GARVER

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Fayetteville, AR 72703

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www.GarverUSA.com

March 25, 2016

ADEQ Enforcement Analyst
Arkansas Department of Environmental Quality
Attn: Mr. Alan Anderson,
5301 Northshore Drive
North Little Rock, AR 72118-5317

Re: Siloam Springs Wastewater Treatment Plant
On-Site Reuse
City of Siloam Springs, Benton County

Dear Mr. Anderson:

Enclosed for your review are two sets of half size hard copy drawings and specifications and a CD with a digital copy of the plans and specifications for the reference project. The project consists of non-potable water reuse improvements at the City's wastewater treatment plant.

The City desires to construct this year, open bids in May. As such, your prompt review is greatly appreciated. Please call me if you have any questions.

Sincerely,

GARVER

Jerry T. Martin, E.I.
Project Engineer

Attachments: Two Half Size Drawings and Specifications
CD – Digital Copy of Plans and Specifications
cc: Tom Myers, City of Siloam Springs

SPECIFICATIONS AND CONTRACT DOCUMENTS

CITY OF Siloam Springs

For the Construction of

WASTEWATER TREATMENT PLANT ON-SITE REUSE

SILOAM SPRINGS, ARKANSAS

ADH REVIEW SET

Garver Project No. 15048100

Prepared For:

City of Siloam Springs

March 2016

GARVER

GarverUSA.com

SILOAM SPRINGS WWTP ON-SITE REUSE

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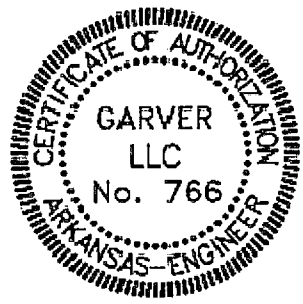
SILOAM SPRINGS WWTP ON-SITE REUSE
GARVER PROJECT NO. 15048100

I hereby certify that the applicable portions of this project plans and specifications were prepared by me or under my direct supervision and that I am a duly Licensed Engineer under the laws of the State of Arkansas.

SEAL AND SIGNATURE	APPLICABLE DIVISION OR PROJECT RESPONSIBILITY
Christopher Buntin, P.E.  Digitally Signed: 03/24/2016	Civil
Jonathan White, P.E.  Digitally Signed 03/25/2016 Digitally Signed:	Electrical

GARVER, LLC CERTIFICATE OF AUTHORIZATION:



SECTION 00030

ADVERTISEMENT FOR BIDS

OWNER: City of Siloam Springs, Arkansas
P.O. Box 80
Siloam Springs, Arkansas 72761

PROJECT NAME: Siloam Springs Wastewater Treatment Plant On-Site Reuse

The City of Siloam Springs will be accepting sealed bids for Siloam Springs Wastewater Treatment Plant On-Site Reuse until 2:00 p.m. CST on Monday, May 9, 2016 at the City Administration Building, City Clerk, 400 N. Broadway, Siloam Springs, Arkansas. Sealed bids shall be mailed or hand delivered to the City Clerk at 400 N. Broadway/P.O. Box 80, Siloam Springs, Arkansas 72761, in an envelope marked as follows: "Sealed Bid Enclosed -- (Siloam Springs Wastewater Treatment Plant On-Site Reuse)". The sealed bids must be received by the City Clerk prior to the above date and time.

The scope of work includes nonpotable water reuse improvements at the Wastewater Treatment Plant (WWTP) in Siloam Springs, Arkansas, generally including a new pump station at the chlorine contact basin and new yard piping throughout the WWTP.

A non-mandatory pre-bid meeting is scheduled for all interested bidders on Monday, April 18th, at 2:00 p.m. CST, in the Board Room of the City Administration Building. All interested contractors are strongly encouraged to attend. A site visit to the WWTP will follow the pre-bid meeting.

Digital copies of the bid documents are available at www.GarverUSA.com for a fee of $30. These documents may be downloaded by selecting this project from the "Plan Room" link, and by entering Quest Project Number 4348644 on the "Browse Projects" page. For assistance and free membership registration, contact QuestCDN at 952.233.1632 or info@questcdn.com. Documents can be examined at the plan room at www.GarverUSA.com. Addendums to the bid package will be issued through the Garver online Plan Holders List; therefore, all prime bidders shall be responsible for downloading the bid documents from the Garver online plan room in order to be included in the Plan Holders List.

Mechanics and laborers on the project shall be paid not less than the minimum hourly rates set out in Prevailing Wage Determination Number 15-458. The awarded Contractor will be responsible for submitting a "Statement of Intent to Pay Prevailing Wages" form to the Arkansas Department of Labor within 30 days of a Notice to Proceed. A copy of this form and the minimum hourly rates are bound in the contract documents.

In order to perform public work, the successful Bidder shall, as applicable, hold such Contractor's and Business Licenses as required by State statutes and the Rules and Regulations of the Arkansas Contractor's Licensing Board.

Bids shall be accompanied by a cashier's or certified check upon a national or state bank in an amount of five percent (5%) of the total maximum bid price payable without recourse to the Owner, or a bid bond in the same amount from a reliable surety company, as a guarantee that the Bidder will enter into a contract and execute performance and payment bonds within fifteen (15) days after notice of award of Contract to him. Such bid guarantee shall be made payable to City of Siloam Springs.

The successful bidder must furnish a performance, payment, and maintenance bond upon the form provided in the amount of one hundred per cent (100%) of the contract price from an approved surety company holding a permit from the State of Arkansas to act as surety, or other surety or sureties acceptable to the Owner.

The City shall open and compare the bids and thereafter award the contract to the lowest responsible bidder, but only if it is in the opinion of the City that the best interests of the City would be served thereby. The City reserves the right to reject any or all bids, to waive irregularities, and to postpone the award of the Contract for a period of time which shall not exceed 90 days from the bid opening date.

Advertisement Dates
3rd day of April, 2016
10th day of April, 2016

END OF SECTION

SECTION 00100

INSTRUCTIONS TO BIDDERS

1. FORMAT

The Contract Documents are divided into parts, divisions, and sections in keeping with accepted industry practice in order to separate categories of subject matter for convenient reference thereto. 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.

2. SPECIFICATION LANGUAGE

"Command" type sentences are used in Contract Documents. These refer to and are directed to the Contractor.

3. GENERAL DESCRIPTION OF THE PROJECT

A general description of the work to be done is contained in the ADVERTISEMENT FOR BIDS. The scope is indicated on the accompanying Drawings and specified in applicable parts of these Contract Documents.

4. QUALIFICATION OF BIDDERS

The prospective bidders must meet the statutorily prescribed requirements before Award of Contract by the Owner.

Before a Contract will be awarded for the work contemplated herein, the Owner will conduct such investigation as is necessary to determine the performance record and ability of the apparent low Bidder to perform the size and type of work specified under this Contract. Upon request, the Bidder shall submit such information as deemed necessary by the Owner to evaluate the Bidder's qualifications.

5. DOCUMENT INTERPRETATION

The Contract Documents governing the work proposed herein consist of the Drawings and all material bound herewith. These Contract Documents are intended to be mutually cooperative. **Any person contemplating the submission of a Bid shall have thoroughly examined all of the various parts of these Documents, and should there be any doubt as to the meaning or intent of said Contract Documents, the Bidder should request of the Engineer, in writing (received by the Engineer at least five (5) working days prior to bid opening) an interpretation thereof. Any interpretation or change in said Contract Documents will be made only in writing, in the form of Addenda to the Documents which will be furnished to all Bidders receiving a set of the Documents.** Bidders shall submit with their Proposals, or indicate receipt of, all Addenda. The Owner or Engineer will not be responsible for any other explanation or interpretations of said Documents not issued in writing by Addendum.

6. **BIDDER'S UNDERSTANDING**

Each Bidder must inform himself of the conditions relating to the execution of the Work, and it is assumed that he will inspect the site and become thoroughly familiar with all the Contract Documents. Failure to do so will not relieve the successful Bidder of his obligation to enter into a Contract and complete the contemplated Work in strict accordance with the Contract Documents. It shall be the Bidder's obligation to verify for himself and to his complete satisfaction all information concerning site and subsurface conditions.

Information derived from 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 of the contract Documents.

Each Bidder shall inform himself of, and the Bidder awarded a Contract shall comply with, federal, state, and local laws, statutes, and ordinances relative to the execution of the Work. This requirement includes, but is not limited to, applicable regulations concerning minimum wage rates, nondiscrimination in the employment of labor, protection of public and employee safety and health, environmental protection, the protection of natural resources, fire protection, burning and non-burning requirements, permits, fees, and similar subjects.

7. PROJECT MANUAL AND DRAWINGS

Bidders may purchase plans and specifications at the price listed in the Advertisement For Bids no later than two days prior to the bid date.

The successful Bidder will be furnished three sets of Documents without charge.

8. TYPE OF BID

Unit prices, if applicable, shall be submitted in the appropriate places on the Bid. The total amount to be paid the Contractor shall be the total amount of the unit price items as adjusted based on actual quantities installed and any approved change orders.

9. PREPARATION OF BIDS

Bidders shall fully complete the bid form including all written amounts. No changes shall be made in the phraseology of the forms. Written unit amounts shall govern in cases of discrepancy between the unit price amounts stated in writing and the unit price amounts stated in figures. Failure to properly complete the bid form may be grounds for disqualification.

Any bid may be deemed disqualified which contains material omissions, or significant irregularities, or in which any of the prices are obviously unbalanced, or which in any manner shall fail to conform to the conditions of the published ADVERTISEMENT FOR BIDS.

Only one bid from any individual, firm, partnership, or corporation, under the same or different names, will be considered. Should it appear to the Owner that any Bidder is interested in more than one bid for work contemplated, all bids in which such Bidder is interested will be rejected.

The Bidder shall sign his Bid in the blank space provided. If the Bidder is a corporation, the legal name of the corporation shall be set forth above, together with the signature and title of the officer of officers authorized to sign Contracts on behalf of the corporation. If Bidder is a partnership or sole proprietorship, the true name of the firm shall be set forth above, together with the signature of the firm's authorized agent. If signature is by an agent, other than an officer of a corporation or a member of a partnership or sole proprietorship, a notarized power of attorney must be on file with the Owner prior to opening of bids, or submitted with the Bid.

10. STATE AND LOCAL SALES AND USE TAXES

Unless the Supplementary Conditions contains a statement that the Owner is exempt from state sales tax on materials incorporated into the Work due to the qualification of the Work under this Contract, all state and local sales and use taxes incurred on materials or equipment, as required by the laws and statutes of any state and its political subdivisions, shall be paid by the Contractor. Prices quoted in the Bid shall include all sales and use taxes.

11. SUBMISSION OF BIDS

All Bids must be submitted, not later than the time prescribed, at the place, and in the manner set forth in the ADVERTISEMENT FOR BIDS. Bids must be made on the Bid forms provided herein. Each Bid must be submitted in a sealed envelope, so marked as to indicate its contents without being opened, and addressed in conformance with the instructions in the ADVERTISEMENT FOR BIDS. Bids may not be submitted by Fax machine or electronically. The Contractor's license number shall be printed on the outside of the bid envelope, and the bid bond shall be in a separate envelope attached to the bid envelope.

12. MODIFICATION OF BID

Any Bidder may modify his bid by Fax or written communication at any time three hours prior to the scheduled closing time for receipt of bids, provided such communication is received by the Owner three hours prior to the closing time. The Fax or written communication should not reveal the bid price; it shall, however, state the addition or subtraction or other modification so that the final prices or terms will not be known by the Owner until the sealed bid is opened.

13. WITHDRAWAL OF BID

Any Bid may be withdrawn three hours prior to the scheduled time for the opening of Bid either by fax or written request, or in person. No Bid may be withdrawn three hours prior to the time scheduled for opening of Bids, unless the time specified in Item, AWARD OF CONTRACT, of these INSTRUCTIONS TO BIDDERS shall have elapsed.

14. BID SECURITY

Bids must be include a Bid Bond in the form of cash, a certified check, cashier's check drawn on a bank in good standing, or a bond issued by a Surety authorized to issue such bonds in the State of Arkansas, in the amount of 5% of the total amount of the Bid submitted. This bid security shall be given as a guarantee that the Bidder will not withdraw his Bid for a period of ninety **(90)** days after bid opening, and that if awarded the Contract, the successful Bidder will execute the attached Contract and furnish properly executed Performance and Payment Bonds, each in the full amount of the Contract price within the time specified. **The Bid will be disqualified if a Bid Bond is not attached in the approved form specified above.**

The Attorney-in-fact (Resident Agent) who executes this bond on behalf of the Surety must attach an original notarized copy of his power-of-attorney as evidence of his authority to bind the Surety on the date of execution of the bond.

All bid bonds and Contract bonds shall be executed by a licensed resident agent of the surety having his place of business in the State of Arkansas and in all ways complying with the laws of the State of Arkansas. The mere countersigning of a bond will not be sufficient.

15. RETURN OF BID SECURITY

Within fifteen **(15)** days after the award of the contract, the Owner will return the bid securities to all Bidders whose Bids are not to be further considered in awarding the Contract. Retained bid securities will be held until the Contract has been finally executed, after which all bid securities, other than Bidders' bonds and any guarantees which have been forfeited, will be returned to the respective Bidders whose Proposals they accompanied.

16. AWARD OF CONTRACT

Within ninety **(90)** calendar days after the opening of Bids, unless otherwise stated in the ADVERTISEMENT FOR BIDS or SUPPLEMENTARY CONDITIONS of these Documents, and provided it is in the best interest of the Owner, the Owner will accept one of the Bids or will act in accordance with BASIS OF AWARD, below. The acceptance of the bid will be by written notice of award, mailed or delivered to the office designated in the Bid. In the event of failure of the lowest responsible and responsive qualified Bidder to sign and return the Contract with acceptable Performance and Payment Bonds, as prescribed herein, the Owner may award the Contract to the next lowest possible responsible and responsive qualified Bidder. Such award, if made, will be made within 90 days after the opening of Bids.

17. BASIS OF AWARD

If, at the time this Contract is to be awarded, the total Base Bid of the lowest acceptable Proposal exceeds the funds then estimated by the Owner as available, the Owner may reject all bids or take such other action as best serves the Owner's interests, including consideration of selected Alternates.

18. EXECUTION OF CONTRACT

The successful Bidder shall, within ten (10) consecutive days after receiving notice of award, sign and deliver to the Owner the Contract hereto attached together with the acceptable bonds and insurance policies as required in these Documents. Within ten (10) consecutive days after receiving the signed Contract with acceptable bonds from the successful Bidder, the Owner's authorized agent will sign the Contract. Signature by both parties constitutes execution of the Contract.

The successful Bidder shall conform to the Rules and Regulations of Arkansas Department of Finance and Administration concerning nonresident contractor's notice and bond requirements.

19. PERFORMANCE AND PAYMENT BONDS

The successful Bidder shall file with the Owner a Performance Bond and Payment Bond each in the full amount of the Contract Price in accordance with the requirements of the State of Arkansas as applicable, as security for the faithful performance of the contract and the payment of all persons supplying labor and materials for the construction of the Work. The Surety furnishing the bond shall have a sound financial standing and a record of service satisfactory to the Owner, shall be authorized to do business in the State of Arkansas, and shall be listed on the current U.S. Department of Treasury Circular Number 570, or amendments thereto in the Federal Register, of acceptable Sureties for Federal Projects.

If the Surety or any Bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the project is located or it ceases to meet the requirements of the preceding paragraph, Contractor shall within five days thereafter substitute another Bond and Surety, both of which must be acceptable to Owner.

The Attorney-in-fact (Resident Agent) who executes this Performance Bond and Payment Bond in behalf of the Surety must attach a notarized copy of his power-of-attorney as evidence of his authority to bind the Surety on the date of execution of the bond. All Contracts, Performance and Payment Bonds, and respective powers-of-attorney will have the same date.

In the event the contract completion date is extended, the Contractor shall provide new Performance and Payment bonds reflecting the revised Contract completion date or estimated time of completion.

20. FAILURE TO EXECUTE CONTRACT AND FURNISH BOND

The Bidder who has a Contract awarded to him and who fails to properly execute the Contract and furnish the Performance Bond and Payment Bond, within the time frame stipulated elsewhere in these documents, shall forfeit the bid security that accompanied his bid, and the bid security shall be retained as liquidated damages by the Owner, and it is agreed that this sum is a fair estimate of the amount of damages the Owner will sustain in case the bidder fails to enter into a Contract and furnish the bonds as herein above

provided. Bid security deposited in the form of cash, a certified check, or cashier's check shall be subject to the same requirements as a Bid Bond.

21. PERFORMANCE OF WORK BY CONTRACTOR

The Contractor shall perform at least 40% of the total amount of the work to be performed under this Contract with his own forces. Any Contractor that proposes to do less than 40% of the work with his own forces shall request in writing and receive approval from the Owner prior to the opening of bids. If, during the progress of the Work hereunder, the Contractor requests a reduction of such percentage, and the Engineer determines that it would be to the Owner's advantage, the percentage of the Work required to be performed by the Contractor's own forces may be reduced; provided prior written approval of such reduction is obtained by the Contractor from the Owner.

22. TIME OF COMPLETION

The time of completion of the Work to be performed under this Contract is of the essence of the Contract. Delays and extensions of time may be allowed in accordance with the provisions stated in the GENERAL CONDITIONS. The time allowed for the completion of the work is stated in the Proposal.

23. PROVIDING REQUIRED INSURANCE

The Bidder's attention is directed to the insurance requirements set forth in the GENERAL CONDITIONS (amended in the SUPPLEMENTAL CONDITIONS, if appropriate). Submittal of a bid indicates full understanding and intent to comply with the insurance requirements which are a condition of the Contract.

24. TRENCH AND EXCAVATION SAFETY SYSTEM

In accordance with **Act 291 of 1993 of the State of Arkansas (A.C.A. §22—9-212)**, Bidders must provide a separate price for trench and excavation safety programs in the space provided on the bid form. Failure to do so will subject the bidder to disqualification.

25. SUBCONTRACTOR'S PERFORMANCE AND PAYMENT BOND

In accordance with **Act 190 of 1993 of the State of Arkansas (A.C.A. §22-9-404)**, subcontractors shall provide to the General Contractor a performance and payment bond if the condition of Section 1 of Act 190 are applicable to the project.

In the event the Work is not completed by the contract completion date, the Contractor shall provide new Performance and Payment bonds for any subcontractors reflecting the revised Contract completion date or estimated time of completion.

26. MAINTENANCE BOND

Prior to final payment a two **(2)** year Maintenance bond shall be furnished by the Contractor covering any defects in materials and workmanship for the required improvements installed in the amount of 50% of the total cost of those improvements. Improvements to be covered by the Surety shall include all improvements installed by the Contractor. The bond shall be in full force and effect for not less than two **(2)** years from

the date of final acceptance of the improvements, and further stating that any and all defects in materials and workmanship shall be corrected by the contractor by the end of the bond period. Work performed under the terms of the maintenance bond shall be approved by the City Engineer.

The Maintenance bond is subject to the same requirements and standards as the Performance and Payment bond.

END OF SECTION

The Bidder does hereby acknowledge the receipt of the following Addenda to these Plans and Specifications:

Addendum Number: _____ Date: _____
_____ Date: _____

SUBCONTRACTORS

List all the subcontractors and the line items they are performing with the total amount and percentage of work they are doing.

Subcontractor	Line items	Total Amount	% of Work

BID FORM

Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

A. Unit Price Schedules. The Bid Form includes three deductive alternates. Deductive alternate number 3 includes all line work for Line 4 – SW Tie In on construction drawings, deductive alternate number 2 includes all non-potable water line work on Line 5 – BNR loop on construction drawings, and deductive alternate number 1 includes all non-potable water line work and related Yard Hydrants on construction drawings.

B. Deductive alternate number 3 includes item 19

1. Items included under this deductive alternate include approximately 250 LF of 4" Purple PVC Pipe, fittings and valves and boxes, and approximately 50 LF of 2" HDPE line for tie in to existing system and associated fittings as show in construction drawings.

C. Deductive alternate number 2 includes item 20

1. Items included under this deductive alternate include approximately 450 LF of 2" HDPE line and fittings as shown in construction drawings.

D. Deductive alternate number 1 includes items 21 and 22

1. Items included under this deductive alternate include 5 2" post hydrants, approximately 200 LF of 2" HDPE line and fittings, and 3 2" hoses connections and 150 LF of copper piping and fittings.

E. If the Owner chooses deductive alternates, they will be omitted from the base bid in sequential order. Deductive alternate 1 would be omitted from the base bid first.

BID FORM

No.	Quantity	Unit	Item Description	Unit Price $	Total Amount $
1	1	LS	Mobilization		
2	1	LS	Demobilization		
3	1	LS	Excavation Safety		
4	1	LS	Performance and Payment Bonds		
5	1	LS	2 Year Maintenance Bond		
6	10	SY	Sidewalk Repair		
7	15	SY	Asphalt Repair		
8	20	LF	Curb and Gutter Repair		
9	1	LS	Pump Pad		
10	1	LS	Non-Potable Water Pump Station Package		
11	1	LS	200 Gallon Hydropneumatic Tank		
12	50	LF	4" DI FLxFL Suction Piping		
13	6	EA	4" DI FLxFL 45 Bend		
14	6	EA	Pipe Supports		

15	1	LS	Electrical System Tie In		
16	1	LS	Line 1 - Main Feed Line		
17	1	LS	Line 2 - BFP Tie In		
18	1	LS	Line 3 - NW Tie In		
19	1	LS	Line 4 - SW Tie In		
20	1	LS	Line 5 - BNR Loop		
21	1	LS	Yard Hydrants Upgrades and additions		
22	3	EA	Water Shutoff/Drain Assembly		

TOTAL BASE BID PRICE =

TOTAL BASE BID PRICE*

_____ ($_____)
Words Numbers

*Total amount to complete project including all items listed above.

DEDUCTIVE ALTERNATE NUMBER 3**

_____ ($_____)
Words Numbers

**Total amount for item 19

DEDUCTIVE ALTERNATE NUMBER 2***

_____ ($_____)
Words Numbers

***Total amount for item 20

DEDUCTIVE ALTERNATE NUMBER 1****

_____ ($_____)
Words Numbers

****Total amount for items 21 to 22

BIDDER'S DECLARATION AND UNDERSTANDING

The undersigned, hereinafter called the bidder, declares that the only persons or parties interested in this Proposal are those named herein, that this Proposal is, in all respects, fair and without fraud, that it is made without collusion with any official of the Owner, and that the Proposal is made without any connection or collusion with any person submitting another Proposal on this Contract.

The Bidder further 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, and that this Proposal is made according to the provisions and under the terms of the Contract Documents, which Documents are hereby made a part of this Proposal.

The Bidder further agrees that he has exercised his own judgment and has utilized all data, which he believes pertinent from the Engineer, Owner, and other sources in arriving at his own conclusions.

CONTRACT EXECUTION AND BONDS

The Bidder agrees that if this Proposal is accepted, he will, within ten (10) consecutive calendar days after notice of award, sign the Contract in the form annexed hereto, and

will at that time, deliver to the Owner the Performance Bond and Payment Bond and Certificate of Insurance required herein, and will, to the extent of his Proposal, furnish all machinery, tools, apparatus, and other means of construction and do the work and furnish all the materials necessary to complete all work as specified or indicated in the Contract Documents.

START OF CONSTRUCTION AND CONTRACT COMPLETION TIME

The Bidder further agrees to begin work on or before the date stated in the Notice to Proceed issued by the Owner to the Contractor and shall complete the construction in all respects by within **150** calendar days after the date specified in the Notice to Proceed.

LIQUIDATED DAMAGES

In the event the Bidder is awarded the Contract and shall fail to complete the work within the time limit or extended time limit agreed upon, as more particularly set forth in the Contract Documents, liquidated damages shall be paid to the Owner for all work awarded under the Contract until the work shall have been satisfactorily completed as provided by the Contract Documents, plus any costs to the Owner or monies paid by the Owner to the Engineer for additional engineering and inspection services associated with such delays.

Liquidated damages shall be cumulative for work not completed on schedule. Work that is not completed on schedule shall be rated at **$500 per day** until the work is completed.

This Bid submitted by:

_____
Contractor Name

_____

_____
Contractor Address

Arkansas State Contractors License #:_____

SEAL (if Bidder is a corporation)

By: _____

END OF SECTION

SECTION 00360

NOTICE OF AWARD

To: _____

_____

_____

PROJECT DESCRIPTION: **Siloam Springs WWTP On-Site Reuse**

The OWNER has considered the PROPOSAL submitted by you for the above described WORK in response to its ADVERTISEMENT FOR BIDS.

You are hereby notified that your PROPOSAL has been accepted for the project described above in the amount of $_____ Dollars and _____ cents ($_____).

You are required by the **Instructions to Bidders** to execute the **Construction Contract** in its entirety and furnish the required **Performance Bond, Payment Bond** within ten **(10)** calendar days from the date of this **NOTICE OF AWARD**.

If you fail to execute said Contract and to furnish said bonds and certificate of insurance within ten **(10)** days from the date of this NOTICE OF AWARD, said OWNER will be entitled to consider all your rights arising out of the OWNER'S acceptance of your PROPOSAL as abandoned and as a forfeiture of your BID BOND. The OWNER will be entitled to such other rights as may be granted by law.

You are required to return an acknowledged copy of this NOTICE OF AWARD to the OWNER within ten **(10)** days of this Notice.

Dated this ___ day of _____, 2016.

By: _____
Steve Gorszczyk

Title: Public Works Director

Receipt acknowledge this ___ day of _____, 2016.

By: _____

Title: _____

END OF SECTION

SECTION 00400

AGREEMENT

This **AGREEMENT**, made and entered into on this the ____ day of _____, 2016 by and between _____, hereinafter called the Contractor and THE CITY OF SILOAM SPRINGS, hereinafter called the City. The Contractor, for the consideration hereinafter set forth, hereby agrees with the City as follows:

The Contractor shall furnish all the materials, labor, equipment and all other things along with any and all related expenses incurred to perform all Work as specified in the manner and form as provided in the hereto attached Contract Documents. The Work is generally described as **Siloam Springs Wastewater Treatment Plant On-Site Reuse**

1. The Contractor shall commence Work under this Agreement on a date to be specified in a written Notice to Proceed and shall fully complete all the Work hereunder in **(150)** calendar days.

