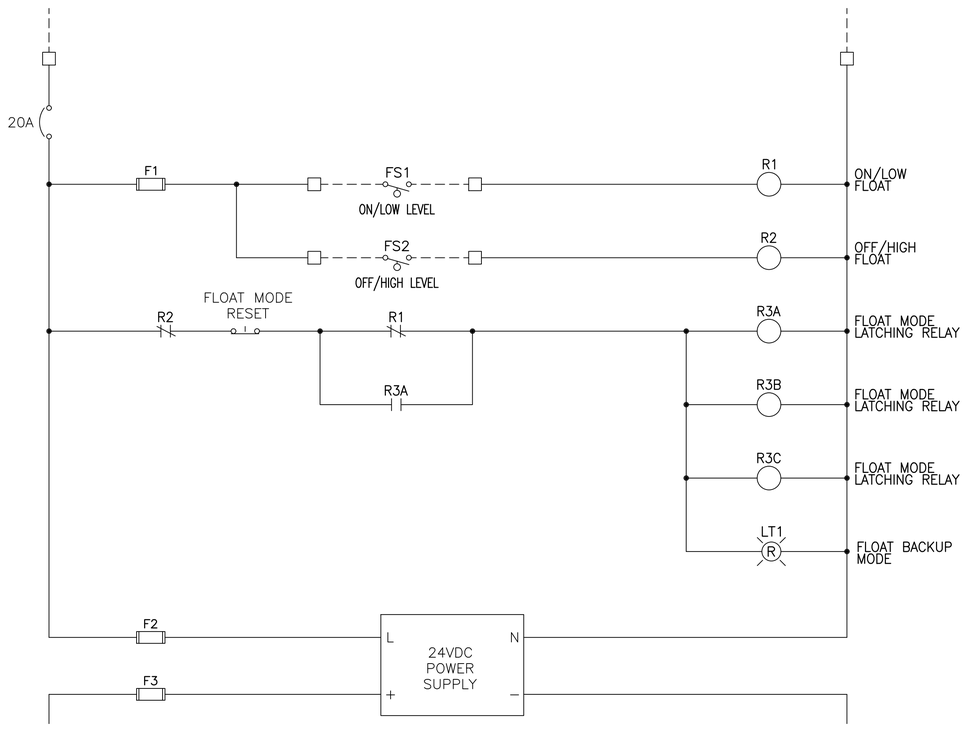
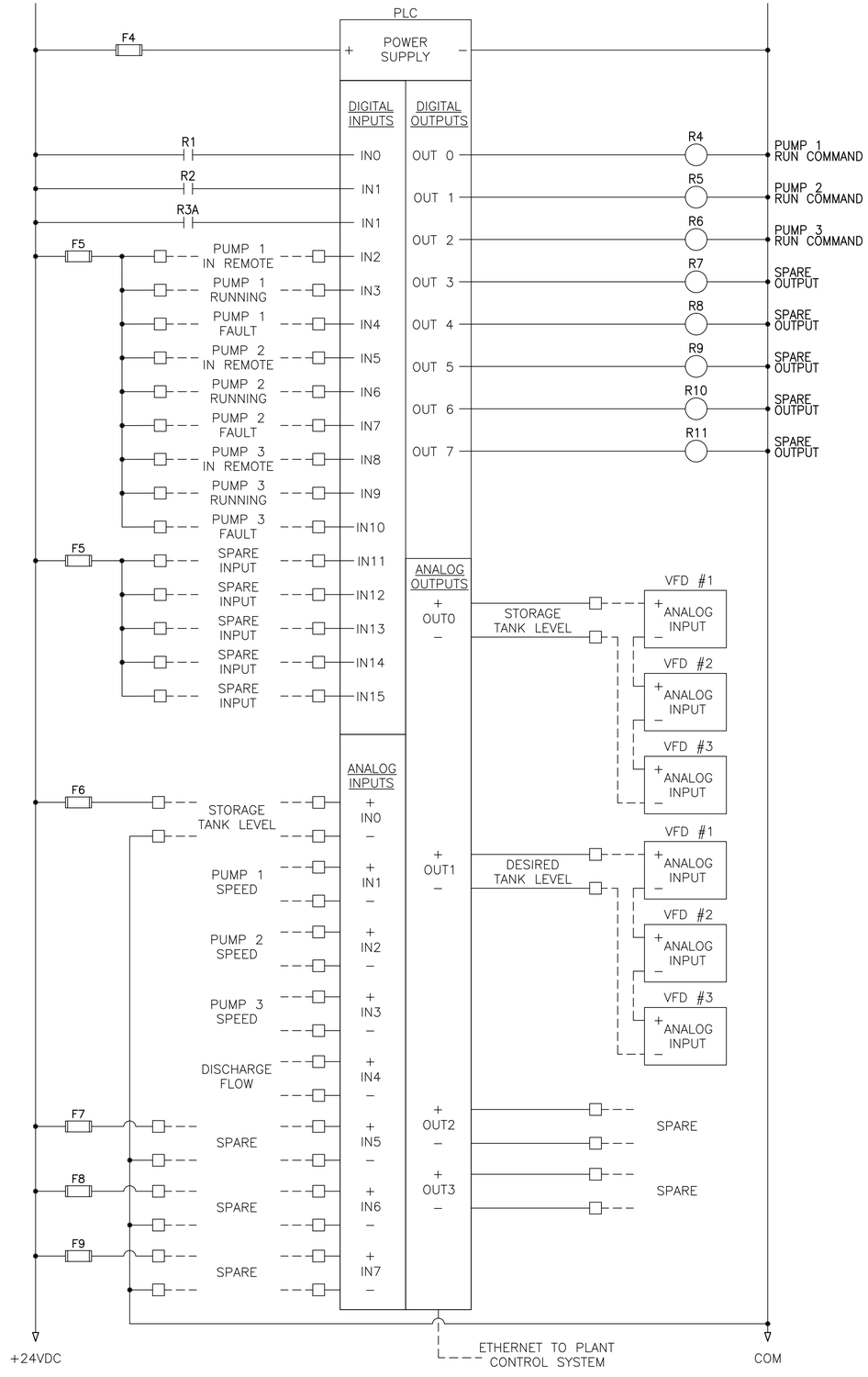