2. The Contractor and the City recognize that time is of the essence in the progress of this project and that the City will suffer financial loss if the Work is not fully completed within the time specified herein. Therefore, the Contractor and the City agree that liquidated damages in the amount of **five hundred dollars ($500)** a day will be assessed by the City against the Contractor for each day after the time specified herein that the Work is not fully completed.

   a. The City hereby agrees to pay to the Contractor for the faithful performance of the Work set forth in this Agreement the estimated amount of _____ _____ Dollars ($ _____) as per the unit prices in the PROPOSAL contained herein.

3. Incorporated by reference into this Agreement are the Instruction to Bidders, Proposal, the Contract Documents and the Plans & Specifications together with any written modifications thereto.

IN WITNESS WHEREOF, the City and the Contractor have executed this Agreement on the day and date first above written, in four (4) counterparts, each of which shall be deemed an original contract.

_____ The City of Siloam Springs

_____

_____

Company and Address _____

John Turner, MAYOR

_____

Company Officer Name and Signature

ATTEST:

_____

WITNESS Renea Ellis, CITY CLERK

END OF SECTION

SECTION 00680

NOTICE TO PROCEED

TO: _____

_____

_____

DATE: _____

PROJECT NAME: **Siloam Springs WWTP On-Site Reuse**

You are hereby notified to commence WORK in accordance with the Contract dated _____, 2016, on or before _____, 2016, and you are to complete the WORK by _____, 2016.

_____

Steve Gorszczyk
Public Works Director
City of Siloam Springs, AR

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE TO PROCEED is hereby acknowledged this the _____ day of _____, 2016.

_____

Contractor Name

_____

_____

Contractor Address

By : _____

Title : _____

END OF SECTION

SECTION 00700

GENERAL CONDITIONS

These General Conditions contain contractual-legal Articles that establish the requirements and conditions governing responsibility, policy, and procedures that apply during the construction and warranty period. Any modifications to the following Articles that are special to the Project under consideration will be made in the Supplementary Conditions.

DEFINITIONS

Wherever in the Contract Documents the following terms are used, the intent and meaning shall be interpreted as follows:

1. AS APPROVED
   The words "as approved", unless otherwise qualified, shall be understood to be followed by the words "by the Engineer".

2. AS SHOWN, AND AS INDICATED
   The words "as shown" and "as indicated" shall be understood to be followed by the words "on the Drawings".

3. BIDDER
   The person or persons, partnership, firm or corporation submitting a Proposal for the Work contemplated.

4. CONTRACT
   The "Contract" is the written agreement covering the performance of the work and the furnishing of labor, materials, incidental services, tools and equipment in the construction of the Work. It includes the "Contract Documents" and all supplemental agreements amending or extending the Work contemplated and which may be required to complete the Work in a substantial and acceptable manner. Supplemental agreements are written agreements covering alterations, amendments, or extensions to the Contract and include Contract Change Orders.

5. CONTRACT DOCUMENTS
   The "Contract Documents" consist of, but is not limited to, the following documents: Advertisement for Bids, Agreement, General Conditions, Supplementary Conditions, Notice to Proceed, Instructions to Bidders, Proposal, Change Order Procedures, the Specifications, and the Drawings (or Plans), including all modifications thereof incorporated into the Documents before their execution, and including all other requirements incorporated by specific reference thereof.

6. CONTRACTOR
   The person or persons, partnership, firm, or corporation who enters into the Contract awarded him by the Owner.

7. DAYS
Unless otherwise specifically stated, the term "days" will be understood to mean calendar days.

8. DRAWINGS
The term "Drawings" refers to the official Drawings, profiles, cross sections, elevations, details, and other working drawings and supplementary drawings, or reproductions thereof, sealed by the Engineer, which show the location, character, dimensions, and details of the Work to be performed. Drawings may either be bound in the same book as the Project Manual or bound separately and are a part of the Contract Documents, regardless of the method of binding.

9. ENGINEER
The City Engineer; unless a Professional Engineer is identified as such in the contract documents. The term "Engineer" means the Engineer or his authorized representative. Garver is an authorized representative.

10. NOTICE
The term "notice" or the requirement to notify, as used in the Contract Documents or applicable state or federal statutes, shall signify a written communication delivered in person or by certified or registered mail to the individual, or to a member of the firm, or to an officer of the corporation for whom it is intended. Certified or registered mail shall be addressed to the last business address known to him who gives the notice.

11. OR EQUAL
The term "or equal" shall be understood to indicate that the "equal" product is the same or better than the product named in function, performance, reliability, quality, and general configuration. The Engineer will make determination of equality in reference to the Project design requirements. Such "equal" products shall not be purchased or installed by the Contractor without the Engineer's written approval.

12. OWNER
The City of Siloam Springs is the Owner.

13. PLANS (See Drawings)

14. SPECIFICATIONS
Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards, and workmanship as applied to the Work and certain administrative details applicable thereto.

Where standard specifications, such as those as AASHTO, ASTM, AHTD, etc., have been referred to, the applicable portions of such standard specifications shall become a part of these Contract Documents.

Where portions of the work traverse or adjoin local streets, state highways, railroads, or Federal property, and the agency in control of such property has established standard specifications governing items of work that differ from these Specifications, the most stringent requirements shall apply.

The Contractor shall comply with all regulations and requirements of the Siloam Springs Street Department, wherever the work traverses or crosses City streets. Likewise, work in the right-of-way of all state highways shall conform to all regulations and requirements of the Arkansas Highway and Transportation Department.

15. NOTICE TO PROCEED

A written notice given by the Owner to the Contractor (with a copy to the Engineer) fixing the date on which the Contract time will commence to run and on which the Contractor shall start to perform his obligation under the Contract. The Notice to Proceed shall be given within thirty **(30)** days following execution of the Contract by the Owner.

16. SUBSTANTIAL COMPLETION

"Substantial Completion" shall be that degree of completion of the Project, or a defined portion of the Project, sufficient to provide the Owner, at his discretion, the full-time use of the Project or defined portion of the Project for the purposes for which it was intended and as more fully provided in Article 65 (below) of these General Conditions.

17. WORK

The "Work" within these Contract Documents shall include all material, labor, and tools; all appliances, machinery, transportation, and appurtenances necessary to perform and complete the Contract; and such additional items not specifically indicated or described which can be reasonably inferred as belonging to the item described or indicated and as required by good practice to provide a complete and satisfactory system or structure. As used herein, "provide" shall be understood to mean, "provide complete in-place", that is, "furnish and install".

CONTRACT DOCUMENTS

18. INTENT OF CONTRACT DOCUMENTS

The Contract Documents are complementary, and what is called for by one shall be as binding as if called for by all. The intent of the Documents is to include all Work (except specific items to be furnished by the Owner) necessary for completion of the Contract. Materials or Work described in words which when so

applied have a well-known technical and trade meaning shall be held to refer to such recognized standards.

19. DISCREPANCIES AND OMISSIONS

Any discrepancies or omissions found in the Contract Documents shall be reported to the Engineer immediately. The Engineer will clarify discrepancies or omissions, in writing, within a reasonable time.

In resolving inconsistencies among two or more Sections of the Contract Documents, precedence shall be given in the following order:

1. CONTRACT
2. SUPPLEMENTARY CONDITIONS
3. SPECIFICATIONS
4. INSTRUCTIONS TO BIDDERS
5. GENERAL CONDITIONS
6. DRAWINGS

Figure dimensions on Drawings shall take precedence over scale dimensions. Detailed Drawings shall take precedence over general Drawings. It is understood and agreed that the Work shall be performed and completed according to the true spirit, meaning, and intent of these Documents.

20. ALTERATIONS - CHANGES IN WORK

The Owner, without notice to the Sureties and without invalidating the Contract, may order changes in the Work within the general scope of the Contract by altering, adding to, or deducting from the Work, the Contract being adjusted accordingly. All such Work shall be executed under the conditions of the original Contract and bonds, except as specifically adjusted at the time of ordering such change.

In giving instructions, the Engineer may order minor changes in the Work not involving extra cost and not inconsistent with the purposes of the Project, but otherwise, except in an emergency endangering life or property, additions or deductions from the Work shall be performed only in pursuance of an approved Change Order from the Owner, as provided in Section 01028, CHANGE ORDER PROCEDURES, and no claim for additional payment shall be valid unless so ordered.

If the Work is reduced by alterations, such action shall not constitute a claim for damages based on loss of anticipated profits.

21. VERIFICATION OF CONTRACT DOCUMENTS

The Contractor shall thoroughly examine and become familiar with all of the various parts of these Contract Documents and determine the nature and location

of the Work, the general and local conditions, and all other matters, which can in any way affect the Work under this Contract. Failure to make an examination necessary for this determination shall not release the Contractor from the obligations of this Contract. The Contractor warrants that no verbal agreement or conversation with any officer, agent, or employee of the Owner, or with the Engineer either before or after the execution of this Contract has affected or modified any of the terms or obligations herein contained.

22. DOCUMENTS TO BE KEPT ON THE JOB SITE

The Contractor shall keep one copy of the Contract Documents on the job site, in good order, available to the Engineer and to his representatives. The Contractor shall maintain on a daily basis at the job site, and make available to the Engineer on request, one current record set of the Drawings which have been accurately marked up to indicate all modifications in the completed Work that differ from the design information shown on the Drawings. Upon substantial completion of the Work, the Contractor shall give the Engineer one complete set of marked up record Drawings. Failure of the Contractor to submit accurate Record Drawings to the Engineer will be adequate justification for postponement of the Final Inspection and Final Payment.

23. ADDITIONAL CONTRACT DOCUMENTS

The Engineer will furnish to the Contractor on request and free of charge, three copies of the Project Manual and three sets of full-size Drawings. Additional copies of the Project Manual and the Drawings may be obtained on request by paying the price as shown in the Advertisement for Bids of the Contract Documents.

24. OWNERSHIP OF DRAWINGS

All Drawings, Plans, Specifications, and copies thereof furnished by the Engineer and the Owner are their property. They are not to be used by the Contractor on other work and, with the exception of the signed Contract set, are to be returned to them on request at the completion of the Work. All models are the property of the Owner.

THE ENGINEER

25. AUTHORITY OF THE ENGINEER

The Engineer shall be the Owner's representative during the construction period. His authority and responsibility shall be limited to the provisions set forth in these Contract Documents. The Engineer shall have the authority to reject Work and material, which does not conform to the Contract Documents. However, neither the Engineer's authority to act under this provision, nor any decision made by him in good faith either to exercise or not to exercise such authority, shall give rise to any duty or responsibility of the Engineer to the Contractor, any Subcontractor, their respective Sureties, and of their agents or employees, or any other person performing any of the work.

26. **DUTIES AND RESPONSIBILITIES OF THE ENGINEER**

The Engineer may make periodic visits to the Project site to observe the progress and quality of the Work and to determine, in general, if the work is proceeding in accordance with the intent of the Contract Documents. He shall not be required to make comprehensive or continuous inspections to check quality or quantity of the Work, and he shall not be responsible for construction means, methods, techniques, sequences, or connection with the Work. Visits and observations made by the Engineer shall not relieve the Contractor of his obligation to conduct comprehensive inspection of the Work, and to furnish materials and perform acceptable Work, and to provide adequate safety precautions, in conformance with the intent of the Contract.

The Engineer will make decisions, in writing, on all claims of the Contractor arising from interpretation or execution of the Contract Documents. Such decision and Change Order shall be necessary before the Contractor can receive additional money under the terms of the Contract. Changes in Work ordered by the Engineer will be made in compliance with Article 20, ALTERATIONS - CHANGES IN WORK.

One or more construction observers may be assigned to observe the work for compliance with the Contract Documents and to act in matters of construction under this Contract. It is understood that such Construction observers shall have the power to issue instructions and make decisions within the limitations of the authority of the Engineer. The Contractor shall furnish all reasonable assistance required by the Engineer or construction observer for proper review of the Work. Construction observers shall not have the power of authority to delete, increase, modify or otherwise change the requirements of the Contract Documents. The above-mentioned observation shall not relieve the Contractor of his obligations to conduct comprehensive inspections of the Work and to furnish materials and perform acceptable Work and to provide adequate safety precautions, in conformance with the intent of the Contract.

27. REJECTED MATERIAL

Any material condemned or rejected by the Engineer or his authorized construction observer because of nonconformity with the Contract Documents shall be removed at once from the vicinity of the Work by the Contractor at his own expense, and the same shall not be used on the work.

28. **UNNOTICED DEFECTS**

Any defective Work or material that may be discovered by the Engineer before the final acceptance of Work, or before final payment has been made, or during the guarantee period, shall be removed and replaced by Work and materials which shall conform to the provisions of the Contract Documents. Failure on the part of the Engineer to condemn or reject bad or inferior Work or materials shall not be construed to imply acceptance of such Work

or materials. The Owner shall reserve and retain all of its rights and remedies at law against the Contractor and its surety for correction of any and all latent defects discovered after the guarantee period.

29. RIGHT TO RETAIN IMPERFECT WORK

In any part of portion of the Work done or material furnished under this Contract shall prove defective and not in accordance with the Drawings and Specifications, and if the imperfection in the same shall not be of sufficient magnitude or importance as to make the Work dangerous or unsuitable, or if the removal of such Work will create conditions which are dangerous or undesirable, the Owner shall have the right and authority to retain such Work but shall make such deductions in the final payment therefore as may be just and reasonable. The Owner shall also have the option to require, at no added cost to the Owner, extended warranties, maintenance bonds, or other remedies to provide for repair or reconstruction of imperfect work.

30. LINES AND GRADES

All stakes, marks, and other information shall be carefully preserved by the Contractor, and in case of their careless or unnecessary destruction or removal by him or his employees, such stakes, marks, and other information will be replaced at the Contractor's expense.

31. SHOP DRAWINGS SUBMITTAL PROCEDURE

The Contractor shall submit three (3) 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) required for the construction. Shop drawings shall be submitted in sufficient time to allow the Engineer not less than twenty **(20)** regular working days per submittal for examining the shop drawings.

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.

Unless otherwise approved by the Engineer, 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 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.

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 drawings may be rejected and one (1) set will be returned to the Contractor with such changes or corrections indicated, and the contractor shall correct and resubmit the shop drawings in quadruplicate, unless otherwise directed by the Engineer. No changes shall be made by the Contractor to resubmitted shop drawings other than those changes indicated by the Engineer, unless such changes are clearly described in a letter accompanying the resubmitted shop drawings.

The review of such shop drawings and catalog cuts by the Engineer shall not relieve the Contractor from responsibility for correctness of dimensions, 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 a 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. When the Contractor does call such deviations to the attention of the Engineer, the Contractor shall state in his letter whether or not such deviations involve any deduction or extra cost adjustment.

32. ADDITIONAL DETAIL DRAWINGS AND INSTRUCTIONS

The Engineer will furnish, with reasonable promptness, additional instructions by means of drawings or otherwise, if, in the Engineer's opinion, such are required for the proper execution of the Work. All such drawings and instructions will be consistent with the Contract Documents, true development thereof, and reasonably inferable there from.

THE CONTRACTOR AND HIS EMPLOYEES

33. INDEPENDENT CONTRACTORS

The contractor shall perform all work under this contract as an Independent Contractor and shall not be considered as an agent of the Owner or of the Engineer, nor shall the Contractor's subcontractors be employees or subagents of the Owner or of the Engineer.

34. SUBCONTRACTING

A. The Contractor shall not employ any subcontractors that the Engineer may object to in writing as lacking capability to properly perform Work of the type and scope anticipated. No changes will be allowed from the approved subcontractor list without written approval of the Engineer.

B. The Contractor agrees that he is as fully responsible to the Owner for the acts and omissions of his subcontractors and of persons either directly or indirectly employed by them as he is for the acts and omissions of persons directly employed by him.

C. Nothing contained in the Contract Documents shall create any contractual relation between any subcontractor and the Owner.

35. INSURANCE AND LIABILITY

A. GENERAL

The Contractor shall provide (from insurance companies licensed to do business in the State of Arkansas, and acceptable to the Owner) the insurance coverage designated hereinafter and pay all costs associated there with.

Upon the Contractor's execution of the Contract, Contractor shall furnish the Owner with complete copies of all insurance policies and certificates of insurance specified herein showing the type, amount, class of operations covered, effective dates, and date of expiration of policies, and containing substantially the following statement. "The insurance covered by this certificate will not be canceled or materially altered, except after 30 days written notice has been received by the Owner". In case of the breach of any provision of this Article, the Owner at its option, may take out and maintain, at the expense of the Contractor, such insurance as the Owner may deem proper and may deduct the cost of such insurance from any monies which may be due or become due the Contractor under this Contract.

B. SURETY AND INSURER QUALIFICATIONS

All bonds shall be executed by a licensed resident agent of the surety having his place of business in the State of Arkansas, and in all ways complying with the laws of the State of Arkansas. The mere countersigning of bonds will not be sufficient. Further, the said surety or insurance company shall be duly licensed and qualified to do business in the State of Arkansas.

C. CONTRACTOR AND SUBCONTRACTOR INSURANCE

The Contractor shall not execute the Contract or commence Work under this Contract until he has obtained all the insurance required hereunder and such insurance has been reviewed and approved by the Owner. Nor shall the Contractor allow any subcontractor to commence Work on his subcontract until insurance specified below has been obtained. Review of the insurance by the Owner shall not relieve or decrease the liability of the Contractor hereunder.

D. WORKER'S COMPENSATION & EMPLOYER'S LIABILITY INSURANCE

The Contractor shall maintain during the life of this Contract the statutory Worker's Compensation Insurance and, in addition, Employer's Liability

Insurance in an amount not less than one hundred thousand ($100,000) dollars for each occurrence, for all of his employees to be engaged in Work on the Project under this Contract and, in case any such Work is sublet, the Contractor shall require the subcontractor similarly to provide Worker's Compensation and Employer's Liability Insurance for all of their employees to be engaged in such Work. Where Work under this Contract includes any water or navigational exposure, coverage shall be included to cover the Federal Longshoremen's and Harbor worker's Act and the Federal Jones Act. Employer's Liability Insurance shall be extended to include waiver of subrogation to the Owner.

E. GENERAL LIABILITY INSURANCE

The Contractor shall maintain during the life of this Contract such general liability, completed operations and products liability, and automobile liability insurance as will provide coverage for claims for damages for personal injury, including accidental death, as well as for claims for property damage, which may arise directly or indirectly from performance of the Work under this contract. The general liability policy should also specifically ensure the contractual liability assumed by the Contractor under Article Indemnification. Amount of insurance to be provided shall be no less than as shown below:

1. Contractor's Comprehensive General Liability Insurance

For not less than the following limits of liability:

Bodily Injury:	$500,000 each occurrence $500,000 aggregate
Property Damage:	$250,000 each occurrence $250,000 aggregate

Include the following coverage:

} Broad Form Property Damage and Personal Injury Liability.

} Independent Contractor's Coverage

2. Contractor's Comprehensive Automobile Liability Insurance

For not less than the following limits of liability:

Bodily Injury:	$500,000 each person $1,000,000 each occurrence

Property Damage: $100,000 each occurrence

OR

Bodily Injury and Property Damage: $1,000,000 combined single limit each occurrence.

Include Hired car and Nonownership Coverage.

3. Contractor's Excess Umbrella Policy: $1,000,000 limit of liability policy shall be provided.

ENGINEER AND OWNER SHALL BE INCLUDED AS ADDITIONAL INSURED: Insurance certificates furnished by the Contractor and/or subcontractor(s) shall include the Engineer and Owner as an "Additional Insured" for all Liability and Property Damage policies.

In the event any Work under this Contract is performed by a subcontractor, the Contractor shall be responsible for any liability directly or indirectly arising out of the Work performed under this Contract by a subcontractor, which liability is not covered by the subcontractor's insurance.

The Contractor's and any subcontractor's general liability and automobile liability insurance policies shall include the Owner and Engineer, their officers, agents, and employees as additional insured for any claim arising out of Work performed under this Contract.

F. BUILDER'S RISK ALL-RISK INSURANCE

Unless otherwise modified in the Supplementary Conditions, the Contractor shall secure and maintain during the life of this Contract, Builder's Risk All Risk Insurance coverage in an amount equal to the full replacement value of structures, equipment, electrical, and mechanical systems only. Such insurance shall not exclude coverage for landslide, collapse, blasting, or loss due to the results of faulty workmanship and shall provide for losses to be paid to the Contractor, Subcontractor, and the Owner as their interests may appear.

G. OWNER'S AND CONTRACTOR'S PROTECTIVE LIABILITY INSURANCE

The Contractor shall, at his expense, provide the Owner with an Owner's and Contractor's Protective Liability Insurance Policy naming the Owner as the named insured and the Engineer, its architects and engineers, and each of their officers, agents and employees as additional insured under

that policy, said policy to protect said parties from claims which may arise from operations under the Contract.

Limits of policy coverage shall be:

Bodily Injury:	$500,000 each person $1,000,000 aggregate
Property Damage:	$250,000 each person $250,000 aggregate

OR $1,000,000 combined-single limit each occurrence/aggregate.

H. INSURANCE COVERAGE FOR SPECIAL CONDITIONS

When the construction is to be accomplished within a public or private right-of-way requiring special insurance coverage, the Contractor shall conform to the particular requirements and provide the required insurance. The Contractor shall include in his liability policy all endorsements that the said authority may require for the protection of the authority, its officers, agents and employees. Insurance coverage for special conditions, when required, shall be provided as set forth in the Supplementary Conditions.

I. NO PERSONAL LIABILITY OF PUBLIC OFFICIALS

In carrying out any of the provisions hereof in exercising any authority granted by the Contractor, there will be no personal liability upon any public official.

36. INDEMNITY

The contractor shall indemnify and hold harmless the Owner, the Engineer, and their agents and employees from and against damages, losses, and expenses including attorney's fees, arising out of or resulting from the performance of the Work, provided that any such claim, damage, loss or expense is: (1) attributable to bodily injury, sickness, disease, or death, or to injury or to destruction of tangible property (other than the Work itself), including the loss of use resulting there from, and (2) caused in whole or in part by any act or omission of the Contractor, any subcontractor, anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, except to the extent that such claims, damages, losses, and expenses are proximately caused by the negligence of any indemnities.

In any and all claims against the Owner, 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 acts any of them may be liable, the indemnification obligation under this Article 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 Benefit Acts.

37. TAXES AND CHARGES

The Contractor shall pay any and all sales and use taxes, including any and all change of taxes thereof necessary to complete the work under the Contract, and all withholding taxes, whether state or federal, and pay all Social Security charges and also all State Unemployment Compensation charges, and pay or cause to be withheld, as the case may be, any and all taxes, charges, or fees or sums whatsoever, which are now or may hereafter be required to be paid or withheld under any laws.

38. ORDINANCES, PERMITS, AND LICENSES

The Contractor shall keep himself informed of all local ordinances, as well as state and federal laws, which in any manner affect the Work herein specified. The Contractor shall at all times comply with said ordinances, laws, and regulations, and protect and indemnify the Owner, the Engineer and their respective employees, and its officers and agents against any claim or liability arising from or based on the violation of any such laws, ordinances, or regulations. All permits, licenses, and inspection fees necessary for prosecution and completion of the Work shall be secured and paid for by the Contractor, unless otherwise specified.

The Contractor shall observe and comply with all applicable local, state, and federal occupational safety and health regulations during the prosecution of work under this contract. In addition, full compliance by the Contractor with the U.S. Department of Labor's Occupational Safety and Health Standards, as established in Public Law 91-596, will be required under the terms of this Contract.

39. SUPERINTENDENT

The Contractor shall keep on the Work, during its progress, competent supervisory personnel. The Contractor shall designate, in writing, before starting Work, one authorized representative who shall have complete authority to represent and to act for the Contractor. The Contractor shall give efficient supervision to the Work, using his best skill and attention. The Contractor shall be solely responsible for all construction means, methods, techniques, and procedures, and for providing adequate safety precautions and coordinating all portions of the Work under the Contract. It is specifically understood and agreed that the Engineer, its employees and agents, shall not have control or charge of and shall not be responsible for the construction means, methods, techniques, procedures, or for providing adequate safety precautions in connection with the Work under the Contract.

40. RECEPTION OF ENGINEER'S DIRECTION

The superintendent, or other duly authorized representative of the Contractor, shall represent the Contractor in all directions given to him by the Engineer. Any direction of major importance may be confirmed in writing. Any direction will be so confirmed, in each case, on written request from the Contractor.

41. SANITATION

Sanitary conveniences conforming to state and local codes shall be erected and maintained by the Contractor at all times while workers are employed on the Work. The sanitary conveniences facilities shall be as approved by the Engineer.

42. EMPLOYEES

The Contractor shall employ only men or women who are competent and skillful in their respective line of work. Whenever the Engineer or Owner shall notify the Contractor that any person on the Work is, in their opinion, incompetent, unfaithful, or disorderly or refuses to carry out the provisions of this Contract or uses threatening or abusive language to any person representing the Owner on the Work, or is otherwise unsatisfactory, such person shall be immediately discharged from the Project and shall not be re-employed thereon except with the consent of the Owner.

43. PROJECT MEETINGS

The Engineer may conduct Project meetings, as he deems necessary, for the purposes of discussing and resolving matters concerning the various elements of the Work. Time and place for these meetings and the names of persons required to be present shall be as directed by the Engineer. Contractor shall comply with these attendance requirements and shall also require his subcontractors to comply.

44. SAFETY

A. The Contractor shall be solely and completely responsible for conditions of the job site, including safety of all persons (including employees) and property during performance of the Work. This requirement shall apply continuously and not be limited to normal working hours. Safety provisions shall conform to U.S. Department of Labor; (OSHA); the State Labor Department Laws; all other applicable federal, state, county, and local laws, ordinances, and codes; the requirements set forth below; and any regulations that may be detailed in other parts of these documents. Where any of these are in conflict, the more stringent requirements shall be followed. The Contractor's failure to thoroughly familiarize himself with the aforementioned safety provisions shall not relieve him from compliance with the obligations and penalties set forth herein.

B. 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.

C. 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.

D. The Contractor, as a 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 aforementioned authorities, all articles necessary for providing first aid to the injured, and shall establish the procedure for the immediate removal to a hospital of a doctor's care of persons (including employees) who may be injured on the job site. If death or serious injuries or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Engineer and the Owner. 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.

E. The Contractor shall submit a written report to the Engineer of any accident or injury occurring at the Construction Site.

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

No information relative to the Work shall be released by the Contractor, either before or after completion of the Work, for publication or for advertising purposes without the prior written consent of the Owner.

45. CONTRACTOR'S TOOLS AND EQUIPMENT

The Contractor's tools and equipment used on the Work shall be furnished in sufficient quantity and of a capacity and type that will safely perform the Work specified, and shall be maintained and used in a manner that will not create a hazard to persons or property, or cause a delay in the progress of the Work.

46. PROTECTION OF WORK AND PROPERTY

The Contractor shall at all times safely guard the Owner's property from injury or loss in connection with this Contract. The contractor shall at all times safely guard and protect from damage his own Work, and that of adjacent property (as provided by laws and the Contract Documents). All passageways, guard fences, lights, and other facilities required for protection by federal, state, or municipal laws and regulations and local conditions, must be provided and maintained.

The Contractor shall protect his Work and materials from damage due to the nature of the Work, the elements, carelessness of other Contractors, or from any cause whatever until the completion and acceptance of the Work. All loss or damages arising out of the nature of the work to be done under these Contract Documents, or from any obstruction or defects which may be encountered in the prosecution of the Work, or from the action of the elements, shall be sustained by the Contractor.

In addition, the Contractor shall take special precautions to prevent the "flotation" of all tanks and structures prior to their final acceptance and filling for beneficial use. The Contract price shall include all costs associated with such special precautions. Also, the Contractor shall not load or permit any part of any structure to be loaded with a weight that will endanger its safety or its structural integrity.

In the event that the stakes and marks placed by the Engineer are destroyed through carelessness on the part of the Contractor, and that the destruction of these stakes and marks causes a delay in the work, the Contractor shall have no claim for damages or extensions of time. In the case of any permanent monuments or benchmarks which must of necessity be removed or disturbed in the construction of the work, the Contractor shall carefully protect and preserve the same until they can be properly referenced and relocated. The Contractor shall also furnish at his own expense such materials and assistance as are necessary for the proper replacement of monuments or bench marks that have been moved or destroyed.

47. RESPONSIBILITY OF CONTRACTOR TO ACT IN EMERGENCY

In case of an emergency, which threatens loss or injury of property, and/or safety of life, the Contractor shall act, without previous instructions from the Owner of Engineer, as the situation may warrant. The Contractor shall notify the Engineer thereof immediately thereafter.

Any claim for compensation by the Contractor, together with substantiating documents in regard to expense, shall be submitted to the Owner through the Engineer and the amount of compensation shall be determined by agreement.

48. MATERIALS AND APPLIANCES

Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation, and other facilities necessary for the execution and completion of the Work.

Unless otherwise specified, all material shall be new, and both workmanship and materials shall of good quality. The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

In selecting and/or approving equipment for installation in the Project, the Owner and Engineer assume no responsibility for injury or claims resulting from failure of the equipment to comply with applicable national, state, and local safety codes or requirements, or the safety requirements of a recognized agency, or failure due to faulty design concepts, or defective workmanship and materials.

49. CONTRACTOR'S AND MANUFACTURERS' COMPLIANCE WITH STATE SAFETY, OSHA, AND OTHER CODE REQUIREMENTS.

The completed work shall include all necessary permanent safety devices, such as machinery guards and similar ordinary safety items required by the state and federal (OSHA) industrial authorities and applicable local and national codes. Further, any features of the Work (including Owner-selected equipment) subject to such safety regulations shall be fabricated, furnished, and installed in compliance with these requirements. Contractors and manufacturers of equipment shall be held responsible for compliance with the requirements included herein. Contractors shall notify all equipment suppliers and subcontractors of the provisions of this Article.

50. SUBSTITUTION OF MATERIALS

Except for Owner-selected equipment items and items where no substitution is clearly specified, whenever any material, article, devise, product, fixture, form, type or construction, or process is indicated or specified by patent or proprietary name, by name of manufacturer, or by catalog number, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the material or process desired. This procedure is not to be construed as eliminating from competition other products of equal or better quality by other manufacturers where fully suitable in design, and shall be deemed to be followed by the words "or equal". The Bidder may, in such cases, submit complete data to the Engineer (with his Bid Proposal, as stipulated herein above) for consideration of another material, type, or process, which shall be substantially equal in every respect to that so indicated or specified. Substitute materials shall not be used unless approved in writing. The Owner or his authorized agent will be the sole judge of the substituted article or material.

51. TESTS, SAMPLES AND INSPECTIONS

The Contractor shall furnish, without extra charge, the necessary test pieces and samples, including facilities and labor for obtaining the same, as requested by the Engineer. When required, the Contractor shall furnish certificates of tests of materials and equipment made at the point of manufacture by a recognized testing laboratory.

The Owner, Engineer, authorized government agents, and their representatives shall at all times be provided safe access to the Work wherever it is in preparation or progress, and the Contractor shall provide facilities for such access and for inspection, including maintenance of temporary and permanent access.

If the Specifications, the Engineers instructions, laws, ordinances, or any public authority requires any Work to be specifically tested or approved, the Contractor shall give timely notice of its readiness for inspection. Inspections to be conducted by an approved testing laboratory will be promptly made, and where practicable, at the source of supply. **If any Work should be covered up without approval or consent of the Engineer, it shall be uncovered for examination at the Contractor's expense.**

52. ROYALTIES AND PATENTS

The Contractor shall pay all royalty and license fees, unless otherwise specified. The Contractor shall defend all suits and claims for infringement of any patent rights and shall save the Owner and the Engineer harmless from any and all loss, including reasonable attorneys' fees, on account thereof, up to the amount of the Contract Price.

53. CONTRACTOR'S RIGHT TO STOP WORK OR TERMINATE CONTRACT

If the Work should be stopped under an order of any court or other public authority for a period of more than 3 months, through no act or fault of the Contractor, its Subcontractors, or respective employees or agents, then the Contractor may, upon 15 days' written notice to the Owner and the Engineer, if said default has not been cured, stop Work to terminate this Contract and recover from the Owner payment for the reasonable value of Work performed.

54. CORRECTION OF DEFECTIVE WORK FOUND DURING WARRANTY PERIOD

The Contractor hereby agrees to make, at his own expense, all repairs or replacement necessitated by defects in materials or workmanship, supplied under terms of this Contract, and pay for any damage to other work resulting from such defects, which become evident within two (2) years after the date of final acceptance of the Work and after receipt of the Maintenance Bond, or within such longer period of time as may be prescribed by law or by the terms of any applicable special guarantee required by the Contract Documents. The contractor further assumes responsibility for a similar guarantee for all Work and materials provided by subcontractors or manufacturers of packaged equipment components. The effective date for the start of the guarantee or warranty period for equipment qualifying as substantially complete is defined in Article 16, SUBSTANTIAL COMPLETION, and Article 65, SUBSTANTIAL COMPLETION DATE, in these General Conditions. The Contractor also agrees to hold the Owner and the Engineer harmless from liability of any kind arising from damage due to said defects. The Contractor shall make all repairs and replacements promptly upon receipt of written order for same from the Owner. If the Contractor fails to make the repairs and replacements promptly, the Owner may do the Work, and the Contractor and his surety shall be liable for the cost thereof. Any additional requirements for the Project relative to correction of defective Work after final acceptance are set forth in the Supplementary Conditions.

PROGRESS OF THE WORK

55. BEGINNING OF THE WORK

Before Work shall be started and materials ordered, the Contractor shall meet and consult with the Owner and/or Engineer relative to materials, equipment, and all arrangements for prosecuting the Work.

56. SCHEDULES AND PROGRESS REPORTS

The Contractor shall submit to the Owner such schedule of quantities and costs, progress schedules, payrolls, reports, records, and other data as the Owner may request concerning Work performed or to be performed under this contract.

Construction Schedule Requirements: The Contractor shall comply with the following requirements concerning construction scheduling and payments:

The Contractor shall submit a construction schedule of the bar graph type (or other approved type) prior to the pre-construction conference showing the following information as a minimum:

1. Date of Notice to Proceed with Contract Work

2. Actual date construction is scheduled to start if different from the date of Notice to Proceed.

3. Contract completion date.

4. Beginning and completion dates for each phase of Work.

5. The dates at which special detail drawings are required.

6. Respective dates for submission of shop drawings and the beginning of manufacture, the testing of, and the installation of materials, supplies, and equipment.

7. All construction milestone dates.

8. A separate graph showing Work placement in dollars versus Contract time.

The schedule shall incorporate approved Contract changes. The schedule shall be maintained in an up-to-date condition monthly and shall be available for inspection at the construction site at all times.

The construction schedule shall be submitted in conjunction with an/or in addition to any other requirements concerning schedule within these Specifications.

57. PROSECUTION OF THE WORK

It is expressly understood and agreed that the time of beginning, rate of progress, and time of completion of the Work are the essence of this Contract. The Work shall be prosecuted at such time, and in or on such part or parts of the Project as may be required, to complete the Project as contemplated in the Contract Documents and the approved construction schedule.

If the Contractor desires to carry on Work at night or outside the regular hours (7:00 a.m. to 6:00 p.m., Monday through Friday), he shall first obtain the permission of the Engineer. He shall also give timely notice to the Engineer to allow satisfactory arrangements to be made for observation of the Work in progress. If the Work to be done "after hours" requires the full-time presence of a representative of the Engineer, then the Contractor must reimburse the Owner for payments made to the Engineer and all other costs incurred for this purpose.

The cost of additional engineering services will be based upon actual hours worked plus out-of-pocket expenses such as lodging, mileage, materials, etc. Otherwise, the Contractor may perform cleanup work only outside of regular hours (including Saturdays and Sundays).

To ensure standardization and uniformity in all parts of the work under this Contractor, like items of materials shall be the products of one manufacturer.

58. ASSIGNMENT

Neither party to the Contractor shall assign the Contract or sublet it as a whole, without the written consent of the other, nor shall the Contractor assign any monies due or to become due to him hereunder without the previous written consent of the Owner.

59. OWNER'S RIGHT TO DO WORK

If the Contractor should, in the opinion of the Engineer, neglect to prosecute the Work properly or should neglect or refuse at his own cost to take up and replace Work as shall have been rejected by the Engineer, then the Owner shall notify the Surety of the condition, and after ten (10) days written notice to the Contractor and the Surety, or without notice if an emergency or danger to the Work or public exists, and without prejudice to any other right which the Owner may have under the Contract, take over that portion of the Work which has been improperly executed or uncompleted, and make good the deficiencies and deduct the cost thereof from the payments then or thereafter due the Contractor, and if such payments are not sufficient thereof, charge the cost to the Contractor and its surety.

60. OWNER'S RIGHT TO TRANSFER EMPLOYMENT

If the Contractor should abandon the Work or should be adjudged bankrupt, or if he should make a general assignment for the benefit of his creditors, or if a receiver should be appointed on account of his insolvency, or if he should persistently or repeatedly refuse or should fail to supply enough properly skilled workers or proper materials, or if he should fail to make prompt payment to subcontractors for material or labor, or disregard laws, ordinances, or the instructions of the Engineer, or otherwise be guilty of a substantial violation of any provision of the Contract or any laws or ordinance, then the Owner may, without prejudice to any other right or remedy, and after giving the Contractor and the surety ten (10) days written notice, transfer the employment for said Work from the Contractor to the Surety. Upon receipt of such notice, such Surety shall enter upon the premises and take possession of all materials, tools, and appliances thereon for the purpose of completing the Work included under this Contract and employ, by Contract and otherwise, any qualified person or persons to finish the Work and provide the materials therefore, in accordance with the Contract Documents, without termination of the continuing full force and effect of this Contract. In case of such transfer of employment to such Surety, the Surety shall be paid in its own name on estimates according to the terms hereof without any right of the Contractor to make any claim for the same or any part thereof.

If after the furnishing of said written notice to the Surety, the Contractor and the Surety still fail to make reasonable progress on the performance of the Work, the Owner may terminate the employment of the Contractor and take possession of the premises and of all materials, tools and appliances, thereon and finish the work by whatever method he may deem expedient and charge the cost thereof to the Contractor and Surety. In such case, the Contractor shall not be entitled to receive any further payment until the Work is finished. If the expense of completing the Contract, including compensation for additional managerial and administrative services, shall exceed such unpaid balance, the Contractor and the Surety shall pay the difference to the Owner.

61. DELAYS AND EXTENSION OF TIME.

If the Contractor is delayed in the progress of the Work by any separate Contractor employed by the Owner, or by strikes, lockouts, fire, excessive adverse weather conditions not reasonably anticipated (on the basis of official weather records from the past ten years minimum, from the locality involved), or acts of God, the contractor shall, within 48 hours of the start of the occurrence, give written notice to the Owner of the cause of the potential delay and estimate the possible time extension involved, and within seven (7) days after the cause of the delay has been remedied, the Contractor shall give written notice to the Owner of any actual time extension requested as a result of the aforementioned occurrence; then the Contract time may be extended by Change Order for such reasonable time as the Owner determines. It is agreed that no claim shall be made or allowed for any damage, which may arise out of any delay caused, by the

above-referenced acts or occurrences, other than claims for the appropriate extension of time.

No extension of time will be granted to the Contractor for delays occurring to parts of the Work that have no measurable impact on the completion of the total work under this Contract; nor will extension of time be granted for delays to parts of Work that are not located on the critical path if the Critical Path Method (CPM) is used for scheduling the Work.

The Contractor acknowledges and agrees that delays due to changes, differing site conditions, and suspensions of work will require that the Contractor revise preferential sequences of construction to maximize the use of the available "float time", before proposing an updated schedule which supports a delay to the Contract as a whole. Time extensions shall not be granted until all "float" or "contingency time", at the time of the delay, available to absorb specific delays and associated impacts is used.

No extension of time will be considered for weather conditions normal to the area in which the work is being performed. Unusual weather conditions, if determined by the Owner to be a severity that would stop all progress of the Work, may be considered as a cause for an extension of Contract completion time. The Contractor shall provide official documentation of weather conditions experienced versus those anticipated as described above.

Delays in delivery of equipment or material purchased by the Contractor or his subcontractors (including Owner-selected) equipment shall not be considered as a just cause for delay.

The contractor shall be fully responsible for the timely ordering, scheduling, expediting, delivery, and installation of all equipment and materials.

Within a reasonable period after the Contractor submits to the Owner a written request for an extension of time, the Engineer will present his written opinion to the Owner as to whether an extension of time is justified, and, if so, his recommendation as to the number of days for time extension. The Owner will make the final decision on all requests for extension of time.
By submitting his Proposal to perform the work herein specified, the Contractor agrees that the materials/equipment specified are available for construction of the project within the time frame(s) stipulated herein. Further, the Contractor thereby agrees that time extension requests/cost increases shall not be justified upon the basis of non-availability of materials/equipment.

In no event shall the Contractor be entitled under this Contract to collect or recover any damages, loss, or expense incurred by any delay other than as caused by the Owner, as stipulated in Article 73, NOTICE OF CLAIM FOR DELAY.

62. LIQUIDATED DAMAGES

The Work shall begin at the time stated in the Notice to Proceed issued by the Owner to the Contractor and shall be completed within the number of consecutive calendar days, or by the calendar date, stated in the accepted Proposal and Contract. The time shall be computed from and including the date stated in the Notice to Proceed. It is agreed that time is of the essence of this Contract.

The Contractor agrees that said Work shall be prosecuted regularly, diligently, and uninterruptedly at such rate of progress as will insure full completion thereof within the time specified. It is expressly understood and agreed, by and between the Contractor and the Owner, that the time for the completion of the Work described herein is a reasonable time for the completion of the same, taking into consideration the average climatic range and usual construction conditions prevailing in this locality.

If the Contractor shall neglect, fail, or refuse, to complete the Work within the time herein specified, or any proper extension thereof granted by the Owner, then the contractor does hereby agree, as a part consideration for the awarding of this Contract, a penalty put as liquidated damages for such breach of Contract, as hereinafter set forth, for each and every calendar day that the Contractor shall be in default after the time stipulated in the Contract for completing the Work.

The said amount is fixed and agreed upon by and between the Contractor and the Owner because of the impracticability and extreme difficulty of fixing and ascertaining the actual damages which the Owner would in such event sustain, and said amount shall be retained from time to time by the Owner from current periodic pay estimates.

63. OTHER CONTRACTS

The owner reserves the right to let other Contracts in connection with the work. 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 his Work with theirs.

If any part of the Work under this Contract depends on the prior acceptable completion of Work by others under separate Contract(s), the contractor shall inspect and promptly report to the Engineer any defects in such Work that would adversely affect the satisfactory completion of the Work under this Contract. The Contractor's failure to so inspect and report shall constitute acceptance of the Work by others as being suitable for the proper reception and completion of the Work under this contract, excluding, however, those defects in the Work by others that occur after the satisfactory completion of the Work specified hereunder.

64. USE OF PREMISES

The Contractor shall confine his equipment, the storage of materials, and the operation of his workers to limits shown on the Drawings or indicated by law, ordinances, permits, or directions of the Engineer, and shall not unreasonably encumber the premises with his materials. The Contractor shall provide, at his own expense, the necessary rights-of-way and access to the Work, which may be required outside the limits of the Owner's property.

65. SUBSTANTIAL COMPLETION DATE

The Owner may, at his sole discretion, issue a written notice of substantial completion for the purpose of establishing the starting date for specific equipment guarantees, and to establish the date that the Owner will assume the responsibility for the cost of operating such equipment. Said notice shall not be considered as final acceptance of any portion of the Work or relieve the Contractor from completing the remaining Work within the specified time and in full compliance with the Contract Documents.

Such substantial completion shall not relieve the Contractor from liquidated damages should the Owner have added costs after the completion date, i.e., if additional construction observation, interest paid, loss of revenue, or other expenses continue to be charged to the Owner.

Substantial completion of an operating facility shall be that degree of completion that will provide a minimum of seven **(7)** continuous workdays of successful operation in which all performance and acceptance testing has been successfully demonstrated to the Engineer. All equipment contained in the Work, plus all other components necessary to enable the Owner to operate the facility in the manner that was intended, shall be complete on the substantial completion date. See "SUBSTANTIAL COMPLETION" under Article DEFINITIONS, of these General Conditions.

66. PERFORMANCE TESTING

Operating equipment and systems shall be performance tested in the presence of the Engineer to demonstrate compliance with the specified requirements. Performance testing shall be conducted under the specified design operating conditions or under such simulated operating conditions as recommended or approved by the Engineer. The Contractor shall schedule such testing with the Engineer at least one **(1)** week in advance of the planned date for testing.

67. OWNER'S USE OF PORTIONS OF THE WORK

The Owner shall have the right to take possession of and use any completed or partially completed portions of the Work. Such use shall not be considered as final acceptance of any portion of the Work, not shall such use be considered as cause for an extension of the Contract completion time, unless authorized by a Change Order issued by the Owner.

68. CUTTING AND PATCHING

The Contractor shall do all cutting, fitting, or patching of his Work that may be required to make its several parts come together properly and fit it to receive or be received by Work of other Contractors shown upon or reasonable implied by the Drawings. Any defective Work or material, performed or furnished by the Contractor, that may be discovered by the Engineer before the final acceptance of the Work or before final payment has been made, shall be removed and replaced or patched, in a manner as approved by the Engineer at the expense of the Contractor.

69. CLEANING UP

The Contractor shall, at all times, at his own expense, keep property on which Work is in progress and the adjacent property free from accumulations of waste material or rubbish caused by employees or by the Work. Upon completion of the construction, the Contractor shall at his own expense, remove all temporary structures, rubbish, and waste materials resulting from his operations.

PAYMENT

70. CHANGE ORDERS

No Work or Payment shall commence pursuant to any Change Order unless the following shall first occur:

1. The Contractor shall have written approval of the Change Order from the Board of Directors for any change order, which increases the scope of work or the contract amount.

2. The Surety has provided written extended coverage for any Change Order, which either increases the scope of work, or the Contract Amount.

Payment or credit for any alterations covered by a Change Order shall be determined by one or a combination of the methods set forth in A or B as applicable and as provided in Section 01028, Change Order Procedures:

A. UNIT PRICES

If applicable, Unit Prices that are not in the PROPOSAL, the Contractor and Owner may utilize Unit Prices as mutually agreed upon.

B. LUMP SUM

A total lump sum for the Work may be negotiated as mutually agreed upon by the Contractor and Owner. Contractor's quotations for Change Orders shall be in writing and firm for a period of ninety **(90)** days. Any compensation paid in conjunction with the terms of a Change Order shall comprise total compensation due the Contractor for the Work or alteration defined in the Change Order. By signing the Change Order, the Contractor acknowledges that the stipulated compensation includes

payment for the Work or alteration plus all payment for the interruption of schedules, extended overhead, delay or any other impact claim or ripple effect, and by such signing specifically waives any reservation or claim for additional compensation in respect to the subject of the Change Order.

The Owner's request for quotations on alterations to the Work shall not be considered authorization to proceed with the Work prior to the issuance of a formal Change Order, nor shall such request justify any delay in existing Work. Lump Sum quotations for alterations to the work shall include substantiating documentation with an itemized breakdown of Contractor and subcontractor costs, including labor, material, rentals, approved services, overhead, and profit in accordance with Section 01028, CHANGE ORDER PROCEDURES.

The amount of credit to Owner for any such change which results in a net decrease in cost will be the amount of the actual net decrease plus a deduction in the Contractor's fee by an amount equal to overhead and profit percentage of the net decrease.

71. PARTIAL PAYMENTS

A. GENERAL

Nothing contained in this Article shall be construed to affect the right, hereby reserved, to reject the whole or any part of the aforesaid Work, should such Work be later found not to comply with the provisions of the contract Documents. All estimated quantities of Work for which partial payments have been made are subject to review and correction. Payment by the Owner and acceptance by the contractor of partial payments based on periodic estimates of quantities of Work performed shall not in any way, constitute acceptance of the estimated quantities used as the basis for computing the amounts of the partial payments. For public works projects, each partial payment request and final payment request shall contain an affidavit by the Contractor that all provisions of the applicable federal and state requirements regarding apprentices and payment of prevailing wages have been compiled with by him and by his Subcontractors.

B. ESTIMATE AND PAYMENT

Before the first working day of each calendar month, the Contractor shall submit to the Engineer a detailed estimate of the amount earned for the separate portions of the Work, and request payment. As used in this Article, the words "amount earned" means the value, on the date of the estimate for partial payment, of the Work completed in accordance with the Contract Documents, and the value of approved materials delivered to the Project site suitably stored and protected prior to incorporation into the Work. If the Contractor's estimate of amount earned conforms with the

Engineer's evaluation, the Engineer will calculate the amount due the Contractor and make recommendation to the Owner for payment.

An estimate of monthly progress payments shall be provided for the entire job prior to the first payment request. The estimate of progress payments shall be updated if the actual progress differs in any given month. Each monthly payment request shall include the required updated Schedule.

If the updated Schedule is not submitted, the Owner may withhold payment until this item is completed. The Contractor shall be paid within thirty **(30)** days of approval of the payment request.

C. DEDUCTION FROM ESTIMATE

Unless modified in the Supplementary Conditions, deductions from the estimate will be as described below.

The Owner will deduct from the estimate, and retain as part security, 10% of the amount earned for Work satisfactorily completed. However, no deduction or retainage will be made on the approved items of material delivered to and properly stored at the job site, but not incorporated in the Work. When the Work is 50% complete, the Owner may "freeze" the retainage at 5% of the dollar value of the total contract provided that the contractor is making satisfactory progress and there is no specific cause for a greater retainage. The Owner may reinstate the retainage up to 10% of the dollar value of "Work complete to date" if the Owner determines, at his discretion, that the Contractor is not making satisfactory progress or where there is other specific cause for such withholding. Retainage of 5 percent of the total contract will not be paid until the final estimate is approved by the Owner, and within thirty **(30)** days of receiving the Maintenance Bond.

D. QUALIFICATION FOR PARTIAL PAYMENT FOR MATERIALS DELIVERED

Unless modified in the Supplementary Conditions, qualification for partial payment for materials delivered but not yet incorporated into the Work shall be as described below.

Materials, as used herein, shall be considered to be those items, which are fabricated or manufactured materials and equipment. To receive partial payment for materials delivered to the site, but not incorporated in the Work, it shall be necessary for the Contractor to include invoices of such materials and documentation warranting that the materials and equipment are covered by appropriate property insurance and other arrangements to protect Owner's interest therein; all of which must be satisfactory to Owner.

At his sole discretion, the Owner may approve items for which partial payment is to be made. Proper storage and protection shall be provided by the Contractor, and as approved by the Engineer. Final payment shall be made only for materials actually incorporated in the Work and, upon acceptance of the Work, all materials remaining for which advance payments had been made shall revert to the Contractor, unless otherwise agreed, and partial payments made for these items shall be deducted from the final payment for the work.

E. PAYMENT

After deducting the retainage and the amount of all previous partial payments made to the Contractor, the amount earned as of the current month will be made payable to the contractor within thirty **(30)** days of the Owner's receipt of an approved request.

72. NOTICE OF CLAIM FOR DELAY

If the Contractor intends to file a claim for additional compensation for delay caused by the Owner at a particular time, he shall file a notice of claim with the Owner within seven **(7)** days of the beginning of the occurrence. The notice of claim shall be in duplicate, in writing, and need not state the amount. No claim for additional compensation will be considered unless the provisions of Article 61, DELAYS AND EXTENSION OF TIME, are complied with, and a notice of claim has been filed with the Owner in writing, as stated above. Should the Owner be prevented or enjoined from proceeding with Work or from authorizing its prosecution by reason of any litigation, the Contractor shall not be entitled to make or assert claim for damage by reason of said delay; but time for completion of the Work will be extended to such reasonable time as the Owner may determine will compensate for time lost by such delay, with such determination to be set forth in writing.

73. RELEASE OF LIENS OR CLAIMS

The Contractor shall indemnify and save harmless the Owner from all claims for labor, supplies, equipment, and materials furnished under this Contract. Prior to the final payment, the Contractor shall furnish to the Owner, as part of his final payment request, an affidavit that all of the Contractor's obligations on the Project have been satisfied and that there are no unpaid taxes, liens, vendors' liens, rights to lien or any other type of claim against the Project, and that the hourly wages paid to all persons on the Project were in accordance with the applicable federal, state, and contracted wage scales.