BOOSTER PUMP RTU SCHEMATIC

SCALE: NONE



GENERAL NOTES:

1. ALL PLC AND ASSOCIATED I/O SHALL MATCH THE PLANT'S CURRENT STANDARD – AUTOMATION DIRECT DIRECTLOGIC DL205 SERIES PLCs, RACK, AND I/O MODULES.

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

BOOSTER PUMP RTU

ALABAMA LICENSED No. 34989-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON 7/19/24

JOB NO: 2024-0776-00
DATE: 07/19/2024

ED-03

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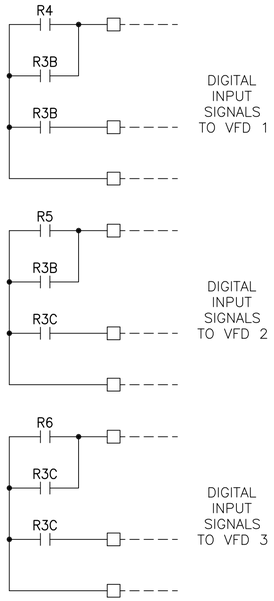
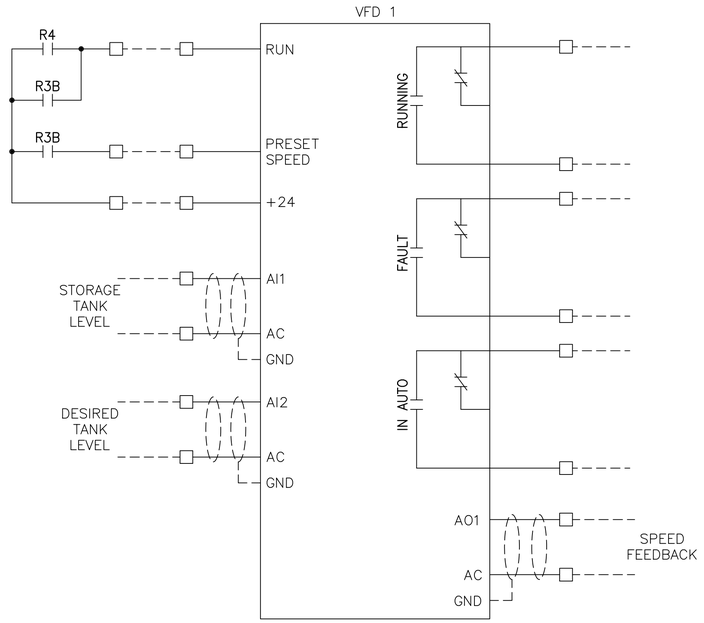


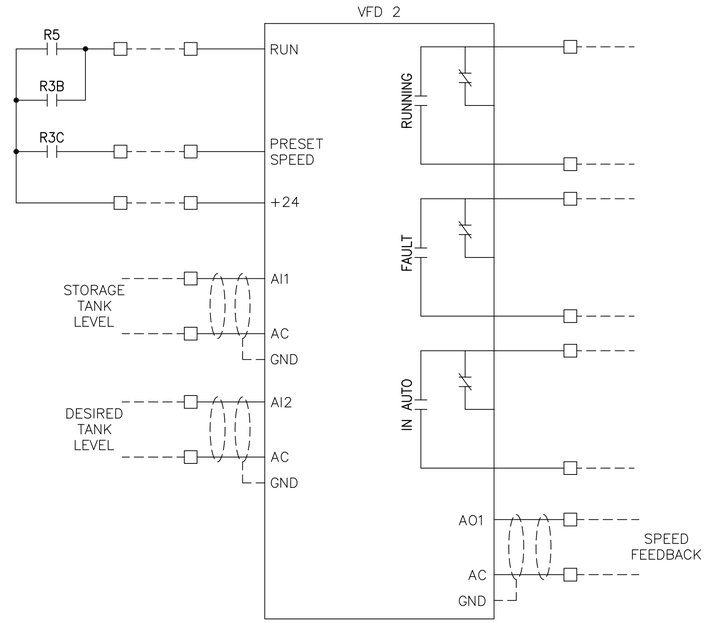
BOOSTER PUMP RTU SCHEMATIC CONT.