74. FINAL PAYMENT

Upon completion of all of the work under this Contract, the Contractor shall notify the Engineer, in writing, that he has completed his part of the Contract and shall request final inspection. Upon receipt of the Contractor's written notice that the work is ready for final inspection, the Engineer shall make such inspection

and shall submit to the Owner his recommendation as to acceptance of the completed Work and as to the final estimate of the amount due the Contractor under this Contract. Upon approval of this final estimate by the Owner and compliance with provisions in Article 74, RELEASE OF LIENS OR CLAIMS, receipt of the two-year maintenance bond, and other provisions as may be applicable, the Owner shall pay to the Contractor all monies due him under the provisions of these Contract Documents.

75. NO WAIVER OF RIGHTS

Neither the inspection of the Owner, through the Engineer or any of his employees, nor any order by the Owner for payment of money, nor any payment for, or acceptance of, the whole or any part of the Work by the Owner or Engineer, nor any extension of time, nor any possession taken by the Owner or its employees shall operate as a waiver of any provision of this Contract, or any power herein reserved to the Owner, or any right to damages herein provided nor shall any waiver of any breach in this Contract be held to be a waiver of any other or subsequent breach.

76. ACCEPTANCE OF FINAL PAYMENT CONSTITUTES RELEASE

The acceptance by the Contractor of the final payment shall release the Owner and the Engineer, as agent of the Owner, from all claims and all liability to the Contractor for all things done or furnished in connection with the Work, and every act of the Owner and others relating to or arising out of the Work. No payment, however, final or otherwise, shall operate to release the Contractor or his Sureties from obligations under this Contract and the Performance and Payment Bonds, and other bonds and warranties, as herein provided.

77. DISPUTES

Any claim or dispute whatever, arising in any way out of the work, this project, or the contract documents, shall be litigated solely in the trial courts of Benton County, Arkansas, and appellate courts of Arkansas.

END OF SECTION

ASA HUTCHINSON
GOVERNOR

STATE OF ARKANSAS
ARKANSAS DEPARTMENT OF LABOR
PREVAILING WAGE DIVISION

LEON JONES, JR.
DIRECTOR

10421 WEST MARKHAM • LITTLE ROCK, AR 72205-2190
Phone: 501-682-4536 Fax: 501-682-4506 TRS: 800-285-1131

Chris Buntin
Garver Engineers L.L.C.
2049 E Joyce Blvd, Suite 400
Fayetteville, AR 72703

March 9, 2016

RE: WASTEWATER TREATMENT PLANT ON-SITE REUSE
SILOAM SPRINGS, ARKANSAS
BENTON COUNTY

Dear Chris Buntin:

In response to your request, enclosed is Arkansas Prevailing Wage Determination Number **15-458** establishing the minimum wage rates to be paid on the above-referenced project. These rates were established pursuant to the Arkansas Prevailing Wage Law, Ark. Code Ann. §§ 22-9-301 to 22-9-315 and the administrative regulations promulgated thereunder.

If the work is subject to the Arkansas Prevailing Wage Law, every specification shall include minimum prevailing wage rates for each craft or type of worker as determined by the Arkansas Department of Labor Ark. Code Ann. § 22-9-308 (b) (2). Also, the public body awarding the contract shall cause to be inserted in the contract a stipulation to the effect that not less than the prevailing hourly rate of wages shall be paid to all workers performing work under the contract. Ark. Code Ann. § 22-9-308 (c). Additionally, the scale of wages shall be posted by the contractor in a prominent and easily accessible place at the work site. Ark. Code Ann. § 22-9-309 (a).

Since this determination contains both Building and Heavy construction classifications, please be advised that "Building construction" means generally the construction of sheltered enclosures with walk-in access for the purpose of housing persons, machinery, equipment or supplies. It includes all construction of such structures, the installation of utilities and the installation of equipment, both above and below grade level, as well as incidental grading, utilities and paving. Additionally, such structures need not be "habitable" to be building construction. The installation of heavy machinery and/or equipment does not generally change the project's character as a building. "Heavy construction" means those construction projects that are not properly classified as "building", "highway", or "residential".

I have enclosed a copy of the 2 sections of the Prevailing Wage Administrative Regulations which apply to a multiple determination (e.g., building and heavy rates). You can access a complete copy of the Arkansas Prevailing Wage Law and Regulations from our website at www.labor.ar.gov .

Also enclosed is a **"Statement of Intent to Pay Prevailing Wages"** form that should be put in your specifications along with the wage determination. The General/Prime Contractor is responsible for getting this form filled out and returned to this office within 30 days of the Notice to Proceed for this project. **When you issue the Notice to Proceed for this project, please send a copy of the notice to my office.**

If you have any questions, please call me at (501) 682-4536 or fax (501) 682-4506.

Sincerely,

Lorna Kay Smith

Lorna K. Smith
Prevailing Wage Division

Enclosures

Memorandum

To: All Architects and Engineers

From: Lorna Smith, Prevailing Wage Division

Re: Sections of the Prevailing Wage Administrative Regulations.

Enclosed are sections 1.101 (2), (8), & (9) and 2.100 (i) (1) & (2) of the Prevailing Wage Administrative Regulations. Please take a few moments to review the sections and share with your associates.

If you would like a complete copy of the Administrative Regulations and/or the Arkansas Prevailing Wage Law, Ark. Code Ann. §§ 22-9-301 through §§ 22-9-315, please use our web site at www.labor.ar.gov or call (501) 682-4536.

1.101 Definitions.

(2) "Building construction" means generally the construction of sheltered enclosures with walk-in access for the purpose of housing persons, machinery, equipment, or supplies. It includes all construction of such structures, the installation of utilities and the installation of equipment, both above and below grade level as well as incidental grading, utilities and paving, unless there is an established area practice to the contrary. Additionally, such structures need not be "habitable" to be building construction. The installation of heavy machinery and/or equipment may not change the project's character as a building. Examples of building construction follow:

Alterations and additions to nonresidential buildings
Apartment buildings (5 stories and above)
Arenas (enclosed)
Auditoriums
Automobile parking garages or decks
Banks and financial buildings
Barracks
Churches
City halls
Civic centers
Commercial buildings
Court houses
Detention facilities
Dormitories
Farm buildings
Fire stations
Hospitals
Industrial buildings
Institutional buildings
Libraries
Mausoleums
Motels
Museums
Nursing & Convalescent facilities
Office buildings
Out-patient clinics
Passenger and freight terminal buildings
Police stations
Power plants
Prefabricated buildings
Remodeling buildings
Renovating buildings
Repairing buildings
Restaurants
Schools
Service stations
Shopping centers
Stores
Subway stations
Theaters
Warehouses
Water & Sewage treatment plants (building only)

(8) "Heavy construction" means those construction projects that are not properly classified as either "building", "highway", or "residential". Unlike these classifications, heavy construction is not a homogenous classification. Because of its catch-all nature, projects within the heavy classification may sometimes be distinguished on the basis of their particular project characteristics, and separate wage determinations. Examples of heavy construction follow:

Antenna towers
Bridges (major bridges designed for Commercial navigation)
Breakwaters
Caissons (other than building or highway)
Canals
Channels
Channel cut-offs

Chemical complexes or facilities (other than buildings)
Cofferdams
Coke ovens
Dams
Demolition (not incidental to construction)
Dikes
Docks
Drainage projects
Dredging projects
Electrification projects (out-door)
Flood control projects
Industrial incinerators (other than building)
Irrigation projects
Jetties
Kilns
Land drainage (not incidental to other construction)
Land leveling (not incidental to other construction)
Land reclamation
Levees
Locks, waterways
Oil refineries
Parking lots
Pipe lines
Ponds
Pumping stations (prefabricated drop-in units)
Railroad construction
Reservoirs Revetments
Runways
Sewage collection and disposal lines
Sewers (sanitary, storm, etc.)
Shoreline maintenance
Ski tows
Storage tanks
Swimming pools (out-door)
Subways (other than buildings)
Taxiways
Tipples
Tunnels
Unsheltered piers & wharves
Viaducts (other than highway)
Water mains
Waterway construction
Water supply lines (not incidental to building)
Water and sewage treatment plants (other than buildings)
Wells

(9) "Highway, road, street, or bridge construction" shall include the construction, alteration or repair of roads, streets, highways, alleys, trails, paths, and other similar projects not incidental to building or heavy construction. Examples of such construction may include:

Alleys
Excavation and embankment (for road construction)
Fencing (highway)
Grade crossing elimination (overpasses or underpasses)
Guard rails on highway
Highway signs
Highway bridges (overpasses; underpasses; grade separation)
Medians
Resurfacing streets and highways
Roadbeds
Roadways
Shoulders
Stabilizing courses
Storm sewers incidental to road construction
Street paving
Taxiway
Traffic signals

Such "highway" construction, which does not qualify for the exemption, contained in Ark. Code Ann. §§ 22-9-303 (b) and Regulation 1.100 (d) (5) shall be considered "heavy construction."

2.100 Obtaining and Compiling Wage Rate Information.

(1) In some cases a project includes construction items that in themselves encompass different categories of construction. Generally, a project is considered mixed and a "multiple determination" issued if the construction items are substantial in relation to project cost – more than 20 percent. Only one determination is issued if construction items are "incidental" in function to the overall character of a project (e.g., paving of parking lots or an access road on a building project), and if there is not a substantial amount of construction in the second category.

(2) In cases involving a mixed project on which a multiple determination (e.g., building and heavy rates) is issued, building rates shall be applicable for a distance extending five (5) feet from any building on the project.

Arkansas Department of Labor
Prevailing Wage Determination Building and Heavy

Date: 3/9/2016

Project: WASTEWATER TREATMENT PLANT ON-SITE REUSE

City: Siloam Springs

Determination#: 15-458

Project County: Benton

Expiration Date: 9/9/2016

Survey #: 715-AM15

CLASSIFICATION	Class	Basic Hourly Rate	Fringe Benefits
Asbestos Worker/Insulator	building	$14.90	$2.85
Bricklayer/Pointer, Cleaner, Caulker, Stone Mason	building	$22.05	$0.00
Carpenter	building	$16.35	$3.75
Carpenter	heavy	$12.05	$1.35
Concrete Finisher/Cement Mason	building	$15.75	$0.00
Concrete Finisher/Cement Mason	heavy	$14.50	$0.00
Electrician/Alarm Installer	heavy	$21.20	$3.80
Elevator Mechanic	building	$24.30	$12.18
Glazier	building	$16.30	$1.10
HVACR Mechanic (Excludes Duct Work)	building	$17.80	$0.95
Ironworker (Including Reinforcing Work)	building	$14.60	$0.00
Laborer	building	$12.70	$0.00
Laborer	heavy	$13.10	$0.00
Marble/Tile/Terrazzo	building	$22.95	$6.41
Metal Building Erector	building	$11.90	$1.20
Millwright	building	$22.15	$8.26
Painter/Sheet Rock Finisher	building	$14.30	$0.00
Painter/Sheet Rock Finisher	heavy	$13.10	$0.00
Pipelayer	heavy	$13.10	$0.00
Plasterer	building	$15.50	$0.00
Plumber/Pipefitter	building	$20.65	$1.95
Roofer	building	$17.40	$3.15
Sheet Metal (Includes Duct Work)	building	$15.50	$0.95
Soft Floor Layer	building	$11.90	$1.20
Sprinkler Fitter	building	$21.00	$2.65
Waterproofer	building	$16.50	$1.85
Group 2 - Operator	building	$14.15	$1.05

CLASSIFICATION	Class	Basic Hourly Rate	Fringe Benefits
Group 3 - Operator	building	$14.25	$0.00
Group 4 - Operator	building	$13.50	$1.35
Aggregate Spreader	heavy	$13.10	$0.00
Asphalt Paving Machine	heavy	$17.65	$1.35
Backhoe - Rubber Tired (1 yard or less)	heavy	$15.30	$3.25
Bulldozer, finish	heavy	$17.60	$6.95
Bulldozer, rough	heavy	$17.05	$6.40
Concrete Paver	heavy	$13.10	$0.00
Crane, Derrick, Dragline, Shovel & Backhoe, 1.5 yards or less	heavy	$15.35	$1.75
Crane, Derrick, Dragline, Shovel & Backhoe, over 1.5 yards	heavy	$18.20	$0.00
Distributor	heavy	$13.10	$0.00
End Dump (Dump Truck)	heavy	$14.50	$0.00
Front End Loader, finish	heavy	$14.35	$0.00
Front End Loader, rough	heavy	$13.70	$1.00
Motor Patrol, finish	heavy	$14.05	$0.00
Motor Patrol, rough	heavy	$16.05	$1.80
Roller	heavy	$14.35	$2.05
Scraper, finish	heavy	$13.10	$0.00
Scraper, rough	heavy	$13.10	$0.00
Trenching Machine	heavy	$13.10	$0.00
Ironworker-Benton & Madison (Including Reinforcing Work)	heavy	$15.20	$5.22
Ironworker-Boone, Carroll, Newton (Including Reinforcing Wo	heavy	$13.35	$5.07
Laborer (Brick/Stone Tender)	building	$13.20	$0.00
Low Voltage/Alarm Installer	building	$14.00	$2.40
Asphalt Screed Operator	heavy	$14.60	$1.85
Excavator/Trackhoe	heavy	$16.15	$3.30
Truck Driver (Excludes Dump Truck)	building	$12.15	$1.64
Truck Driver (Excludes Dump Truck)	heavy	$15.65	$0.00
Electrician	building	$19.20	$1.90

Welders-receive rate prescribed for craft performing operation to which welding is incidental.

Certified 7/3/2015

Classifications that are required, but not listed above, must be requested in writing from the Arkansas Department of Labor, Prevailing Wage Division. Please call (501) 682-4536 for a request form.

Power Equipment Operators:

Group II
Operators engaged in operating the following equipment or performing work relative to the engineer's jurisdiction: Hydraulic cranes, cherry pickers, backhoes, and all derricks with a lifting capacity less than 50 tons, as specified by the manufacturer, all backhoes, tractor or truck type, all overhead & traveling cranes, or tractors with swinging boom attachments, gradealls all above equipment irrespective of motive power, leverman (engineer), hydraulic or bucket dredges, irrespective of size, trackhoes, excavators.

Group III
Heavy Equipment Operators. Operators engaged in operating the following equipment: all bulldozers, all front end loaders, all sidebooms, skytracks, forklifts, all push tractors, all pull scrapers, all motor graders, all trenching machines, regardless of size or motive power, all backfillers, all central mixing plants, 10S and larger, finishing machines, all boiler fireman high or low pressure, all asphalt spreaders, hydro truck crane, multiple drum hoist, irrespective of motive power, all rotary, cable tool, core drill or churn drill, water well and foundation drilling machines, regardless of size, regardless of motive power and dredge tender operator, asphalt paving machines.

Group IV
Light Equipment Operators. Operators engaged in operating the following equipment: Oilerdriver motor crane, single drum hoists, winches and air tuggers, irrespective of motive power, winch or A frame trucks, rollers of all types and pull tractors, regardless of size, elevator operators inside and outside when used for carrying workmen from floor to floor and handling building material, Lad-A-Vator Conveyor, batch plant, and mortar or concrete mixers, below 10S, end dump euclid, pumpcrete spray machine and pressure grout machine, air compressors, regardless of size. All light equipment, welding machines, light plants, pumps, all well point system dewatering and portable pumps, space heaters, irrespective of size, and motive power, equipment greaser, oiler, mechanic helper, drilling machine helper, asphalt distributor and like equipment, safety boat operator and deckhand.

STATEMENT OF INTENT TO PAY PREVAILING WAGES

PROJECT: **WASTEWATER TREATMENT PLANT ON-SITE REUSE**
SILOAM SPRINGS, ARKANSAS
BENTON COUNTY

This is to certify that we, the following listed contractors, are aware of the wage requirements of the Arkansas Prevailing Wage Law and by signature below indicate our intent to pay no less than the rates established by **Arkansas Prevailing Wage Determination Number 15-458** for work performed on the above noted public project. I understand that contractors who violate prevailing wage laws, i.e., incorrect classification/scope of work of workers, improper payments of prevailing wages, etc., are subject to fines and will be required to pay back wages due to workers.

	Business Name	**Address**	**Phone#**	**Signature and Title of Business Official**
General/Prime Contractor				
Electrical Subcontractor				
Mechanical Subcontractor				
Plumbing Subcontractor				
Roofing/ Sheet Metal Subcontractor				

THE GENERAL/PRIME CONTRACTOR IS RESPONSIBLE FOR GETTING THIS FORM FILLED OUT AND RETURNING IT TO THE ARKANSAS DEPARTMENT OF LABOR ***WITHIN 30 DAYS OF THE NOTICE TO PROCEED*** FOR THIS PROJECT. RETURN COMPLETED FORM TO THE ARKANSAS DEPARTMENT OF LABOR, PREVAILING WAGE DIVISION, 10421 W. MARKHAM, LITTLE ROCK, ARKANSAS, 72205.

If it is necessary to stand at the outboard or inboard edge of the deckload where less than 24 inches of bulwark, rail, coaming, or other protection exists, all employees shall be provided with a suitable means of protection against falling from the deckload.

(d) *First-aid and lifesaving equipment.* (1) Provisions for rendering first aid and medical assistance shall be in accordance with subpart D of this part.

(2) The employer shall ensure that there is in the vicinity of each barge in use at least one U.S. Coast Guard-approved 30-inch lifering with not less than 90 feet of line attached, and at least one portable or permanent ladder which will reach the top of the apron to the surface of the water. If the above equipment is not available at the pier, the employer shall furnish it during the time that he is working the barge.

(3) Employees walking or working on the unguarded decks of barges shall be protected with U.S. Coast Guard-approved work vests or buoyant vests.

(e) *Commercial diving operations.* Commercial diving operations shall be subject to subpart T of part 1910, §§ 1910.401-1910.441, of this chapter.

[39 FR 22801, June 24, 1974, as amended at 42 FR 37674, July 22, 1977]

§ 1926.606 Definitions applicable to this subpart.

(a) *Apron*—The area along the waterfront edge of the pier or wharf.

(b) *Bulwark*—The side of a ship above the upper deck.

(c) *Coaming*—The raised frame, as around a hatchway in the deck, to keep out water.

(d) *Jacob's ladder*—A marine ladder of rope or chain with wooden or metal rungs.

(e) *Rail,* for the purpose of § 1926.605, means a light structure serving as a guard at the outer edge of a ship's deck.

Subpart P—Excavations

AUTHORITY: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable, and 29 CFR part 1911.

SOURCE: 54 FR 45959, Oct. 31, 1989, unless otherwise noted.

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) *Scope and application.* This subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) *Definitions applicable to this subpart.*

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces or *sides* means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kickout means the accidental release or failure of a cross brace.

Protective system means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job-built in accordance with §1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

Shoring (Shoring system) means a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

Sides. See "Faces."

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

Support system means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less

(measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See "Shield."

Trench shield. See "Shield."

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 Specific excavation requirements.

(a) *Surface encumbrances.* All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.

(b) *Underground installations.* (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.

(2) Utility companies or owners shall be contacted within established or customary local response times, advised of the proposed work, and asked to establish the location of the utility underground installations prior to the start of actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.

(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.

(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.

(c) *Access and egress*—(1) *Structural ramps.* (i) Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.

(ii) Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.

(iii) Structural members used for ramps and runways shall be of uniform thickness.

(iv) Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.

(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.

(2) *Means of egress from trench excavations.* A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

(d) *Exposure to vehicular traffic.* Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

(e) *Exposure to falling loads.* No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with § 1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.

(f) *Warning system for mobile equipment.* When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

(g) *Hazardous atmospheres*—(1) *Testing and controls.* In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.50–1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.

(ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.

(iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.

(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

(2) *Emergency rescue equipment.* (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

(ii) Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a life-line securely attached to it. The lifeline shall be separate from any line used to handle materials, and shall be individually attended at all times while the employee wearing the lifeline is in the excavation.

(h) *Protection from hazards associated with water accumulation.* (1) Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.

(2) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

(3) If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with paragraphs (h)(1) and (h)(2) of this section.

(i) *Stability of adjacent structures.* (1) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

(2) Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably

expected to pose a hazard to employees shall not be permitted except when:

(i) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or

(ii) The excavation is in stable rock; or

(iii) A registered professional engineer has approved the determination that the structure is sufficently removed from the excavation so as to be unaffected by the excavation activity; or

(iv) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

(3) Sidewalks, pavements, and appurtenant structure shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

(j) *Protection of employees from loose rock or soil.* (1) Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.

(2) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

(k) *Inspections.* (1) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

(2) Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

(l) Walkways shall be provided where employees or equipment are required or permitted to cross over excavations. Guardrails which comply with §1926.502(b) shall be provided where walkways are 6 feet (1.8 m) or more above lower levels.

[54 FR 45959, Oct. 31, 1989, as amended by 59 FR 40730, Aug. 9, 1994]

§ 1926.652 Requirements for protective systems.

(a) *Protection of employees in excavations.* (1) Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with paragraph (b) or (c) of this section except when:

(i) Excavations are made entirely in stable rock; or

(ii) Excavations are less than 5 feet (1.52m) in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

(2) Protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.

(b) *Design of sloping and benching systems.* The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3), or, in the alternative, paragraph (b)(4), as follows:

(1) *Option (1)—Allowable configurations and slopes.* (i) Excavations shall be sloped at an angle not steeper than one and one-half horizontal to one vertical

(34 degrees measured from the horizontal), unless the employer uses one of the other options listed below.

(ii) Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations that are in accordance with the slopes shown for Type C soil in Appendix B to this subpart.

(2) *Option (2)—Determination of slopes and configurations using Appendices A and B.* Maximum allowable slopes, and allowable configurations for sloping and benching systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of sloping or benching systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and shall include all of the following:

(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;

(B) Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

(B) The configurations that were determined to be safe for the particular project; and

(C) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.

(c) *Design of support systems, shield systems, and other protective systems.* Designs of support systems shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) *Option (1)—Designs using appendices A, C and D.* Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.

(2) *Option (2)—Designs Using Manufacturer's Tabulated Data.* (i) Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.

(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall

be made available to the Secretary upon request.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and include all of the following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.

(d) *Materials and equipment.* (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service, and shall be evaluated and approved by a registered professional engineer before being returned to service.

(e) *Installation and removal of support*—(1) *General.* (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.

(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) *Additional requirements for support systems for trench excavations.* (i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and

there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.

(f) *Sloping and benching systems.* Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.

(g) *Shield systems*—(1) *General.* (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) *Additional requirement for shield systems used in trench excavations.* Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

APPENDIX A TO SUBPART P OF PART 1926—SOIL CLASSIFICATION

(a) *Scope and application*—(1) *Scope.* This appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

(2) *Application.* This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in §1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with appendix D. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in §1926.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

(b) *Definitions.* The definitions and examples given below are based on, in whole or in part, the following: American Society for Testing Materials (ASTM) Standards D653-85 and D2488; The Unified Soils Classification System, The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS-121.

Cemented soil means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

Cohesive soil means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

Dry soil means soil that does not exhibit visible signs of moisture content.

Fissured means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

Granular soil means gravel, sand, or silt, (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry.

Layered system means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

Moist soil means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

Plastic means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated soil means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or sheer vane.

Soil classification system means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

Stable rock means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Submerged soil means soil which is underwater or is free seeping.

Type A means cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

(i) The soil is fissured; or

(ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or

(iii) The soil has been previously disturbed; or

(iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

Type B means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or

(ii) Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.

(iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

(iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable; or

(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C means:

(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or

(ii) Granular soils including gravel, sand, and loamy sand; or

(iii) Submerged soil or soil from which water is freely seeping; or

(iv) Submerged rock that is not stable, or

(v) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

Unconfined compressive strength means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

Wet soil means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

(c) *Requirements*—(1) *Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.

(2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the America Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Acceptable visual and manual tests.*—(1) *Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained

material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual tests.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as ⅛-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of ⅛-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488—"Standard Recommended Practice for Description of Soils (Visual—Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a miminum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

APPENDIX B TO SUBPART P OF PART 1926—SLOPING AND BENCHING

(a) *Scope and application.* This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in §1926.652(b)(2).

(b) *Definitions.*

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely

to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and ravelling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) *Requirements*—(1) *Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least ½ horizontal to one vertical (½H:1V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with §1926.651(i).

(4) *Configurations.* Configurations of sloping and benching systems shall be in accordance with Figure B-1.

TABLE B-1

MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V) [1] FOR EXCAVATIONS LESS THAN 20 FEET DEEP [3]
STABLE ROCK TYPE A [2] TYPE B TYPE C	VERTICAL (90°) 3/4 : 1 (53°) 1:1 (45°) 1½: 1 (34°)

NOTES:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

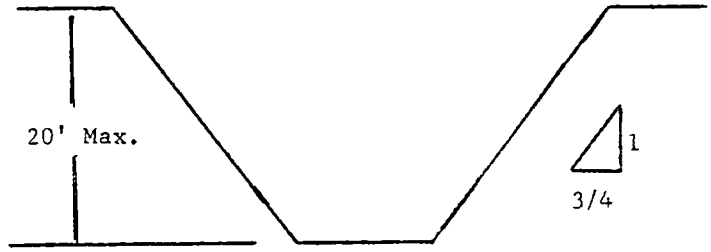
Figure B-1

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

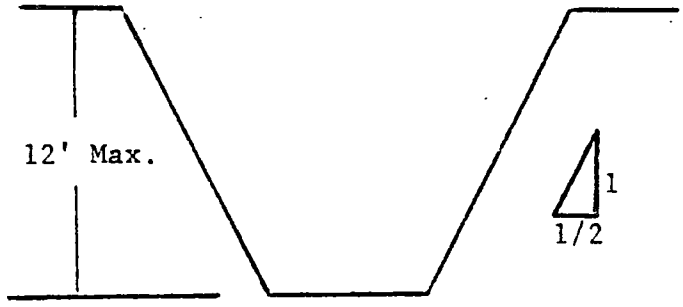
B-1.1 Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.