SCALE: NONE



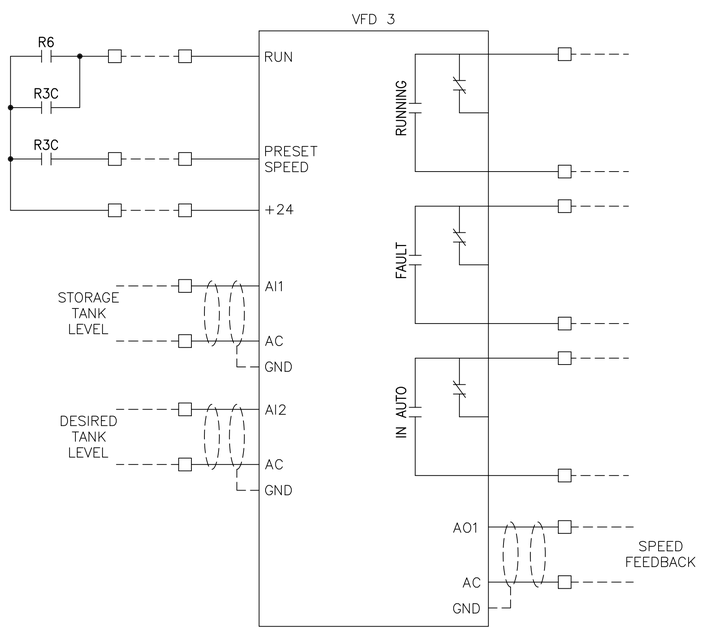
BOOSTER PUMP 1 VFD CONTROL SCHEMATIC

SCALE: NONE



BOOSTER PUMP 2 VFD CONTROL SCHEMATIC

SCALE: NONE



BOOSTER PUMP 3 VFD CONTROL SCHEMATIC

SCALE: NONE

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

BOOSTER PUMP VFD CONTROL WIRING

ALABAMA LICENSED No. 34859-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

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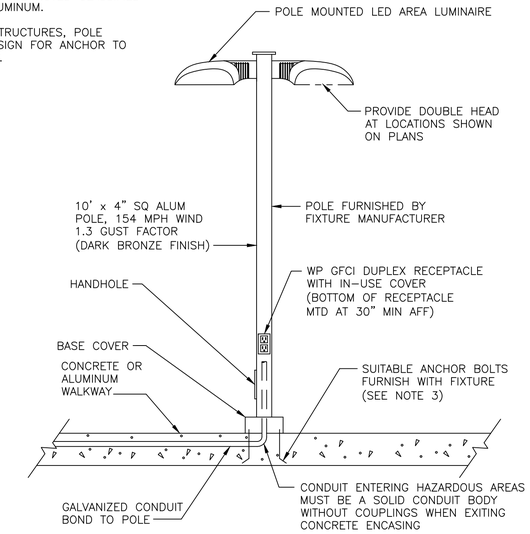
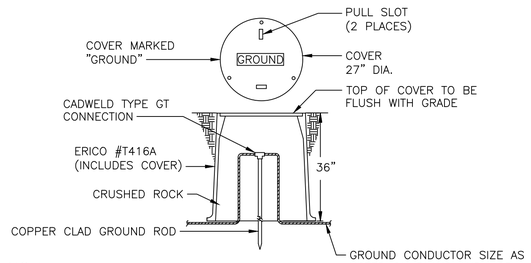
NOTES:

1. PROVIDE EXPLOSION–PROOF SEAL OFF FITTINGS AT ALL AREAS REQUIRED BY THE NEC FOR THE NOTED CLASSIFIED AREA. FITTINGS SHALL BE CAST ALUMINUM.
2. WHERE POLES ARE MOUNTED TO STRUCTURES, POLE MANUFACTURER SHALL PROVIDE DESIGN FOR ANCHOR TO MEET THE SPECIFIED WIND RATINGS.



POLE MOUNTED FIXTURE

SCALE: NTS — D3 / ED-05

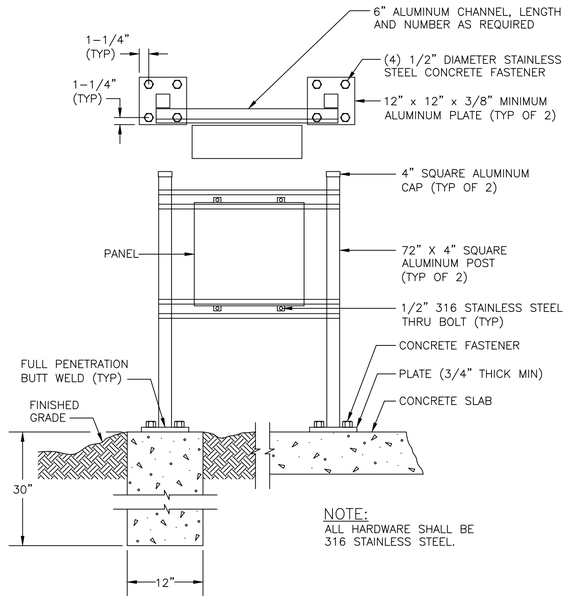


NOTE:

1. TO IMPROVE SYSTEM RESISTANCE, ERICO GEM MAY BE USED AS A BACKFILL MATERIAL IN AN AUGERED HOLE.

GROUND ROD TEST WELL STATION

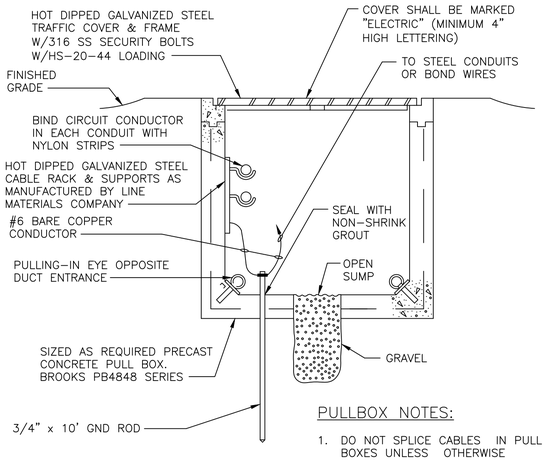
SCALE: NTS — D7 / ED-05



NOTE:
ALL HARDWARE SHALL BE 316 STAINLESS STEEL.