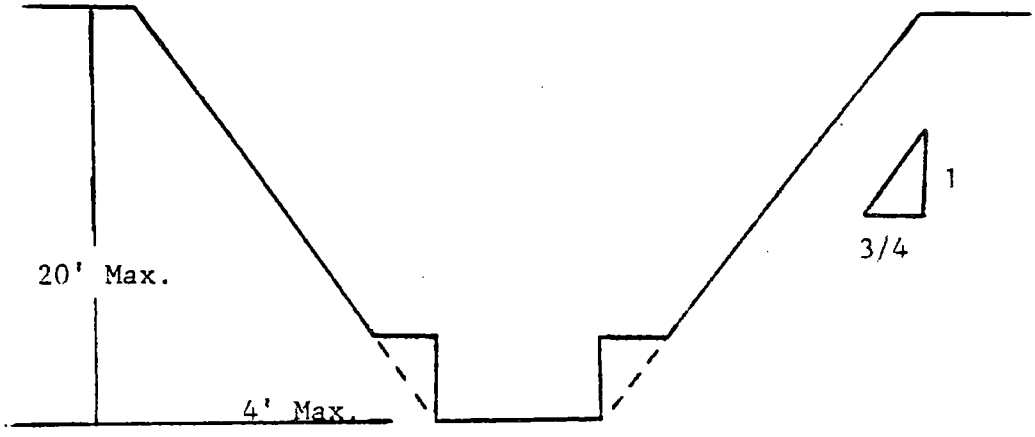
SIMPLE SLOPE—GENERAL

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

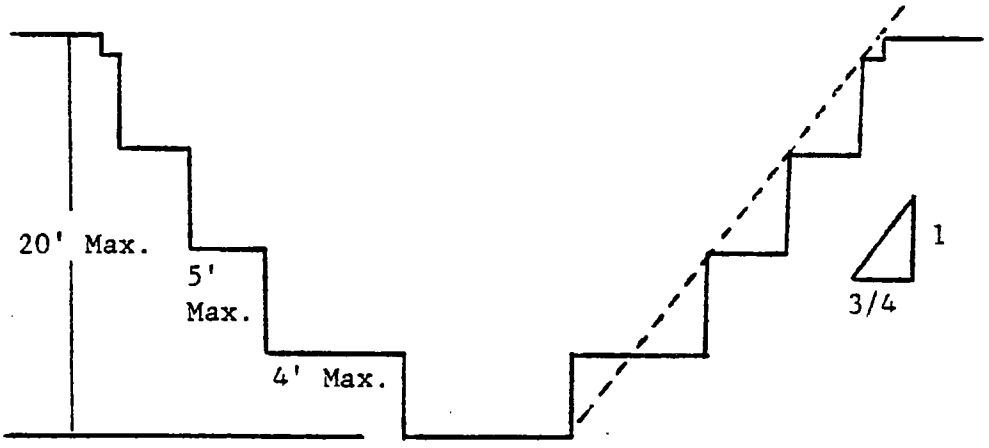


SIMPLE SLOPE—SHORT TERM

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and maximum bench dimensions as follows:

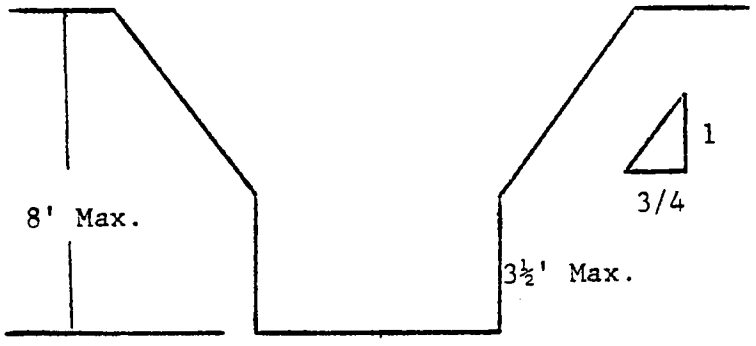


SIMPLE BENCH



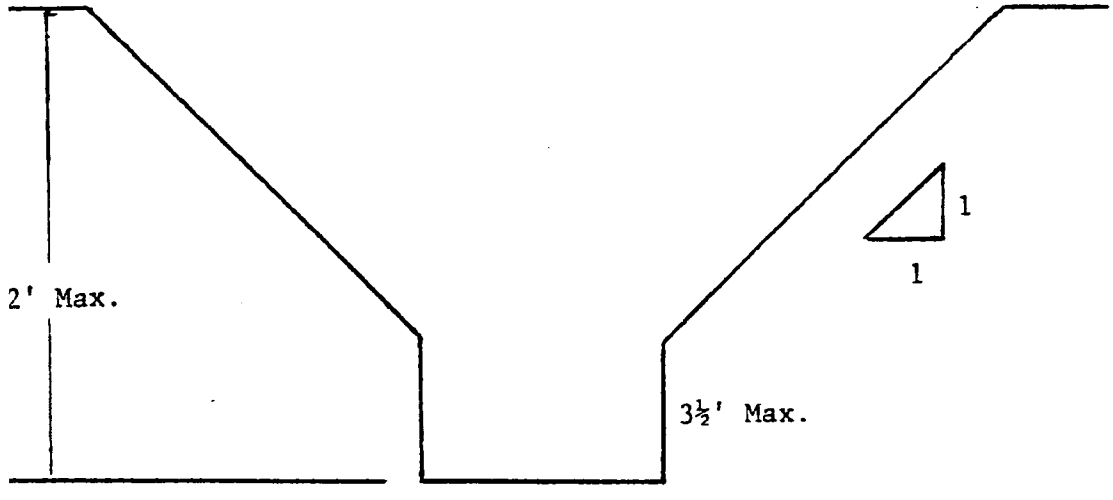
MULTIPLE BENCH

3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



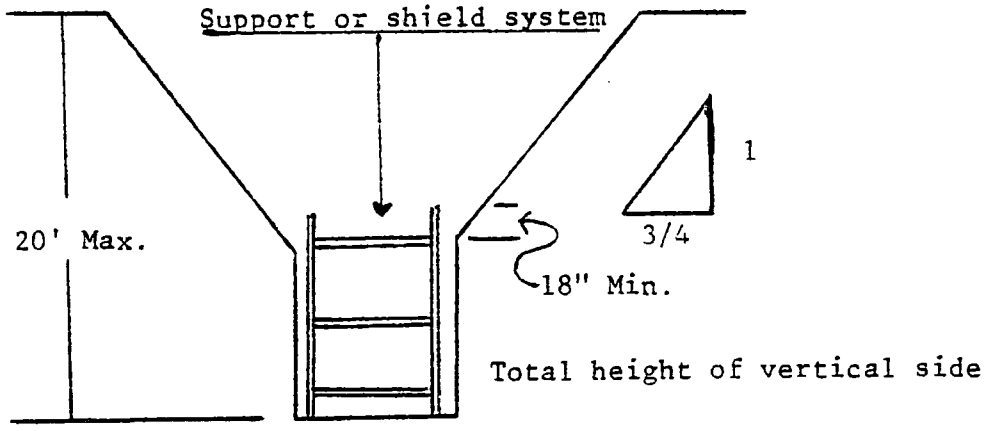
UNSUPPORTED VERTICALLY SIDED LOWER PORTION—MAXIMUM 8 FEET IN DEPTH

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



UNSUPPORTED VERTICALLY SIDED LOWER PORTION—MAXIMUM 12 FEET IN DEPTH

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side.

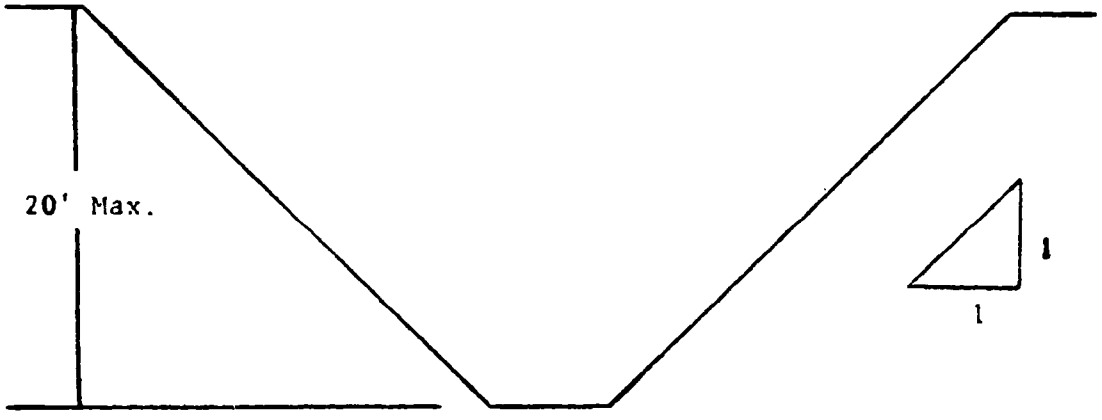


SUPPORTED OR SHIELDED VERTICALLY SIDED LOWER PORTION

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under §1926.652(b).

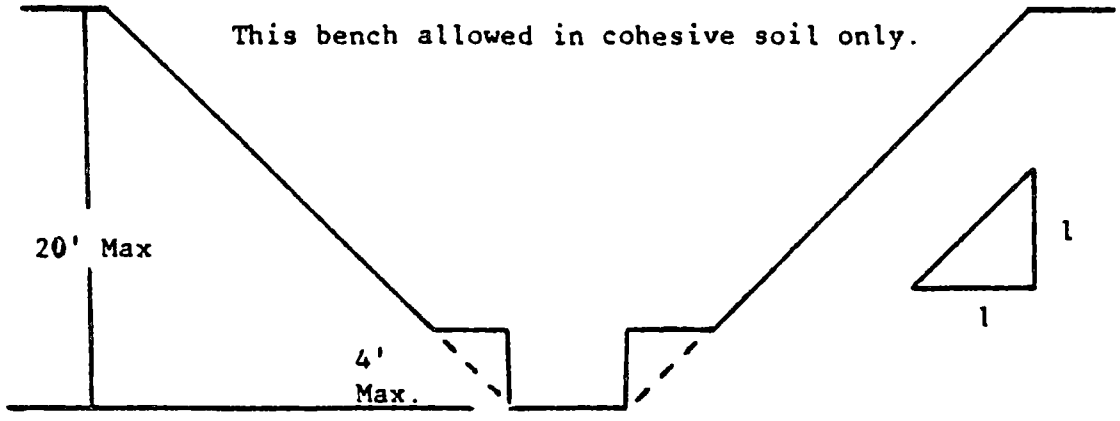
B-1.2 Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

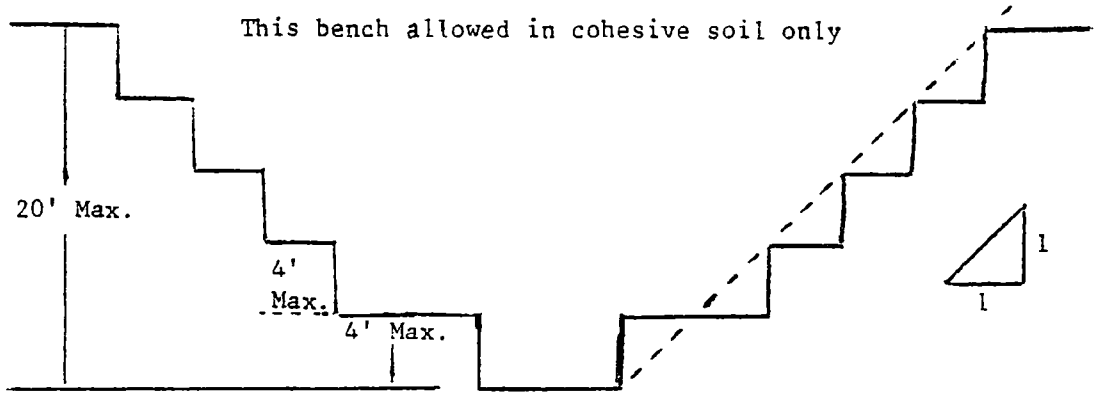


SIMPLE SLOPE

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

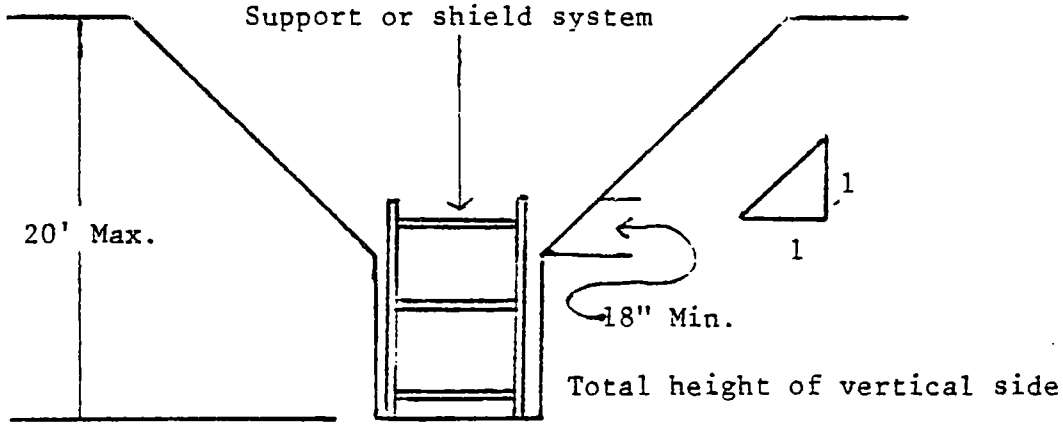


SINGLE BENCH



MULTIPLE BENCH

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

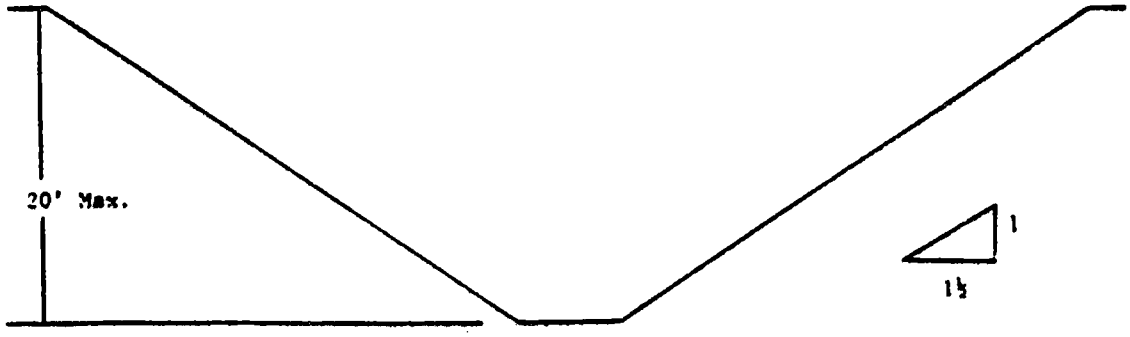


VERTICALLY SIDED LOWER PORTION

4. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

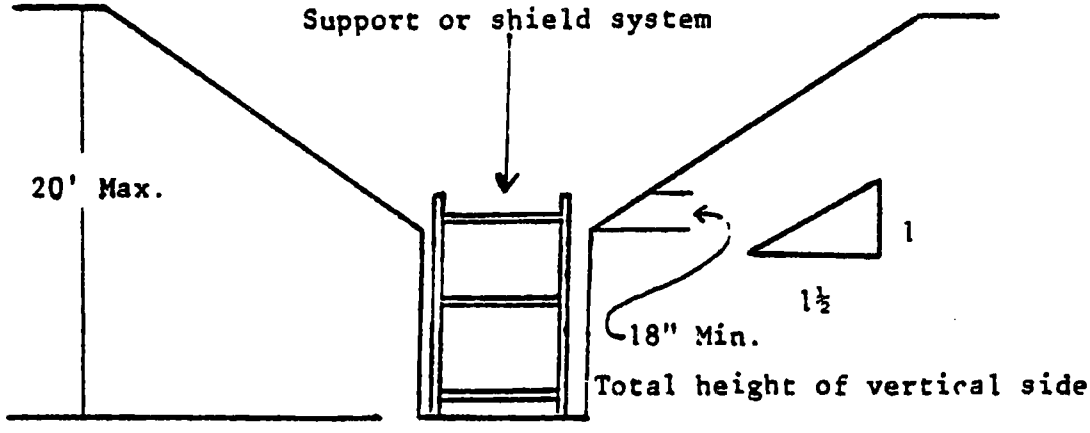
B-1.3 EXCAVATIONS MADE IN TYPE C SOIL

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



SIMPLE SLOPE

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

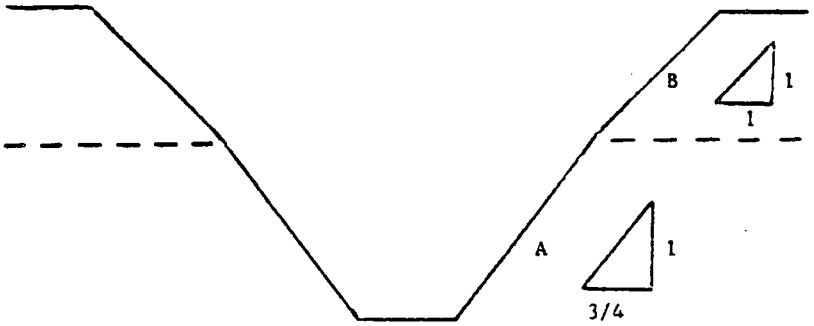


VERTICAL SIDED LOWER PORTION

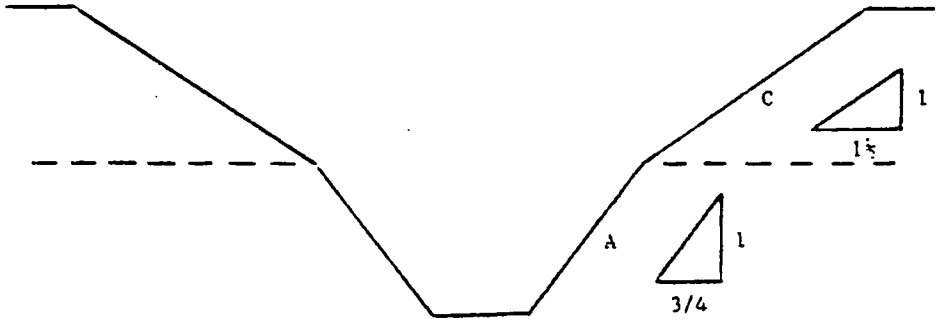
3. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

B-1.4 Excavations Made in Layered Soils

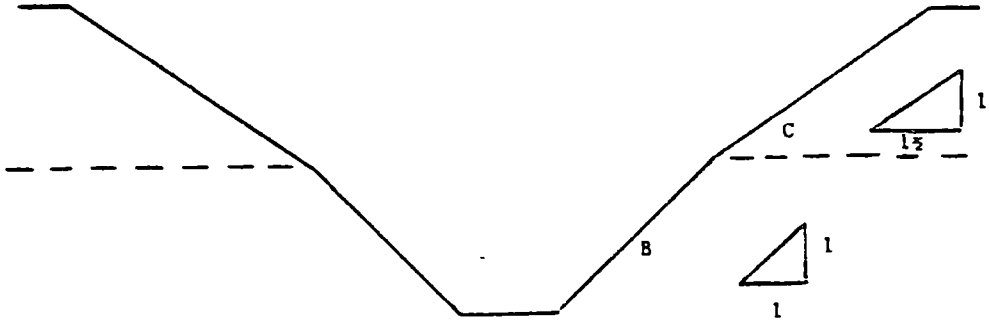
1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.



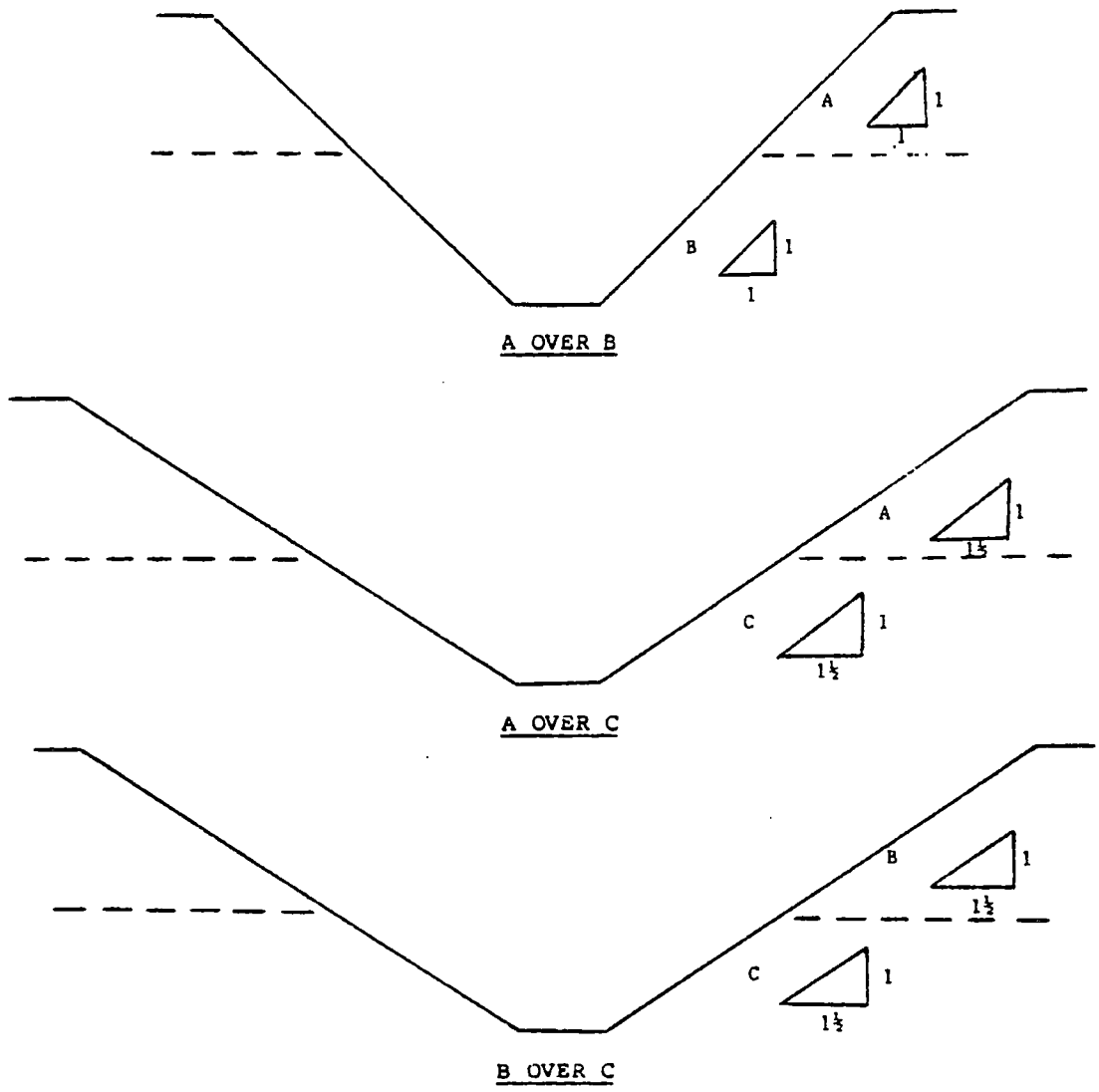
B OVER A



C OVER A



C OVER B



2. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

APPENDIX C TO SUBPART P OF PART 1926—TIMBER SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with §1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in §1926.652(b) and §1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C-1.1, C-1.2, and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil type in which the excavation or portion of

the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data.*—(1) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under §1926.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in §1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with §1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of Tables C-1.1 through C-1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From *Table C-1.1,* for acceptable arrangements of timber can be used.

Arrangement #B1

Space 4×4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3×8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #B2

Space 4×6 crossbraces at eight feet horizontally and four feet vertically.

Space 8×8 wales at four feet vertically.

Space 2×6 uprights at four feet horizontally.

Arrangement #B3

Space 6×6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8×10 wales at four feet vertically.

Space 2×6 uprights at five feet horizontally.

Arrangement #B4

Space 6×6 crossbraces at 12 feet horizontally and four feet vertically.

Space 10×10 wales at four feet vertically.

Spaces 3×8 uprights at six feet horizontally.

(2) *Example 2.*

A trench dug in Type B soil in 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.

Arrangement #B1

Space 6×6 crossbraces at six feet horizontally and five feet vertically.

Space 8×8 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

Arrangement #B2

Space 6×8 crossbraces at eight feet horizontally and five feet vertically.

Space 10×10 wales at five feet vertically.

Space 2×6 uprights at two feet horizontally.

Arrangement #B3

Space 8×8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10×12 wales at five feet vertically.

Space 2×6 uprights at two feet vertically.

(3) *Example 3.*

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C-1.3 two acceptable arrangements of members can be used.

Arrangement #B1

Space 8×8 crossbraces at six feet horizontally and five feet vertically.

Space 10×12 wales at five feet vertically.

Position 2×6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #B2

Space 8×10 crossbraces at eight feet horizontally and five feet vertically.

Space 12×12 wales at five feet vertically.

Position 2×6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.*

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.

Space 8×10 crossbraces at six feet horizontally and five feet vertically.

Space 12×12 wales at five feet vertically.

Use 3×6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) *Notes for all Tables.*

1. Member sizes at spacings other than indicated are to be determined as specified in §1926.652(c), "Design of Protective Systems."

2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement cf crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

TABLE C-1.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A P_a = 25 X H + 72 psf (2 ft Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS **													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	4	5	6	8
5 TO 10	UP TO 6	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---				2X6	
	UP TO 8	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---					2X8
	UP TO 10	4X6	4X6	4X6	6X6	6X6	4	8X8	4			2X6		
	UP TO 12	4X6	4X6	6X6	6X6	6X6	4	8X8	4				2X6	
10 TO 15	UP TO 6	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---				3X8	
	UP TO 8	4X6	4X6	6X6	6X6	6X6	4	8X8	4		2X6			
	UP TO 10	6X6	6X5	6X6	6X8	6X8	4	8X10	4			2X6		
	UP TO 12	6X6	6X6	6X6	6X8	6X8	4	10X10	4				3X8	
15 TO 20	UP TO 6	6X6	6X6	6X6	6X8	6X8	4	6X8	4	3X6				
	UP TO 8	6X6	6X6	6X6	6X8	6X8	4	8X8	4	3X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X10	4	8X10	4	3X6				
	UP TO 12	8X8	8X8	8X8	8X8	8X10	4	10X10	4	3X6				
OVER 20	SEE NOTE 1													

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may by substituted for wood.