PANEL MOUNTING DETAIL

SCALE: NTS — D10 / ED-05



PULLBOX NOTES:

1. DO NOT SPLICE CABLES IN PULL BOXES UNLESS OTHERWISE NOTED.
2. ALL MOUNTING HARDWARE SHALL BE 316 SS.
3. PULLBOX TO BE PLACED ON 6" BASE OF GRAVEL.

TYPICAL PULLBOX DETAIL

SCALE: NTS — G3 / ED-05

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NO.	DATE	REVISION	BY
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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

ELECTRICAL DETAILS 1

ALABAMA LICENSED NO. 34899-E PROFESSIONAL ENGINEER 7/19/24 DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

ED-05

100% ISSUE FOR BID
07/11/2025

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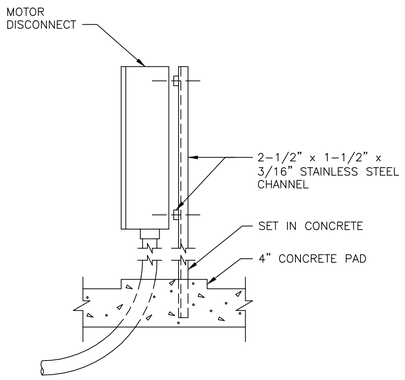
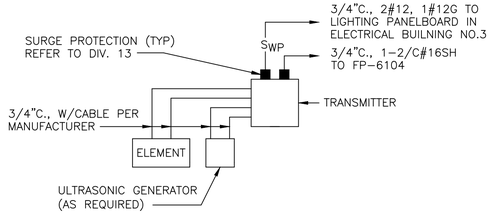


TYPICAL DISCONNECT DETAIL

SCALE: NTS

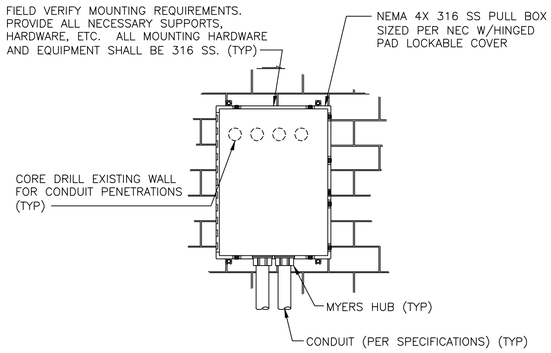
C2 / ED-06



TYPICAL TRANSMITTER DETAIL

SCALE: NTS

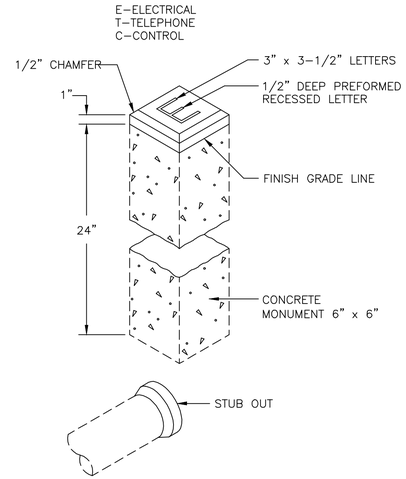
C5 / ED-06



WALL MOUNT PULLBOX

SCALE: NTS

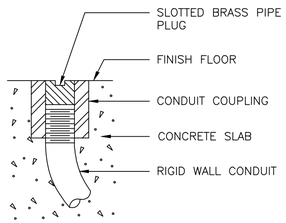
C8 / ED-06



CONDUIT STUB MONUMENT DETAIL

SCALE: NTS

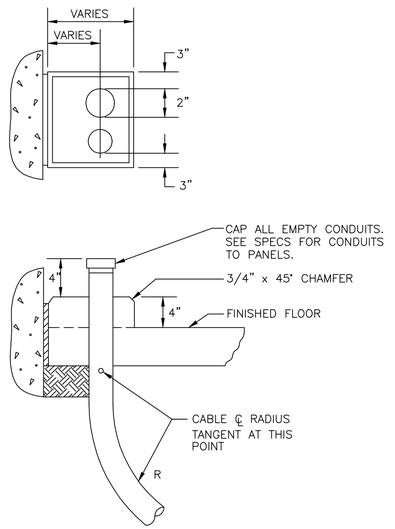
C11 / ED-06



CONDUIT TERMINATION STUB UP DETAIL

SCALE: NTS

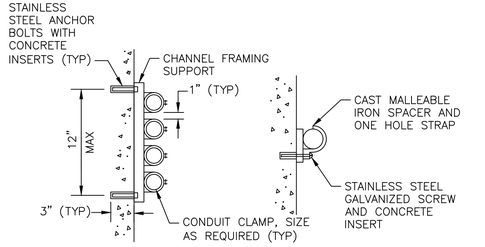
F2 / ED-06

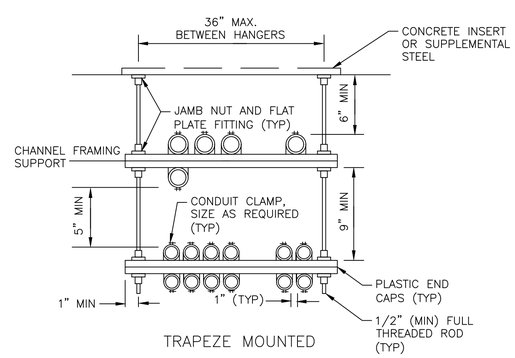


TYPICAL CONDUIT THROUGH SLAB DETAIL

SCALE: NTS

G5 / ED-06

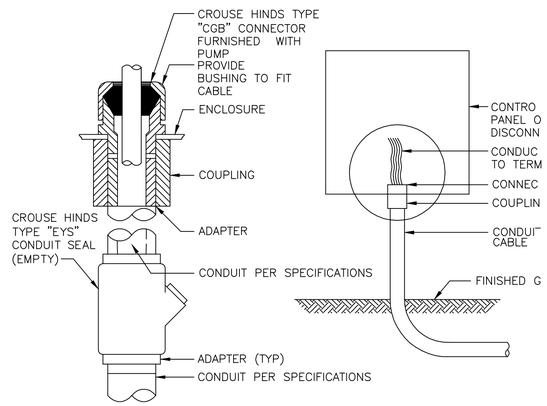




CONDUIT MOUNTING DETAIL

SCALE: NTS

H8 / ED-06



WATER TIGHT CONNECTION DETAIL

SCALE: NTS

G11 / ED-06

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CENTRAL ELMORE WATER
TREATMENT PLANT UPGRADE

ELECTRICAL DETAILS 2

ALABAMA LICENSED No. 34099-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

ED-06

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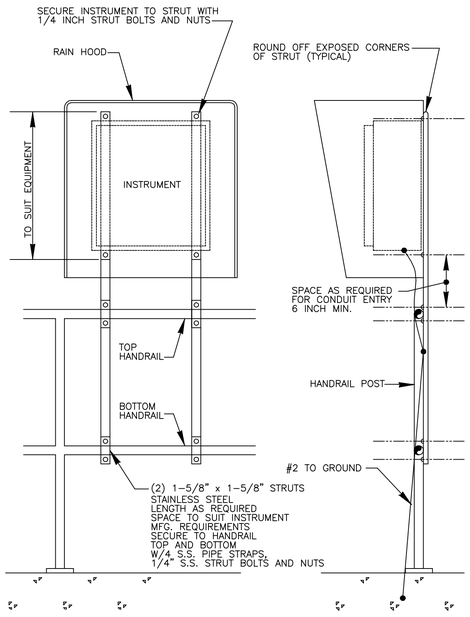
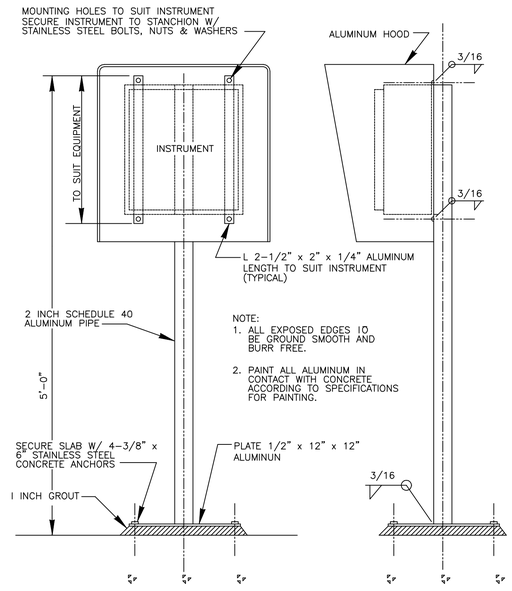