TABLE C-1.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B $P_a = 45 \times H + 72$ psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**													
	CROSS BRACES						WALES		UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	2	3		
5 TO 10	UP TO 6	4X6	4X6	6X6	6X6	6X6	5	6X8	5			2X6		
	UP TO 8	6X6	6X6	6X6	6X8	6X8	5	8X10	5			2X6		
	UP TO 10	6X6	6X6	6X6	6X8	6X8	5	10X10	5			2X6		
	See Note 1													
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5		2X6			
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5		2X6			
	UP TO 10	8X8	8X8	8X8	8X8	8X10	5	10X12	5		2X6			
	See Note 1													
15 TO 20	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	3X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	3X6				
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	3X6				
	See Note 1													
OVER 20	SEE NOTE 1													

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may by substituted for wood.

TABLE C-1.3

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C P_a = 80 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**														
	CROSS BRACES									UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN.)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET) (See Note 2)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE				
5 TO 10	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	2X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
10 TO 15	UP TO 6	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 8	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
	See Note 1													
15 TO 20	UP TO 6	8X10	8X10	8X10	8X10	10X10	5	12X12	5	3X6				
	See Note 1													
	See Note 1													
	See Note 1													
OVER 20	SEE NOTE 1													

* Mixed Oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A P_a = 25 X H ± 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN.)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	4	5	6	8
5 TO 10	UP TO 6	4X4	4X4	4X4	4X4	4X6	4	Not Req'd	Not Req'd				4X6	
	UP TO 8	4X4	4X4	4X4	4X6	4X6	4	Not Req'd	Not Req'd					4X8
	UP TO 10	4X6	4X6	4X6	6X6	6X6	4	8X8	4			4X6		
	UP TO 12	4X6	4X6	4X6	6X6	6X6	4	8X8	4				4X6	
10 TO 15	UP TO 6	4X4	4X4	4X4	6X6	6X6	4	Not Req'd	Not Req'd				4X10	
	UP TO 8	4X6	4X6	4X6	6X6	6X6	4	6X8	4		4X6			
	UP TO 10	6X6	6X6	6X6	6X6	6X6	4	8X8	4			4X8		
	UP TO 12	6X6	6X6	6X6	6X6	6X6	4	8X10	4		4X6		4X10	
15 TO 20	UP TO 6	6X6	6X6	6X6	6X6	6X6	4	6X8	4	3X6				
	UP TO 8	6X6	6X6	6X6	6X6	6X6	4	8X8	4	3X6	4X12			
	UP TO 10	6X6	6X6	6X6	6X6	6X8	4	8X10	4	3X6				
	UP TO 12	6X6	6X6	6X6	6X8	6X8	4	8X12	4	3X6	4X12			
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B P_a = 45 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES						WALES		UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN.)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	2	3	4	6
5 TO 10	UP TO 6	4X6	4X6	4X6	6X6	6X6	5	6X8	5			3X12 4X8		4X12
	UP TO 8	4X6	4X6	6X6	6X6	6X6	5	8X8	5		3X8		4X8	
	UP TO 10	4X6	4X6	6X6	6X6	6X8	5	8X10	5			4X8		
	See Note 1													
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5	3X6	4X10			
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5	3X6	4X10			
	UP TO 10	6X8	6X8	8X8	8X8	8X8	5	10X12	5	3X6	4X10			
	See Note 1													
15 TO 20	UP TO 6	6X8	6X8	6X8	6X8	8X8	5	8X10	5	4X6				
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X12	5	4X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
	See Note 1													
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.3

TIMBER TRENCH SHORING — MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C P_a = 80 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **												
	CROSS BRACES						WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)				VERT. SPACING (FEET)	SIZE (IN.)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15			CLOSE				
5 TO 10	UP TO 6	6X6	6X6	6X6	6X6	8X8	5	8X8	5	3X6				
	UP TO 8	6X6	6X6	6X6	8X8	8X8	5	10X10	5	3X6				
	UP TO 10	6X6	6X6	8X8	8X8	8X8	5	10X12	5	3X6				
	See Note 1												
10 TO 15	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	10X10	5	4X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
	See Note 1												
	See Note 1												
15 TO 20	UP TO 6	8X8	8X8	8X8	8X10	8X10	5	10X12	5	4X6				
	See Note 1												
	See Note 1												
	See Note 1												
OVER 20	SEE NOTE 1												

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.

APPENDIX D TO SUBPART P OF PART 1926—ALUMINUM HYDRAULIC SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with §1926.652(c)(2).

(b) *Soil Classification.* In order to use data presented in this appendix, the soil type or types in which the excavation is made must

first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables D-1.1, D-1.2, D-1.3 and E-1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D-1.1 and D-1.2 are for vertical shores in Types A and B soil. Tables D-1.3 and D1.4 are for horizontal waler systems in Types B and C soil.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations (footnotes) regarding Table D-1.1 through D-1.4 are presented in paragraph (g) of this appendix.

(6) Figures, illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations page is entitled "Aluminum Hydraulic Shoring; Typical Installations."

(d) *Basis and limitations of the data.*

(1) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufaturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(3) Limitation of application.

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in §1926.652(c).

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with §1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion or a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4.* The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting are found in the horizontal wale Tables D-1.3 and D-1.4. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the waler system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(f) *Example to Illustrate the Use of the Tables:*

(1) Example 1:

A trench dug in Type A soil is 6 feet deep and 3 feet wide. From Table D-1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) Example 2:

A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

(3) A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. The

trench is 16 feet deep and 9 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by footnote #B2) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically, plywood (per footnote (g)(7) to the D-1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep and 12 feet wide. 8 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 3×12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(5) Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0 section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically. 3×12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(g) *Footnotes, and general notes, for Tables D-1.1, D-1.2, D-1.3, and D-1.4.*

(1) For applications other than those listed in the tables, refer to §1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to §1926.652(c)(2) and §1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5×3.5×0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2 inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 in. thick softwood or 0.75 inch. thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) See appendix D, item (d), for basis and limitations of the data.

ALUMINUM HYDRAULIC SHORING
TYPICAL INSTALLATIONS

FIGURE NO. 1
VERTICAL ALUMINUM HYDRAULIC SHORING (SPOT BRACING)

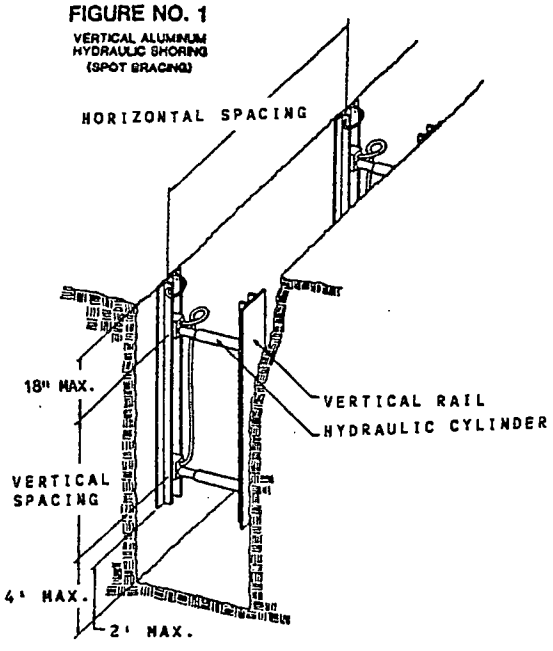


FIGURE NO. 2
VERTICAL ALUMINUM HYDRAULIC SHORING (WITH PLYWOOD)

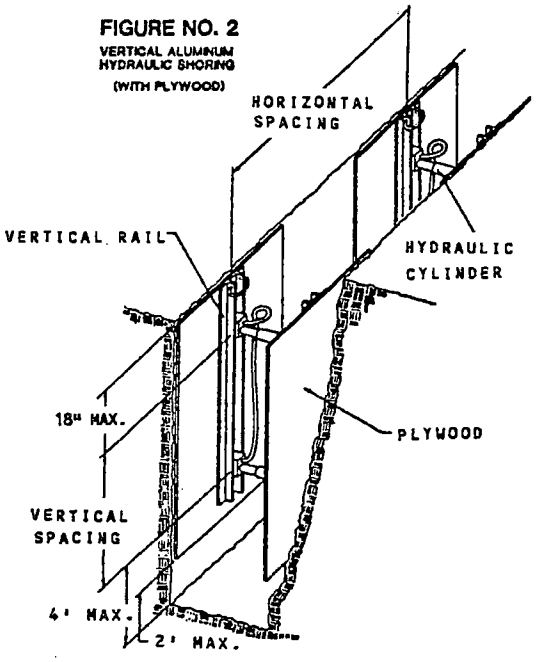


FIGURE NO. 3
VERTICAL ALUMINUM HYDRAULIC SHORING (STACKED)

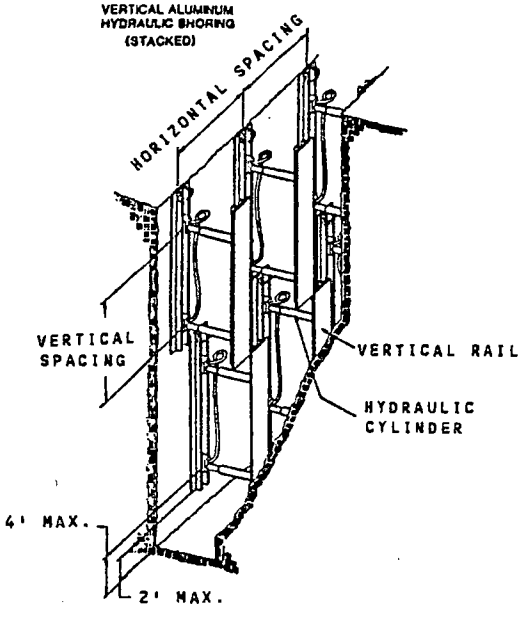


FIGURE NO. 4
ALUMINUM HYDRAULIC SHORING WALER SYSTEM (TYPICAL)

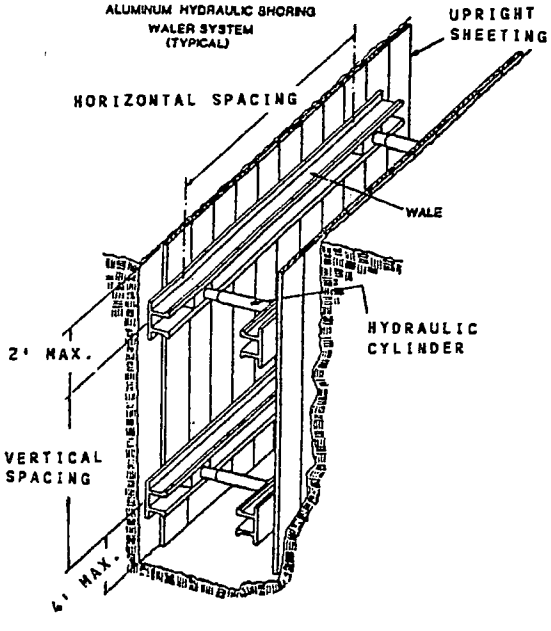


TABLE D - I.I
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE A

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	8				
OVER 15 UP TO 20	7				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g) (1)
Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.2
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	6.5				
OVER 15 UP TO 20	5.5				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (**1**): See Appendix D, Item (g) (1)
Note (**2**): See Appendix D, Item (g) (2)

TABLE D - 1.3
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCH (FEET)						MAX.HORIZ.SPACING (ON CENTER)		
	VERTICAL SPACING (FEET)	* SECTION MODULUS (IN^3)	UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	8.0	2 IN	8.0	2 IN NOTE(2)	8.0	3 IN	—	—	3x12
		7.0	9.0	2 IN	9.0	2 IN NOTE(2)	9.0	3 IN			
		14.0	12.0	3 IN	12.0	3 IN	12.0	3 IN			
OVER 10 UP TO 15	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	—	3x12	—
		7.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 15 UP TO 20	4	3.5	5.5	2 IN	5.5	2 IN NOTE(2)	5.5	3 IN	3x12	—	—
		7.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
		14.0	9.0	3 IN	9.0	3 IN	9.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, item (g) (1)
Notes (2): See Appendix D, Item (g) (2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

TABLE D - 1.4
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE C

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCH (FEET)						MAX.HORIZ SPACING (ON CENTER)		
	VERTICAL SPACING (FEET)	* SECTION MODULUS (IN^3)	UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	3x12	—	—
		7.0	6.5	2 IN	6.5	2 IN NOTE(2)	6.5	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 10 UP TO 15	4	3.5	4.0	2 IN	4.0	2 IN NOTE(2)	4.0	3 IN	3x12	—	—
		7.0	5.5	3 IN	5.5	3 IN	5.5	3 IN			
		14.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
OVER 15 UP TO 20	4	3.5	3.5	2 IN	3.5	2 IN NOTE(2)	3.5	3 IN	3x12	—	—
		7.0	5.0	3 IN	5.0	3 IN	5.0	3 IN			
		14.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, item (g) (1)
Notes (2): See Appendix D, Item (g) (2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

APPENDIX E TO SUBPART P OF PART 1926—ALTERNATIVES TO TIMBER SHORING

Figure 1. Aluminum Hydraulic Shoring

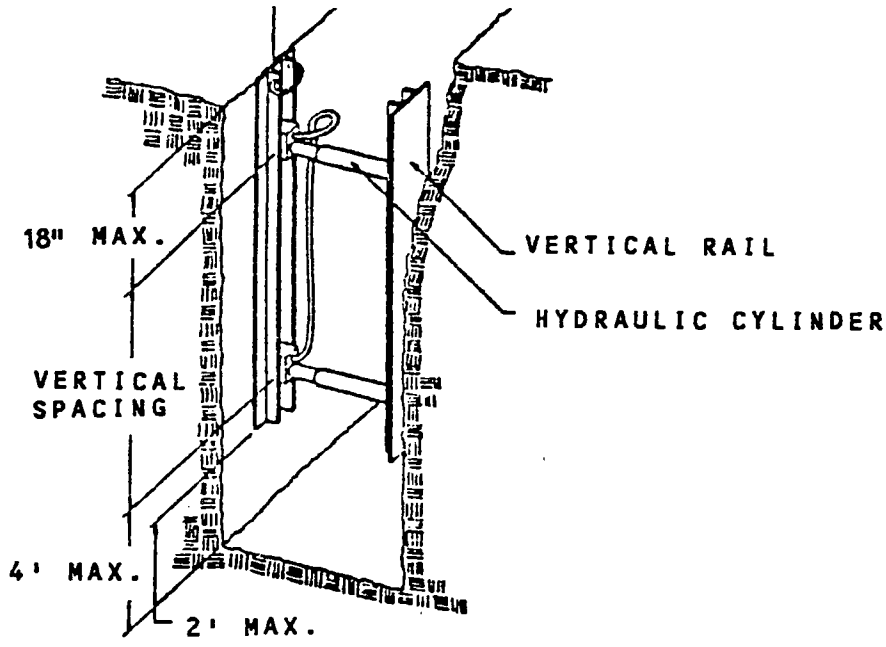


Figure 2. Pneumatic/hydraulic Shoring

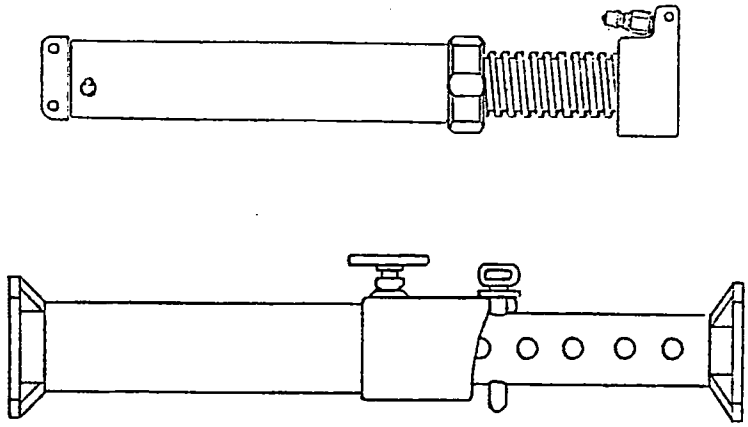


Figure 3. Trench Jacks (Screw Jacks)

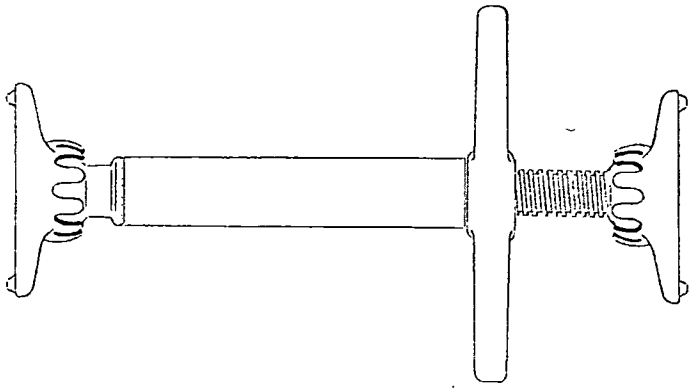
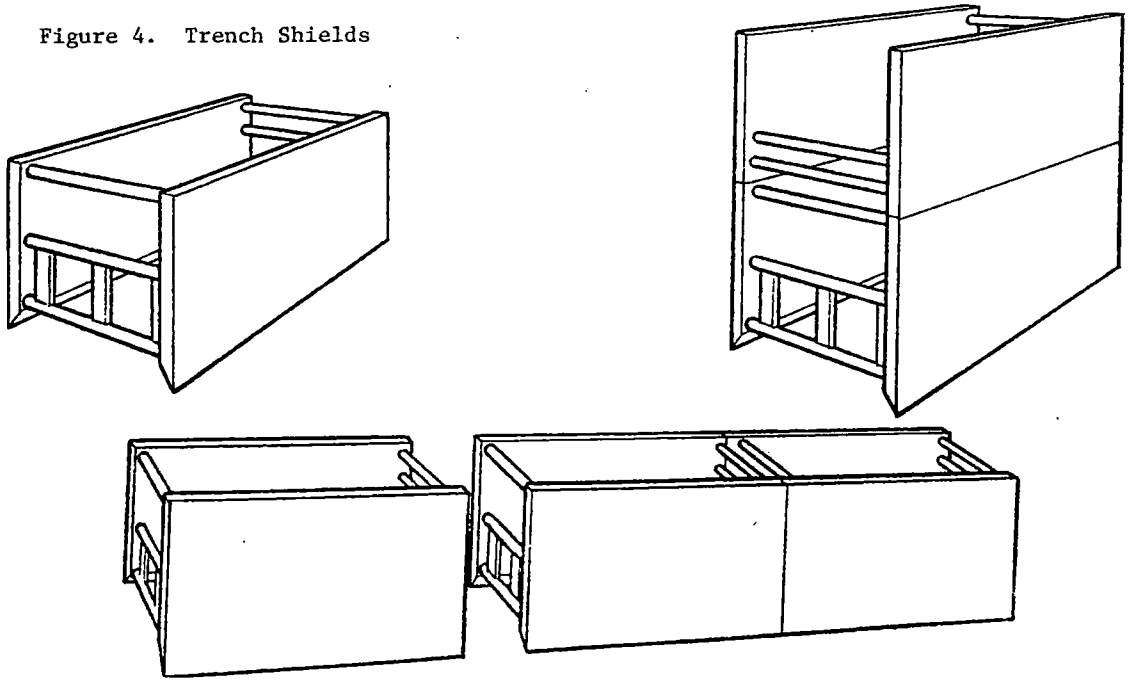


Figure 4. Trench Shields



APPENDIX F TO SUBPART P OF PART 1926—SELECTION OF PROTECTIVE SYSTEMS

The following figures are a graphic summary of the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with §1926.652 (b) and (c).

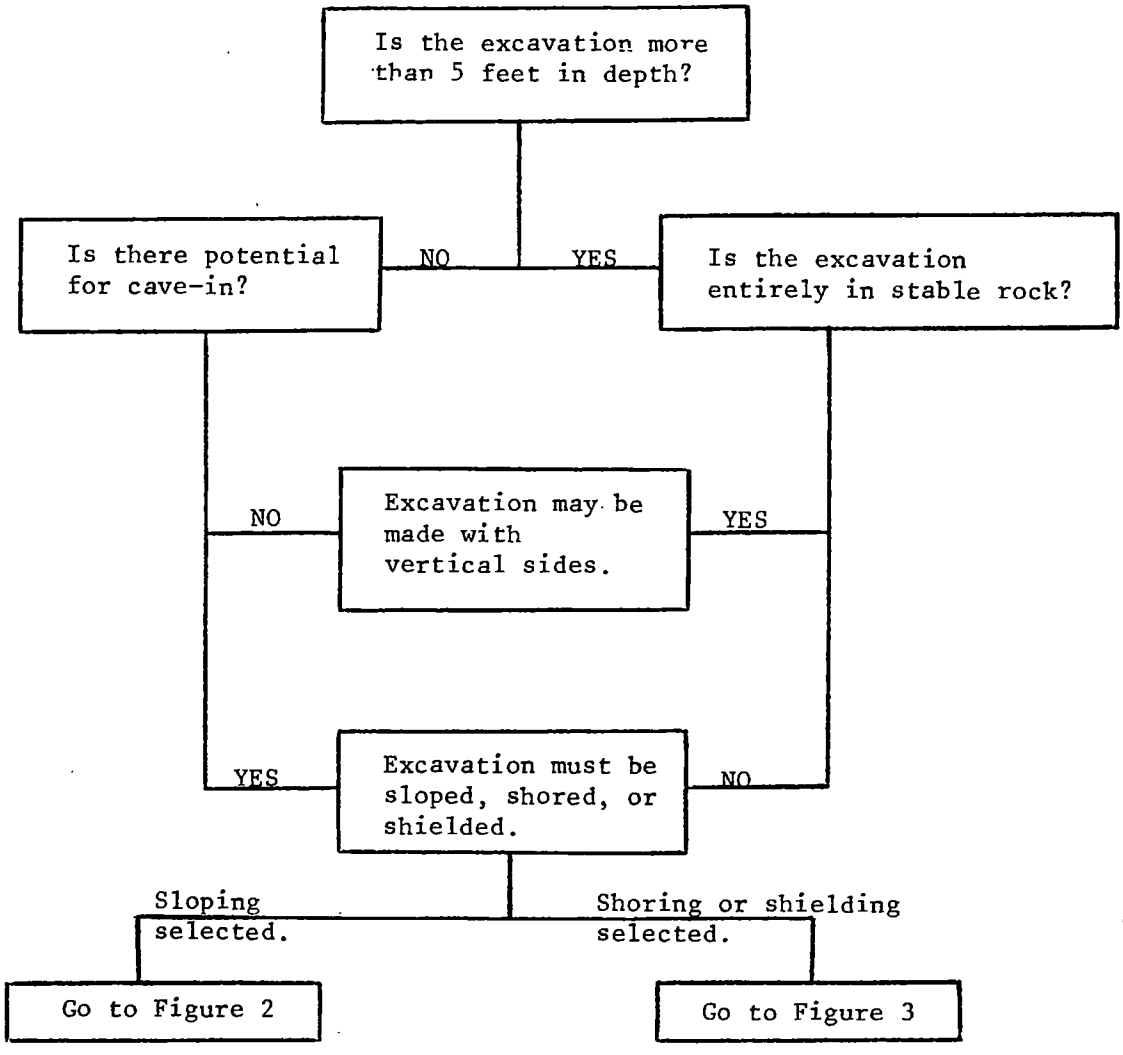


FIGURE 1 - PRELIMINARY DECISIONS

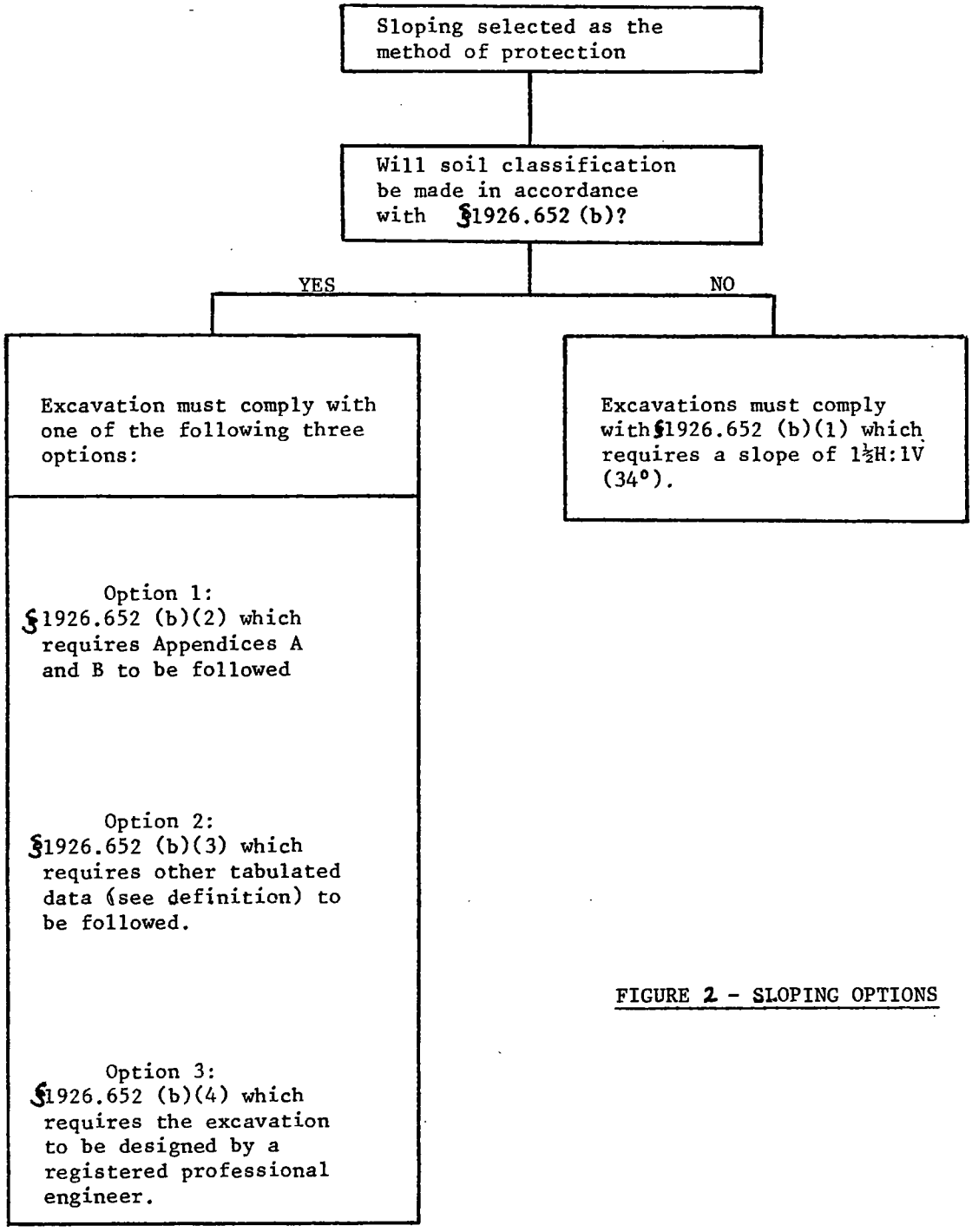


FIGURE 2 - SLOPING OPTIONS

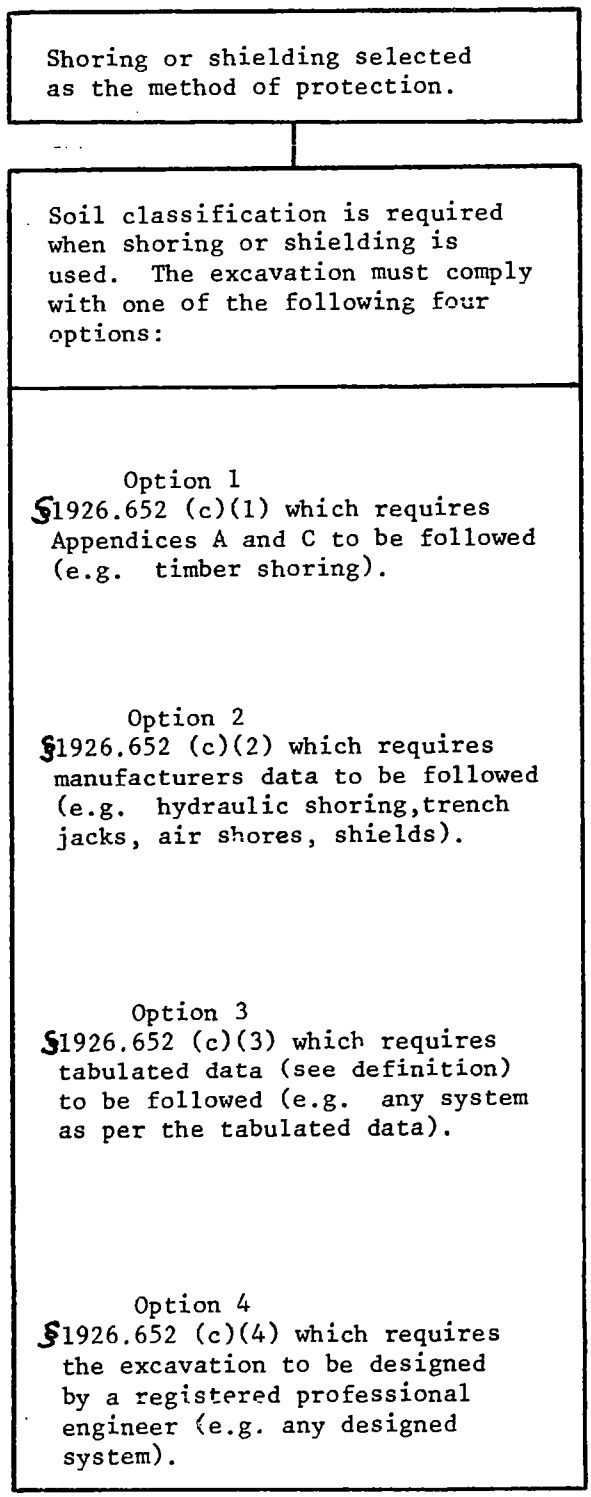


FIGURE 3 - SHORING AND SHIELDING OPTIONS

SECTION 01000

ABBREVIATIONS

The following is an explanation of the abbreviations which are used throughout the Specifications.