INSTRUMENT HANDRAIL MOUNTING

D2 / ED-07

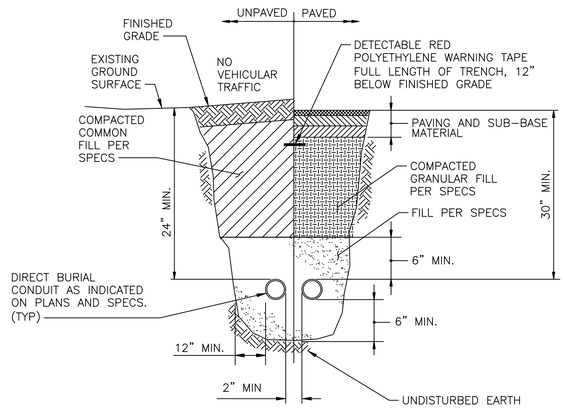
SCALE: NTS



INSTRUMENT STANCHION MOUNTING

D5 / ED-07

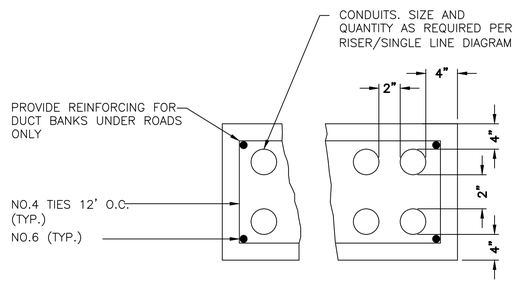
SCALE: NTS



TYPICAL DIRECT BURIED CONDUIT DETAIL

G3 / ED-08

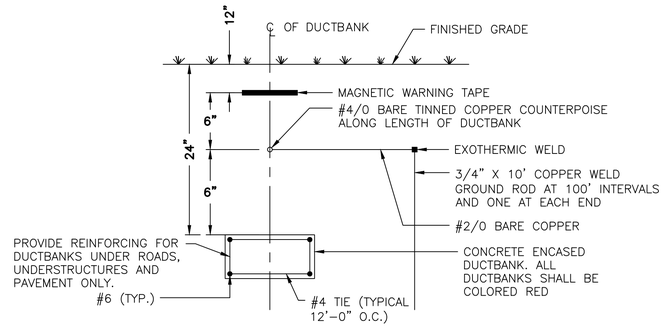
SCALE: NTS



TYPICAL DUCTBANK CONDUIT SECTION

G6 / ED-08

SCALE: NTS



TYPICAL DUCTBANK DETAIL

G10 / ED-08

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

ELECTRICAL DETAILS 3

ALABAMA LICENSED No. 34899-E PROFESSIONAL ENGINEER 7/11/25 DANIEL COLE STEVENSON

JOB NO: 2024-0776-00
DATE: 07/19/2024

ED-07

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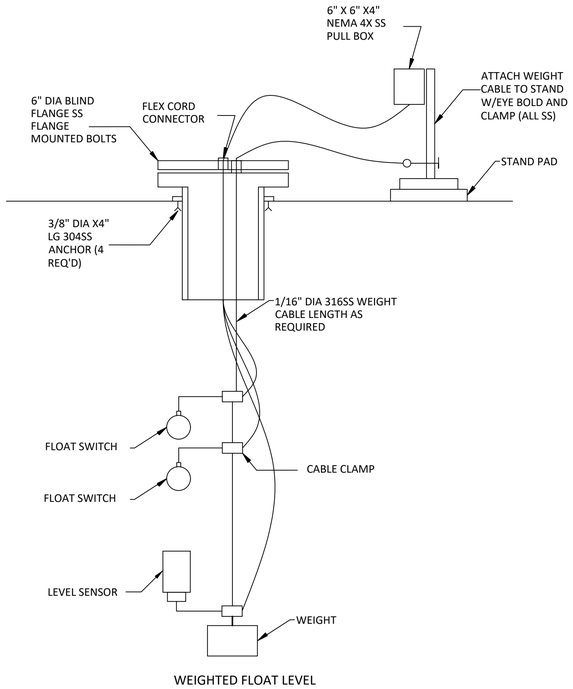
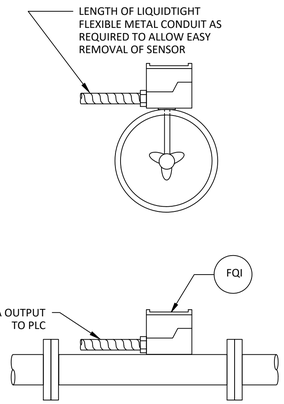