1. AASHTO - The American Association of State Highway and Transportation Officials, the successor to AASHO.

2. ASA - The American Standards Association.

3. AISC - The American Institute for Steel Construction.

4. ASTM - The American Society for Testing and Materials.

5. AWWA - The American Water Works Association.

6. MBMA - The Metal Building Manufacturers Association.

7. RPM - Revolutions Per Minute.

8. AWS - The American Welding Society.

9. AREA - The American Railway Engineering Association.

10. NEMA - The National Electrical Manufacturers Association.

11. AHTD - Arkansas Highway and Transportation Department

All references throughout these specifications, such as AWWA, shall reference the latest revision available and shall be considered a part of these specifications.

END OF SECTION

SECTION 01009

SUMMARY OF WORK

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

This Section describes the project in general, and provides an overview of the extent of the work to be performed. Detailed requirements and extent of work is stated in the applicable Specification Sections and is shown on the Drawings. The Contractor shall, except as otherwise specifically stated herein or in any applicable parts of the Contract Documents, provide and pay for all labor, materials, equipment, tools, construction equipment, and other facilities and services necessary for proper execution, and completion of his work.

1.02 REASONABLY IMPLIED PARTS OF THE WORK SHALL BE DONE THOUGH ABSENT FROM SPECIFICATIONS

Any part of the work which is not mentioned in the Specifications but is shown on the Drawings, or any part not shown on the Drawings but described in the Specifications, or any part not shown on the Drawings nor described in the Specifications, but which is necessary or normally required as a part of such work, or is necessary or required to make each installation satisfactorily and legally operable, shall be performed by the Contractor as incidental work without extra cost to the Owner, as if fully described in the Specifications and shown on the Drawings, and the expense thereof shall be included in the applicable unit prices or lump sum bid for the work.

1.03 DESCRIPTION OF THE PROJECT

Work covered by these Contract Documents in general covers the construction of the following facilities on Siloam Springs WWTP On-Site Reuse:

1 Completion of related work items as indicated on the Drawings and/or required by the Detailed Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 CONTRACTOR'S RESPONSIBILITIES

3.01 GENERAL CONSTRUCTION WORK

A. The Contractor shall execute all work.

B. The Contractor shall also:

1. Provide temporary sanitary toilet facilities.

2. Provide an adequate supply of potable drinking water for use by his employees and by the Engineer.

3. Coordinate with the Engineer and Owner all rerouting of existing streets. The Contractor shall maintain all streets in service during construction of the new facilities.

4. Provide all construction staking for the project unless otherwise stated on the plans.

3.02 DRAWINGS

Drawings are shown as attachments in the Specifications and Contract Documents.

END OF SECTION

SECTION 01011

SITE CONDITIONS

PART 1 GENERAL

1.01 SITE INVESTIGATION AND REPRESENTATION

A. The Contractor acknowledges by submission of his Bid that he has satisfied himself as to the nature and location of the work, the general and local conditions, particularly those bearing upon availability of transportation, disposal, handling and storage of materials, availability of labor, water, electric power, roads, and uncertainties of weather, river stages, or similar physical condition 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 by submission of his Bid that he has satisfied himself as to the character, quality, and quantity of surface and subsurface materials to be encountered from inspecting the site. Any failure by the Contractor to acquaint himself with all the available information will not relieve him from responsibility for properly estimating the difficulty or cost of successfully performing the work.

C. Prospective Bidders are invited, at their own expense, to make subsurface investigations, by boring or test hole excavation, as may be desirable, provided, however, that such work be scheduled by appointment with the Engineer. Bidders are not authorized to enter private property during these investigations.

D. In the event subsurface or latent physical conditions are found materially different from those indicated in these Documents, and differing materially from those ordinarily encountered in the project area and generally recognized as inhering in the character of work covered in these Contract Documents, the Contractor shall promptly, and before such conditions are disturbed, notify the Engineer in writing of such changed conditions.

E. The Engineer will investigate such conditions promptly and following this investigation, the Contractor shall proceed with the work, unless otherwise instructed by the Engineer. If the Engineer finds that such conditions do so materially differ and cause an increase or decrease in the cost of, or in the time required for performing the work, the Engineer will recommend to the Owner the amount of adjustment in cost and time he considers reasonable. The Owner will make the final decision on all Change Orders to the Contract regarding any adjustment in cost or time for completion.

1.02 EXISTING UTILITIES

Existing utilities in the vicinity of the project lines and structures include water and sewer lines belonging to the City of Siloam Springs, gas mains and service lines, and overhead electric and telephone lines. Additional utilities include individual property owner's gas lines, water lines, underground electrical service lines, and wastewater lines. No attempt has been made to locate all these utilities and private services. Information is shown on the Drawings relative to the general location of some utilities, as taken from maps supplied by the utilities. Telephone cables and overhead power lines are shown. Private lines are not shown. The general vicinity of existing sewer mains is indicated on the Drawings. Since specific utility locations are not shown on the Drawings, the Contractor shall carefully coordinate the location of utilities with their respective owner's. No compensation will be paid to the Contractor, due to costs associated with locating/avoiding same. The Engineer and Owner will cooperate with the Contractor and utility firms in rerouting new sewer lines, where possible, to reasonably avoid existing utilities.

1.03 CONTRACTOR'S RESPONSIBILITY FOR UTILITY PROPERTIES AND SERVICE

A. Notify all utility offices that are affected by the construction operation at least 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.

B. 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.

C. 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.

D. In the event of interruption to domestic water, sewer, storm drain, or other utility services as a result of accidental breakage due to construction operations, promptly notify the proper authority. Cooperate with said authority in restoration of service as promptly as possible and bear all costs of repair. In no event shall interruption of any utility service be allowed outside working hours unless granted by the owner of the utility.

E. Drainage culverts that are removed or damaged by the Contractor shall be replaced in kind at the expense of the Contractor.

F. The Contractor shall replace, at his own expense, any and all existing utilities or structures damaged during construction.

1.04 NAMES OF KNOWN UTILITIES SERVING THE AREA

The following is a list of the major public utilities serving the work area indicating the name and telephone number of the responsible authority of the various utilities which should be notified if conflicts or emergencies arise during the progress of the work:

Name	Authority	Telephone
Water & Sewer	Siloam Springs Water and Sewer Dept.	479-524-5136
Telephone	CenturyTel Co.	1-800-824-2877
Gas	Arkansas Western Gas	1-800-563-0012
Electricity	Siloam Springs Electric Department	479-524-3777

1.05 FIELD RELOCATION

During the progress of construction, minor relocation of the work may become necessary. Such relocation shall be made only by direction of the Engineer. If existing structures. If the Contractor shall fail to notify the Engineer when an existing structure is encountered, and shall proceed with the work despite this interference, he shall do so at his own risk and expense.

1.06 CONSTRUCTION ON PRIVATE PROPERTIES

The Owner has obtained easements for the utility routes on private property. The Contractor shall protect and/or restore improvements on these properties, including structures, rock walls, fences, drives, culverts, fruit and ornamental trees and shrubs, and grass in yards and pasture lands. Failure to do so will result in retainage of funds otherwise due the Contractor, as necessary to compensate property owners for damages and/or pay restoration costs.

1.07 PAYMENT

No separate payment will be made for work under this Section.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 01014

PROTECTION OF THE ENVIRONMENT

PART 1 GENERAL

1.01 WORK AREAS

The Contractor shall maintain all work areas within and outside the project boundaries free from environmental pollution which would be in violation to any federal, state or local regulations.

1.02 PROTECTION OF SEWERS

Take adequate measures to prevent the impairment of the operation of the existing sewer system. Prevent construction material, pavement, concrete, earth, or other debris from entering a sewer or sewerage structure.

1.03 PROTECTION OF WATERWAYS

A. The Contractor shall observe the rules and regulations of the State of Arkansas and agencies of the United States Government prohibiting the pollution of stream or river waters by dumping of any refuse, rubbish, or debris herein.

B. All sewage flow interfering with construction and requiring diversion, shall be diverted to sewers leading to water pollution control plants and shall not be directed to any waterway. The Contractor shall not cause or permit any action to occur which would cause an overflow to an existing waterway. The Owner does not accept any responsibility for any damages to public or private property resulting therein. Such responsibilities remain with the Contractor.

C. The Contractor shall be responsible for providing an approved method which will handle, carry through, or divert around his work all flows, including storm flows so as to prevent flooding damage to the property.

1.04 MAINTENANCE OF SEWAGE FLOW IN EXISTING LINES

A. During the construction process, the discharge of raw sewage from existing lines as a result of breaking or removal of these lines by the Contractor shall not be permitted. The Contractor shall be required to install temporary piping, temporary pump stations or other facilities as necessary to maintain sewage flow in areas where the construction activities would otherwise lead to raw sewage discharge. No special payment shall be made for the work involved in maintaining sewage flow in existing lines.

B. Upon completion and air testing of a segment of new line, the Contractor will be allowed to place it into service, connecting existing service lines and laterals to that segment as necessary, and routing the flow of the main being replaced through this segment as necessary, if said routing is desired by the Contractor. However, the line will require mandrel testing (if PVC) and repairing, retesting by air, etc., if found to fail the mandrel test.

1.05 DEWATERING

The Contractor shall construct, maintain, and operate all channels, flume drain, sumps, pumps, and/or other temporary diversion and protection works, shall furnish all materials required therefore, and shall furnish, install, maintain, and operate all necessary pumping and other equipment for the environmentally-safe removal and disposal of water from the various parts of the work. Dewatering efforts shall comply with EPA and ADEQ requirements.

1.06 PROTECTION OF AIR QUALITY

A. Trash burning will not be permitted on the construction site.

B. If temporary heating devices are necessary for protection of the work, such devices shall be of an approved type that will not cause pollution of the air.

1.07 CONSTRUCTION NOISE CONTROL

The Contractor shall conduct all his work, use appropriate construction methods and equipment, and furnish and install acoustical barriers, all as

necessary so that no noise emanating from the process or any related tool or equipment will exceed legal noise levels.

1.08 NIGHTTIME WORK

If the Contractor desires to perform any work between the hours of 6 p.m. and 7 a.m., he shall obtain approval of the Engineer and all necessary permits from the appropriate agencies and make all necessary arrangements prior to commencing.

1.09 EROSION CONTROL

The Contractor shall take steps to ensure that excess erosion does not occur during the construction process or during the period between the rough cleanup and the time when a grass stand is established. Areas subject to erosion shall be protected per best management practices as approved by ADEQ. At points where lines cross creeks, the potential for erosion of the backfilled creek bank shall be reduced by spreading rip-rap over the affected area. Steps taken to prevent erosion shall not be a pay item. Erosion control is a subsidiary of Earthwork, Trench Excavation, and Backfill. Inadequate erosion control efforts will result in increased retainage on this pay item.

1.10 PAYMENT

Payment for the work in this section will be included as part of the unit price bid amounts state in the Proposal.

END OF SECTION

SECTION 01016

SAFETY REQUIREMENTS AND PROTECTION OF PROPERTY

PART 1 GENERAL

1.01 CONTRACTOR'S RESPONSIBILITY FOR SAFETY

The Contractor shall do whatever work is necessary for safety and be solely and completely responsible for conditions of the job site including safety of all persons (including employees) and property during the Contract period. This requirement shall apply continuously and not be limited to normal working hours.

1.02 FEDERAL, STATE AND LOCAL SAFETY REQUIREMENTS

Safety provisions shall conform to the Federal and State Department of Labor Occupational Safety Health Act (OSHA), and all other applicable federal, state, county, and local laws, ordinances, codes, the requirements set forth herein, and any regulations that may be specified in other parts of these Contract Documents. It is noted that OSHA released new regulations on confined space entry, which apply to manholes. These regulations were published in the January 14, 1993, Federal Register and officially became enforceable on April 14, 1993. Where any of these are in conflict, the more stringent requirements shall be followed. The Contractor's failure to thoroughly familiarize himself with the aforementioned safety provisions shall not relieve him from compliance with the obligations and penalties set forth therein.

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

The Contractor shall at all times provide proper facilities for safe access to the work by authorized government officials.

1.04 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 supervisors, the safety program, or any safety measures taken in, on, or near the construction site.

1.05 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 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.

C. 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 floors, roofs, walkways, parking areas and driveways. All such barriers shall have adequate warning lights as necessary, or required, for safety.

1.06 ACCIDENT REPORTS

A. If death or serious injuries or serious damages 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 this 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 a claim is made by anyone against the Contractor or any subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the Engineer, giving full details of the claim.

1.07 TRAFFIC SAFETY AND ACCESS TO PROPERTY

A. Comply will all rules and regulations of the city, state and county 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.

1.08 TRAFFIC CONTROL

Traffic control procedures and devices used on all local, county, and state rights-of-way shall meet the requirements of the applicable current laws and regulations for traffic control.

1.09 ACCESS FOR POLICE

The Contractor shall leave his night emergency telephone number or numbers with the Police Department and Sheriff's office, so that contact may be made easily at all times.

1.10 FIRE PREVENTION AND PROTECTION

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

1.11 USE OF EXPLOSIVES

Explosives shall not be used on this project.

1.12 CONTRACTOR TO SAFEGUARD EXISTING UTILITIES

The Contractor shall perform all work, including excavation, dewatering, and demolition operations, in such a manner as to avoid damage to existing fire hydrants, sewer lines, gas mains, power poles, lighting standards, and all other existing utilities, public or private. See Section 01011, SITE CONDITIONS.

1.13 PROTECTION OF PUBLIC/PRIVATE PROPERTY

A. The Contractor shall employ such means and methods as necessary to adequately protect public and private property against damage. In the event of damage to such property, the Contractor shall, at his own expense, immediately restore the property to a condition equal to its original condition and to the satisfaction of the Engineer and the owner of said property.

B. The Contractor shall exercise due care to avoid damage to existing pipe and coatings, wrappings, sewers, conduit, or other existing utilities. Should the Contractor damage or displace any of the above, the Contractor shall repair same to the satisfaction of the Engineer and all expenses in connection therewith shall be borne solely by the Contractor.

C. Some of the work to be done under this contract will be performed on private property. A temporary easement has been obtained from the property owner for construction purposes. The easement does not permit the wanton destruction of trees, shrubs, walls, water and sewer services, or other improvements. The Contractor shall safeguard and restore the properties to a condition as near equal as possible to that found prior to entering them. In some cases, particular instruction will be given the Contractor relative to the protection of certain improvements, and in all cases, lawns will be hand-raked (after all settlement of the trench backfill has occurred) and seeded and fertilized. Since this work is being performed on behalf of the City of Siloam Springs, the Contractor shall exercise good public relations and cooperation with the property owners.

1.14 PAYMENT

Payment for the work in this section will be included as part of the unit price bid amounts stated in the Proposal. No separate payment will be made for the work under this Section.

END OF SECTION

SECTION 01027

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Procedures for preparation and submittal of Applications for Payment.

1.02 RELATED REQUIREMENTS

A. Section 00400 - Owner-Contractor Agreement and Amount.

B. Section 00700 - Progress Payments, Retainage, and times to submit.

1.03 FORMAT

Use the attached cover letter and spreadsheet titled Progress Estimate for all pay applications.

1.04 PREPARATION OF APPLICATION

A. Type required information on attached pay application form.

B. Execute certification by signature of authorized officer.

C. Provide dollar value in each column for each line item for portion of Work performed and for stored products.

D. List each authorized Change Order as an extension on continuation sheet, listing Change Order number and dollar amount as for an original item of work.

E. Prepare Application for Final Payment as specified in Section 01700.

1.05 SUBMITTAL PROCEDURES

A. Submit two (2) copies of each Application for Payment at times stipulated in agreement.

B. Submit under transmittal letter specified in Section 01300.

1.06 SUBSTANTIATING DATA

A. Provide an invoice from the Equipment Supplier for every item of stored material for which payment is requested.

B. When Engineer requires substantiating information, submit data justifying line item amounts in question.

C. Provide one copy of data with cover letter for each copy of submittal. Show Application number and date, and line item by number and description.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

CONTRACTORS NAME AND ADDRESS
PROGRESS ESTIMATE # ___

PROJECT: _____

PROJECT #: _____

CONTRACT START DATE: _____

CONTRACT COMPLETION DATE: _____

In accordance with the above contract, the undersigned approved payment to the Contractor of the amount due as shown below:

Inspector	Street Director	City Engineer	Finance Director

STATEMENT OF WORK

#	Previous Payments		Work to Date	$
1	$		Amount Retained to date	$
2	$		Subtotal	$
3	$		Plus Materials Stored	$
4	$		Total Amount Due Contractor	$
5	$		Previous Payments	$
6	$		Amount due this Payment	$
7	$			
8	$		Original Contract Amount	$
9	$		Net Change Orders	$
			Adjusted Contract Amount	$
#	Change Orders			
1	$			
2	$			

The undersigned Contractor hereby swears under penalty of perjury that all previous progress payments received from the Owner on account of work performed under the Contract referred to above have been applied by the undersigned to discharge in full all obligations of the undersigned incurred in connection with work covered by prior Applications For Payment under said contract, being Applications For Payments numbered 1 through __ inclusive: and all materials and equipment incorporated in said Project or otherwise listed in or covered by this Application For Payment are free and clear of all liens claims, security interests.

Dated: _____

Name: _____
Signature: _____
Title: _____

SECTION 01028

CHANGE ORDER PROCEDURES

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

Procedures for processing Change Orders.

1.02 SUBMITTALS

A. Submit name of the individual authorized to accept changes, and to be responsible for informing others in Contractor's employ of changes in the Work.

B. Change Order Form: Attached as page 3 of this Section.

1.03 DOCUMENTATION OF CHANGE IN CONTRACT SUM AND CONTRACT TIME

A. Document each quotation for a change in cost or time with sufficient data to allow evaluation of the quotation.

B. Provide data to support computations:

1. Actual quantities and costs of products, labor, and equipment.
2. Taxes, insurance and bonds.
3. Overhead and profit.
4. Justification for any change in Contract Time.
5. Credit for deletions from Contract, similarly documented.

C. Support each claim for additional costs, and for work done, with additional information:

1. Origin and date of claim.
2. Dates and times work was performed, and by whom.
3. Time records and wage rates paid.
4. Invoices and receipts for products, equipment, and subcontracts, similarly documented.

1.04 PRELIMINARY PROCEDURES

A. Engineer may submit a Proposal Request which includes: Detailed description of change with supplementary or revised Drawings and Specifications, the projected

time for executing the change and the period of time during which the requested price will be considered valid.

B. Contractor may initiate a change by submittal of a request to Engineer describing the proposed change with a statement of the reason for the change, and the effect on Contract Sum and Contract Time with full documentation.

1.05 EXECUTION OF CHANGE ORDERS

A. The Contractor must obtain approval of any Change Order, in accordance with Article 70 of the GENERAL CONDITIONS, from the Board of Directors of the City of Siloam Springs prior to performance of the work if it requires an expenditure of funds exceeding the contract amount or materially increases the scope of work. **If approval is not obtained prior to the start of work, the City may refuse to appropriate funds for the change.**

B. The Engineer will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

1.06 CORRELATION OF CONTRACTOR SUBMITTALS

A. The Contractor shall promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum as shown on Change Order.

B. The Contractor shall promptly enter changes in Project Record Documents.

CHANGE ORDER

PROJECT	PROJECT #	DATE

CONTRACTOR	ADDRESS

The Contract is revised as follows:

ITEM #	UNIT	QUANTITY	ITEM DESCRIPTION	UNIT PRICE $	PRICE $
				TOTAL	
			ORIGINAL CONTRACT ESTIMATE	+	
			PREVIOUS CHANGE ORDERS	+	
			REVISED CONTRACT ESTIMATE	=	

CHANGE IN CONTRACT DAYS:

ADDITIONAL DAYS	TOTAL EXTENSION	ORIG CONTRACT DATE	REVISED CONTRACT DATE

REASON FOR CHANGE ORDER:

RECOMMENDED FOR APPROVAL:

TITLE	NAME	DATE	SIGNATURE
CONSTRUCTION INSPECTOR			
CITY ENGINEER	JUSTIN BLAND		
FINANCE DIRECTOR	CHRISTINA PETRICHES		
CONTRACTOR			

APPROVED BY THE CITY OF SILOAM SPRINGS:

TITLE	NAME	DATE	SIGNATURE

ATTACHMENTS:

1	
2	
3	
4	

CHANGE ORDER

PROJECT	PROJECT #	DATE

DESCRIPTION OF REQUEST:

REASON FOR CHANGE:

THIS CHANGE AFFECTS:

SPECIFICATION SECTION #	SHEET # OF PLANS

THIS CHANGE INITIATED BY:

NAME OF PERSON INITIATING CHANGE

OWNER RESPONSE:

TITLE	NAME	SIGNATURE	DATE
CONTRACTOR			
CONSTRUCTION INSPECTOR			
CITY ENGINEER	ADAM ROARK		

NOTE: ANY ADJUSTMENTS TO CONTRACT PRICE AND/OR TIME REQUIRED BY THIS CHANGE SHALL REQUIRE AN APPROVED CHANGE ORDER AND WORK SHALL NOT START UNTIL APPROVED.

END OF SECTION

DIVISION 2

EXISTING CONDITIONS

SECTION 02 41 00 - DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Portions of buildings and other areas, equipment and materials selective demolition, and partial demolition work are as shown on Drawings and specified herein.
   2. Equipment and materials to be removed for construction and reinstalled for reuse or continued operation are as shown on the drawings and specified herein.

B. Related Sections:
   1. Section 31 23 23.13 – Fill and Backfill.

1.2 SUBMITTALS

A. Shop Drawings: Plans showing all equipment and materials to be removed and reinstalled for reuse on continued operation including interim storage plans for each item.

B. Quality Control Submittals:
   1. Schedule of demolition, as part of and consistent with the progress schedule specified in Section 01 32 00, CONSTRUCTION PROGRESS DOCUMENTATION.
   2. Methods of demolition and equipment proposed to demolish each structure.
   3. Copies of any authorizations and permits required to perform Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Utilities:
   1. Notify Owner and appropriate utilities 72 hours prior to turning off affected services before starting demolition or alterations.
   2. Remove utility lines exposed by demolition excavation.
   3. Remove electric, sanitary, and storm drainage adjacent to buildings to be demolished.
   4. Excavate utility lines serving buildings to be demolished and provide a permanent leak-proof closure for water and gas lines.
   5. Plug sewer lines at locations shown or at limits of excavation if not shown with min. 2,000 psi compressive strength concrete plug to prevent groundwater infiltrating sewer systems. Length of plug shall be 5 feet minimum.

B. Removal and Storage of Equipment for Reuse:
   1. Do not remove equipment and materials without approval of Engineer.
   2. Properly store and maintain equipment and materials in same condition as when removed.
   3. Engineer will determine condition of equipment and materials prior to removal.