WEIGHTED FLOAT LEVEL

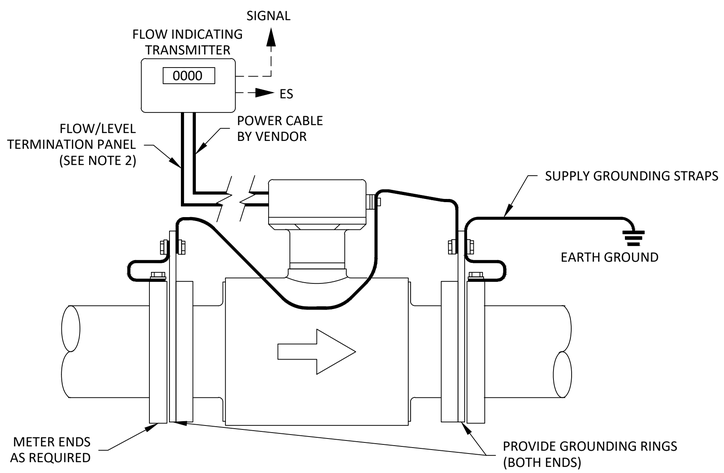
I1 / ID-01 — MULTIPLE FLOAT SWITCH AND SUBMERSABLE LEVEL SENSOR DETAIL

NTS



I2 / ID-01 — TURBINE FLOWMETER INSTALLATION DETAIL

NTS



REMOTE DISPLAY MAGNETIC FLOW METER

I3 / ID-01 — INSTALLATION DETAIL

NTS

NOTES:

1. FOR DETAILED SPECIFICATIONS REFER TO MAGNETIC FLOWMETER SPECIFICATIONS SECTION 40 71 13 OR 13511.
2. POWER SUPPLY TO MAGNETIC METER PRIMARY DEVICE AND TRANSMITTER TO BE FROM SAME SOURCE WITH RESPECT TO VOLTAGE, FREQUENCY AND PHASE.
3. INSTALLATION OF METERS SHALL PROVIDE FOR 5 PIPE DIAMETERS UPSTREAM AND 2 PIPE DIAMETERS DOWNSTREAM. OR AS SPECIFIED IN MANUFACTURER INSTALLATION MANUAL.
4. METER SHALL BE INSTALLED SO THAT IT CAN BE TAKEN OUT OF SERVICE FOR CALIBRATION AND/OR MAINTENANCE WITHOUT DISRUPTING ASSOCIATED PROCESS.
5. METER SHALL NOT BE LOCATED NEAR HEAVY INDUCTION EQUIPMENT (MIN 20 FEET)
6. CONTRACTOR SHALL INSTALL FLOWMETER COMPONENTS PER MANUFACTURER O&M INSTALLATION REQUIREMENTS.
7. FLOWMETER GROUNDING SHALL BE PER MANUFACTURER REQUIREMENTS.
8. ORIENT THE METER SO THAT THE ELECTRODES LIE IN PLANE PARALLEL TO FLOOR.
9. INSTALL AIR BLEED VALVES FOR METER MOUNTED HORIZONTALLY.
10. WALL MOUNT THE TRANSMITTER WITHIN SIGHT OF METER.
11. OUTDOOR INSTALLATIONS SHALL PROVIDE SUNSHIELD FOR TRANSMITTER.

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CENTRAL ELMORE WATER TREATMENT PLANT UPGRADE

INSTALLATION DETAILS PROCESS AND INSTRUMENTATION

ALABAMA LICENSED No. 34899-E PROFESSIONAL ENGINEER DANIEL COLE STEVENSON

JOB NO:	2024-0776-00
DATE:	07/19/2024

ID-01

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