3.2 DEMOLITION

A. Drawings define minimum portion of equipment to be removed and structures to be modified. Unless otherwise shown, rough cuts or breaks may be made exceeding limits of demolition shown.

B. Provide all demolition, removal, temporary storage, and reinstallation of existing equipment as required for implementation of the work.

C. Core drill floor slabs, catch basins, and other concrete improvements to remain in place below ground, or break holes at structure's lowest point to allow water to freely migrate through.

D. Remove piping from areas to be backfilled. Pipe, valves, and fittings adjacent to those to be removed may also be removed as salvage.

E. Remove all materials associated with existing equipment that is to be removed or relocated.

F. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.

G. Cut off drilled piers a minimum of 6 inches below bottom of new foundations.

H. All debris from demolished structures shall be complete removed from the site and disposed of in accordance with all local, state, federal laws and regulations. No structures to be demolished shall be buried onsite.

I. Perform all dewatering and solids removal as specified in Specification Section 33 01 20 – WASTEWATER LIQUID AND SOLIDS REMOVAL AND DISPOSAL for all work within the plant premises including temporary cleaning, bypassing, demolition, and construction of facilities.

3.3 DISPOSAL

A. Dispose of debris and other non-salvaged materials offsite in licensed landfills.

3.4 BACKFILLING

A. Demolished Areas: Backfill to existing ground level, elevations shown, or foundation level of new construction.

B. Backfill Material and Compaction:
   1. For fill in and around structures conform to Section 31 23 23.13, FILL AND BACKFILL. Top 6" of backfill to grade shall be select fill conforming to Section 31 23 23.13 FILL AND BACKFILL and shall be compacted to 90% standard proctor density.
   2. Do not use demolition debris as backfill material.

3.5 SALVAGE

A. Equipment and materials not reused or reinstalled, including all metals and piping within the limits of demolition, unless otherwise specified, shall be delivered to the Owner for scrap.

END OF SECTION

DIVISION 3

CONCRETE

SECTION 03 01 00 - CONCRETE SURFACE REPAIR SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Resurfacing of concrete surfaces in preparation for finish materials.

B. Related sections:
   1. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Association of State Highway and Transportation Officials (AASHTO): T277, Standard Method of Test for Rapid Determination of the Chloride Permeability of Concrete.
   2. ASTM International (ASTM):
      a. C 78, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
      b. A 82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
      c. C 109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
      d. A 185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
      e. C 309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      f. C 348, Standard Test Method for Flexural Strength of Hydraulic Cement Mortars.
      g. C 469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
      h. C 496, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
      i. C 596, Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement.
      j. C 666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
      k. C 672, Standard Test Method for Scaling Resistance for Concrete Surfaces Exposed to Deicing Chemicals.
      l. C 779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
      m. C 882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
      n. C 928, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repair.
      o. C 1012, Standard Test Method for Length Change of Hydraulic Cement Mortars Exposed to a Sulfate Solution.
      p. C 1042, Standard Test Method for Bond Strength of Latex Systems used in Concrete.
      q. C 1202, Standard Test Method for Electrical Induction of Concrete's Ability to Resist Chloride Ion Penetration.
      r. E 699, Criteria for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee.

1.3 DEFINITIONS

A. Low Pressure Spray Mortar: Mortar designated by "S" before the product number, applied by low pressure spraying, or in small areas by hand troweling.

B. Surface Repair Areas: Areas that are deemed to be defective and not meeting the density or surface specified in Section 03 30 00, CAST-IN-PLACE CONCRETE, regardless of depth of the defective area.

1.4 SUBMITTAL

A. Information Submittals:
   1. Mortar System:
      a. Manufacturer's installation bulletin.
      b. Manufacturer's recommended fabric size for mesh reinforcement.
   2. Written description of equipment proposed for hydro-demolition surface preparation.
   3. Certificates:
      a. Certificate of Compliance that proposed product systems meet or exceed specified performance criteria when tested in accordance with Article FIELD QUALITY CONTROL.
      b. Mortar system Manufacturer's Certificate of Proper Installation.
   4. Statements of Qualification:
      a. Independent testing laboratory.
      b. Mortar system Manufacturer's representative.
   5. Mortar system Manufacturer's proposed modified test procedures for ASTM C 109 and ASTM C 882 test methods.
   6. Independent testing laboratory test report.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Independent Testing Laboratory: Based on evaluation of laboratory submitted criteria in accordance with ASTM E 699.
   2. Mortar System Applicator: For low pressure spray mortar system in lieu of endorsement, complete mortar system manufacturer's demonstration in accordance with Article MANUFACTURER'S SERVICES.

PART 2 - PRODUCTS

2.1 LOW PRESSURE SPRAY MORTAR SYSTEM (FOR VERTICAL AND OVERHEAD REPAIRS)

A. Mortar:
   1. One component, rheoplastic, cement based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.
   2. Cured materials mixed to a flow of 70%, at five drops shall conform to the following criteria:
      a. Minimum Slant Shear Bond Strength: 3,000 psi in 28 days in accordance with "modified" ASTM C 882 test method.
      b. Minimum Compressive Strength: 11,000 psi at 28 days in accordance with ASTM C 109.
      c. Minimum Direct Shear Bond Strength: 650 psi in 28 days in accordance with Michigan DOT.
      d. Minimum Tensile Bond Strength (MBT In-House Test): 300 psi. in 28 days.
      e. Minimum Flexural Properties: 1,250 psi in 28 days in accordance with ASTM C 348.
      f. Modulus of Elasticity: 4.1 to 4.5 by 106 psi in accordance with ASTM C 469.
      g. Maximum Permeability: 1,000 coulombs in accordance with AASHTO T 277.

h. System shall not produce a vapor barrier.

B. Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only the addition of water.

C. Free of chlorides and other chemicals causing corrosion.

D. Manufacturer and Product:
1. Master Builders Technologies Co., Cleveland, OH; EMACO S88CI with Concresive liquid (LPL) bonding agent for hand applied areas.
2. Sika Corp., Lyndhurst, NJ; SikaRepair 222 or 223.

2.2 POLYMER-MODIFIED REPAIR MORTAR (HORIZONTAL SURFACE REPAIR)

A. Mortar: One component, polymer-modified, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar conforming to the following properties:
1. Bond strength in accordance with ASTM C 1042 Test Method at 7 days: Minimum 1,750 psi.
2. Modules of Elasticity: ASTM C469, minimum 2.0 by 10^6 psi.
3. Compressive Strength:
a. ASTM C 109 at 1 day: minimum 2,500 psi.
b. ASTM C 109 at 28 days: minimum 7,500 psi.
4. Flexural Properties, ASTM C 348 at 28 days: minimum 1,200 psi.
5. Permeability, AASHTO T 277: 800 coulombs maximum.
6. Splitting Tensile Strength: ASTM C 496 at 7 days, minimum 450 psi.
7. Drying Shrinkage, ASTM C 596 at 28 days: -0.090%.
8. Freeze Thaw Resistance, ASTM C 666, at 300 cycles: 95% RDF.
9. Abrasion Resistance: ASTM C 799, 60 minutes, 0.0165".

B. Manufacturers and Products:
1. Master Builders Technologies Co., Cleveland, OH; EMACO R 310
2. Or approved equal.

2.3 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.4 ACCESSORIES

A. Finishing Aid Manufacturer and Product: Master Builders Inc., Cleveland, OH; CONFILM.

B. Flexible Cementitious Rebar Coating Manufacturer and Product: Master Builders Inc., Cleveland, OH; EMACO P22.

PART 3 - EXECUTION

3.1 GENERAL

A. Where required because of deficiencies, concrete surface repair system shall be low pressure spray mortar for structural repairs.

3.2 PREPARATION

A. Remove unsound and deteriorated concrete from Work by high pressure water blasting machines capable of scoring concrete surfaces to minimum amplitude roughness of 3/16" or as shown. Remove to provide for maximum thickness specified for mortar.

B. High pressure water blasting machines with 16,000 to 20,000 psi minimum.

C. Collect and dispose of water from removal operations in manner and location acceptable to Owner.

D. Do not use power-driven jackhammers and chipping hammers, unless water blasting is prohibited due to potential damage to installed equipment.

E. Remove concrete minimum of 1" clearance around rebar for application and bonding of new mortar to entire periphery of exposed rebar if the following surface conditions exist:
   1. 50% or more of periphery around rebar is exposed during removal of concrete.
   2. 25% or more of periphery around rebar is exposed during removal of concrete and corrosion has eventuated to the extent that loss of section has occurred.
   3. Bond between existing concrete and reinforcement has deteriorated.

F. Clean exposed reinforcing bars of rust and concrete, and coat with flexible cementitious rebar coating.

G. Maintain surface areas free of slurry where concrete has been removed. Remove slurry from prepared areas before new mortar is applied.

H. Clean surface areas to be filled with new mortar of laitance and contamination by high pressure water blasting not more than 24 hours before applying bonding agent, Saturated Surface Dry (SSD) existing concrete at time of application of mortar.

3.3 LOW PRESSURE SPRAY MORTAR APPLICATION

A. Mix mortar in mortar-concrete mixer attached to pump-spray equipment for spray application. Mix with a slow speed drill and jiffler type paddle or small mortar type mixer for hand trowel application.

B. Apply mortar by low pressure spraying with a machine such as Moynotype, MEYCO DEQUNA Model 20.

C. Finish mortar with a hand float application to smooth even surface matching adjacent concrete. Provide finishing aid at full strength.

D. Bonding Agent:
   1. Hand apply bonding agent within 20 minutes of troweling on mortar. Prevent bonding agent from drying by reapplying bonding agent to maintain surface tackiness of coat.
   2. Work mortar firmly and quickly into area and compact with firm trowel stroke. Finish smooth with finishing aid at full strength.

3.4 POLYMER-MODIFIED REPAIR MORTAR APPLICATION FOR REPAIR OF HORIZONTAL SURFACES

A. Mix mortar in mortar-concrete mixer.

B. Hand Troweling: Apply (scrub in) a bond coat slurry of the repair mortar to the SSD prepared substrate before application of the mortar. Do not apply more of the bond coat than can be covered with mortar before the bond coat dries. Do not re-temper this bond coat.

C. Place mortar into prepared area from one side to the other.

D. Work material firmly into the side and bottom of patch to assure a good bond. Level repair mortar and screed to elevation of existing concrete.

E. Finish to same texture as existing concrete around patch.

F. Use self-leveling mixture where appropriate to obtain uniform or plane surface.

3.5 CURING

A. Water fog nozzle all of the mortar systems prior to curing in accordance with mortar system Manufacturer's instructions.

B. Commence water curing after mortar system application and when curing will not cause erosion of mortar.

C. Continuously cure mortar system for a period of 7 days.

D. Do not membrane cure, unless method is part of mortar system Manufacturer's instructions and approval has been obtained.

E. Cure intermediate layers of mortar in accordance with manufacturer's instructions.

3.6 FIELD QUALITY CONTROL

A. Independent testing laboratory shall perform the following:
1. Secure production samples of mixed materials during construction and test for compliance with the Specifications.
2. Obtain actual core samples from the completed repair Work and test.
3. Perform "modified" ASTM C 109 and ASTM C 882 test methods in accordance with manufacturer's approved modifications of testing procedures.

B. Construction Testing:
1. Production Samples:
   a. Obtain mixed mortar material from shotcrete or spray equipment and produce samples, and cure samples prior to testing.
   b. Provide minimum of three samples each test for each 1,000 square feet or portion thereof of mortar repair to be installed.
2. Core Samples of In-Place Repair:
   a. Obtain two core samples and test samples for each 2,000 square feet or portion thereof for actual repair Work:
   b. Cores shall be either 2-1/2" or 3" in diameter and shall be cored through cured mortar repair and into base concrete to total depth equal to at least 2.5 times repair mortar thickness.
   c. Sawcut the cores after removal to trim base concrete thickness to same thickness as mortar so that bond line is at center of repaired sample.
   d. Samples shall be epoxy bonded to steel plates at each end using a bonding agent to prevent failure in bond to steel plates.
   e. Sustain bond line without failure or movement with a minimum of 300 psi in direct tension. The tension test shall use eyebolts or threaded connectors tapped and

threaded into base plate so that tension load is concentric with center of core sample.

C. Repair and fill holes where core samples have been removed using same mortar used in repair.

3.7 MANUFACTURER'S SERVICES

A. Provide mortar system manufacturer's representative at site for installation assistance, inspection and certification of proper installation, and training of mortar system applicators.

B. Mortar System Manufacturer's Demonstration:
   1. Schedule a time for Manufacturer's demonstration of repair system proposed for the Project. Prepare mortar, to specified consistency, for testing and placement. Initiate curing on portions of each type of surface to be repaired to include overhead and vertical applications.
   2. Prepare surface area in advance of demonstration and obtain manufacturer's acceptance of preparation for each type of application.
   3. Demonstrate:
      a. Mixing and application equipment capabilities and procedures, including the flow of material from nozzle or sprayer.
      b. Nozzle operator and person in charge of low pressure sprayer, capabilities and ability to follow prescribed application procedures and properly operate equipment and apply surface repair materials.
   4. Make compression test samples during demonstration and deliver to an independent testing laboratory for testing at 1, 7, and 28 days. Take a core of the demonstration placement and test for tensile bond at 1 day.

3.8 PROTECTION

A. Protect adjacent surfaces, and equipment, from being damaged by overshooting of low pressure spray mortar.

3.9 CLEANING

A. Remove overshot mortar and deposited rebound materials as Work proceeds. Remove from Work, waste materials, unsound material from concrete surfaces, material chipped from walls, water used in preparation of application and finishing.

END OF SECTION

SECTION 03 11 00 - CONCRETE FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete formwork.

B. Related sections:
   1. Section 03 30 00 – Cast-In-Place Concrete.
   2. Section 03 60 00 – Grout.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Concrete Institute (ACI):
      a. 117, Standard Specifications for Tolerances for Concrete Construction and Materials.
      b. 318/318R, Building Code Requirements for Reinforced Concrete.
      c. 347, Formwork for Concrete.

1.3 DESIGN REQUIREMENTS

A. Design, erect, shore, brace, and maintain formwork in accordance with ACI 301, ACI 347, and ACI 318 to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads. Provide concrete finishes specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.
   1. Formwork shop drawings shall be prepared by or under the supervision of a qualified professional engineer licensed in the state of the work.

B. When high range water reducer (superplasticizer) is used in concrete mix, forms shall be designed for full hydrostatic pressure per ACI 347.

C. Make joints in forms watertight.

D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Form Ties-Tapered Through-Bolts: Proposed method of sealing form tie hole; coordinate with details shown.
   2. All formwork erection, shoring and removal are the responsibility of the Contractor and/or the qualified professional engineer the contractor used for the formwork drawings.
   3. Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing re-shoring.
   4. Manufacturer's Data for the Following Product: Form release agent.
   5. Formwork drawings shall be signed and sealed by the professional engineer licensed in the state of the work and responsible for their preparation.

B. Samples: One each as follows:
   1. Form ties.

1.5 QUALIFICATIONS

A. Formwork Designer: Formwork, falsework, and shoring design shall be by a Qualified Professional Engineer licensed in the state of the work.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

A. Wall Forms and Underside of Slabs:
   1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in "new and undamaged" condition, of sufficient strength and surface smoothness to produce specified finish.
   2. Circular Structures:
      a. Conform forms to circular shape of structure.
      b. Straight panels may be substituted for circular forms provided panels do not exceed 2' in horizontal width and angular deflection is no greater than 3-1/2° per joint.

B. Painted Surface Forms: High density overlay plywood for flat concrete surfaces to be painted.

C. All Other Forms: Materials as specified for wall forms.

D. Form Release Agent:
   1. Material: Release agent shall not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent treatments of concrete surfaces when applied to forms. A "ready to use" water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Environmentally safe, meeting local, state, and federal regulations and can be used in potable water facilities.
   2. Manufacturers and Products:
      a. Master Builders, Inc.; Rheofinish 211.
      b. Cresset Chemical Company; Crete-Lease 20-VOC.
      c. US Mix Products Company; US SPEC Slickote.

E. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

F. Form Ties:
   1. Material: Steel
   2. Spreader Inserts:
      a. Conical or spherical type.
      b. Design to maintain positive contact with forming material.
      c. Furnish units that will leave no metal closer than 1" to concrete surface when forms, inserts, and tie ends are removed.
   3. Wire ties not permitted.
   4. Flat bar ties for panel forms furnish plastic or rubber inserts with minimum 1" depth and sufficient dimensions to permit patching of tie hole.
   5. Water Stop Ties: For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
      a. Integral steel water stop 0.103" thick and 0.625" in diameter tightly and continuously welded to tie.
      b. Neoprene water stop 3/16" thick and 15/16" diameter whose center hole is 1/2-diameter of tie, or molded plastic water stop of comparable size.
      c. Orient water stop perpendicular to tie and symmetrical about center of tie.
      d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.

6. Through-Bolts: Tapered minimum 1" diameter at smallest end.
7. Elastic Vinyl Plug:
   a. Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length, and diameter upon removal forming watertight seal.
   b. Manufacturer and Product: Dayton/Richmond Co., Miamisburg, OH; A58 Sure Plug.
   c. Recess plug 1" minimum and grout over hole. See Section 03 60 00 GROUT.

PART 3 - EXECUTION

3.1 FORM SURFACE PREPARATION

A. Thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants prior to coating surface.

B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by the manufacturer.

C. Steel Forms: Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.

3.2 ERECTION

A. General: Unless specified otherwise, follow applicable recommendations of ACI 347.
   1. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
   2. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
   3.

B. Beveled Edges (Chamfer):
   1. Form 3/4" bevels (chamfers) at all exposed concrete edges, unless otherwise shown.
   2. Where beveled edges on existing adjacent structures are other than 3/4", obtain Engineer's approval of size prior to placement of beveled edge.

C. Wall Forms:
   1. Do not reuse forms with damaged surfaces.
   2. Locate form ties and joints in an uninterrupted uniform pattern.
   3. Inspect form surfaces prior to installation to assure conformance with specified tolerances.

D. Forms for Curbs and Sidewalks:
   1. Provide standard steel or wood forms.
   2. Set forms to true lines and grades, and securely stake in position.

E. Form Tolerances: Provide forms in accordance with ACI 117, 347 and 318 and the following tolerances for finishes specified:
   1. Wall Tolerances:
      a. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
      b. Wall Type W-A:
         1). Plumb within 1/4" in 10' or within 1" from top to bottom for walls over 40 feet high.
         2). Depressions in Wall Surface: Maximum 5/16" when 10' straightedge is placed on high points in all directions.
      c. Wall Type W-B:
         1). Plumb within 1/8" in 10' or within 1/2" from top to bottom for walls over 40' high.

2). Depressions in Wall Surface: Maximum 1/8" when 10' straightedge is placed on high points in all directions.

2. Thickness: Maximum -1/4" or +1/2" from dimension shown.
3. Form Offset: Between adjacent pieces of form work, facing material shall not exceed 1/8" where exposed to public view and 1/4" maximum for all other conditions.

3.3 ADDITIONAL REQUIREMENTS

A. Construct forms tight enough to prevent loss of concrete mortar.

B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
   1. Install keyways, reglets, recesses and the like for easy removal.
   2. Do not use rust-stained steel form-facing material.
   3. Use only form or form-tying methods which do not cause spalling of the concrete upon form stripping or tie removal.

C. Set edge forms, bulkheads and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

D. Provide temporary 12 inch wide x 18 inch high openings for cleanouts and inspection ports every 7 feet at the bottom of each lift form and where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations, where possible.

E. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds and bulkheads required in the Work.
   1. Determine sizes and locations from trades providing such items.
   2. Openings shall be of sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous keyways and waterstops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with reinforcement as indicated in the typical structural details. Reinforcing shall be at least 2 inches clear from the opening surfaces and encased items.

F. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris just before placing concrete.

G. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

H. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions before placing reinforcement.

I. Embedded Items.
   1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions and directions furnished with items to be embedded.
      a. Install anchor bolts/rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

b. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles and other conditions.
c. Check special castings, channels or other metal parts that are to be embedded in the concrete prior to and again after placing the concrete.
d. Check nailing blocks, plugs and strips necessary for the attachment of trim, finish and similar work prior to placing the concrete.

J. Pipes and wall spools cast in concrete.
1. Install wall spools, wall flanges, and wall anchors before placing concrete. Do not weld, tie or otherwise connect the wall spools or anchors to the reinforcing steel.
2. Support pipe and fabricated fittings to be encased in concrete on concrete piers or pedestals. Carry concrete supports to firm foundations so that no settlement will occur during construction.
3. Pipes or spools located below operating water level shall have waterstop ring collars and shall be cast in place. Do not block out such piping and grout after the concrete section is cast. Pipes fitted with thrust rings shall be cast in place.

K. Removing and reusing forms.
1. General: Do not remove forms from concrete which has been placed with outside temperature below 50°F without first determining and verifying with Engineer if the concrete has properly set without regard for time. Do not apply loading on green concrete. Immediately after forms are removed, the surface of the concrete shall be carefully examined and any irregularities in the surface shall be repaired and finished as specified.
a. Leave formwork for beam soffits, joists, structural slabs, beams, girders and other structural elements that support weight of concrete in place until concrete has achieved 100 percent its 28-day design compressive strength and a minimum of 7 days.
b. Formwork for sides of beams, walls, columns and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50°F (10 deg C) for 48 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
c. Leave bracing for walls until the top or roof slab concrete reaches 100% of its 28-day design compressive strength and a minimum of 7 days.
d. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
3. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved in writing by the Engineer.

L. Aluminum surfaces in contact with concrete.
1. Aluminum surfaces in contact with concrete or grout or dissimilar metals shall be protected with a Mylar isolator, bituminous paint or other material approved by Engineer.

M. Shores and reshores.
1. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation and removal of shoring and reshoring.
a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
2. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

3. For multi-storied structures, the shoring and reshoring diagrams and procedures shall be signed and sealed by a Registered Professional Engineer in the state where the construction is being undertaken. These diagrams and procedures shall take into account the effect of the loads on the uncured concrete and the construction load on each floor.
4. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

END OF SECTION

SECTION 03 15 00 – CONCRETE ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Waterstops.
   2. Joint fillers.

1.2 REFERENCES

A. ASTM International (ASTM):
   1. ASTM D570 - Standard Test Method for Water Absorption of Plastics.
   2. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   3. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
   4. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   5. ASTM D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
   6. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   7. ASTM D2240 - Standard Test Method for Rubber Property – Durometer Hardness.

B. American National Standards Institute (ANSI):
   1. ANSI A135.4 - Basic Hardboard.

C. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.3 SUBMITTALS

A. Product Data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of Compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.4 QUALITY ASSURANCE

A. Mock-ups:

1. Welding demonstration:
   a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
   1. Polyvinyl chloride waterstops field joints: Shall be free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of the material to water pressure at any point. Replace defective joints. Remove faulty material from the site and disposed of by the CONTRACTOR at its own expense.

C. Inspections:
   1. Quality of welded joints will be subject to acceptance of the ENGINEER.
   2. Polyvinyl chloride waterstop: The following defects that represent a partial list that will be grounds for rejection:
      a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      b. Exterior crack at joint, due to incomplete bond, which is deeper than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      c. Any combination of offset or crack which will result in a net reduction in the cross section of the waterstop in excess of 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      d. Misalignment of the joint, which will result in misalignment of the waterstop in excess of 1/2 inch in 10 feet.
      e. Porosity in the welded joint as evidenced by visual inspection.
      f. Bubbles or inadequate bonding.

PART 2 - PRODUCTS

2.1 WATERSTOPS

A. Waterstops - Polyvinyl chloride (PVC):
   1. Manufacturers: One of the following or equal:
      a. Vinylex Corporation.
      b. Greenstreak Plastic Products Company, Inc.
   2. Type: Ribbed waterstop:
      a. Construction joints: 6-inch wide ribbed type. Vinylex R638, Greenstreak 679, or equal.
      b. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb. Vinylex RB638H, Greenstreak 732, or equal.
      c. Expansion joints: 9-inch wide ribbed type with hollow center bulb or tear web. Vinylex RB938H, Greenstreak 735, or equal for expansion joints 1 inch and narrower, Vinylex TWB938, Greenstreak 739 or equal for expansion joints wider than 1 inch.
   3. Dumbbell type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
   4. Provide polyvinyl chloride waterstops complying with following requirements:
      a. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of this Section.
      b. No scrap or reclaimed material shall be used.
   5. Properties as indicated in the following table:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D 792	Not less than 1.3.
Hardness	ASTM D 2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D 638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D 638	Not less than 300 percent
Alkali Extraction	CRD-C-572	7 day weight change between minus 0.1 percent and plus 0.25 percent. Hardness change within 5 points.
Low Temperature Brittle Point	ASTM D 746	No sign of cracking or chipping at -35 degrees Fahrenheit minimum.
Water Absorption	ASTM D 570	Not more than 0.15 percent after 24 hours.
Accelerated Extraction Tensile	CRD-C-572	Not less than 1,600 pounds per square inch.
Stiffness in Flexure	ASTM D 747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D 624	Not less than 225 pounds per inch.
Thickness	–	3/8 inch
Center Bulb		
6 inch Waterstops	–	7/8 inch or 1-inch nominal outside diameter.
9 inch Waterstops	–	1-inch nominal outside diameter. For expansion joints 1 inch and narrower and 2 inches for expansion joints wider than 1 inch.
Allowable Tolerances		
Width	–	Plus or minus 3/16 inch.
Thickness	–	Plus or minus 1/32 inch.

2.2 JOINT FILLERS

A. Hardboard: 1/8-inch minimum thickness, in accordance with ANSI A135.4 Class 2.

B. Preformed expansion joint materials:
   1. General:
      a. Use specific type in applications as indicated on the Drawings.
      b. No scrap or recycled material shall be used.
   2. Bituminous fiber expansion joint material:
      a. Manufacturers: One of The following or equal:
         1). Tamms Industries, a division of Euclid Chemical Company: Hornboard/fiber.
         2). Approved equal.
   3. Synthetic sponge rubber expansion joint material:
      a. Manufacturers: One of the following or equal:
         3). Tamms Industries, a division of Euclid Chemical Company: Cementone.
         4). Approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Waterstops - General:

1. Waterstops shall be stored so as to permit free circulation of air around the waterstop material and to prevent direct exposure to sunlight.
2. Install waterstops in concrete joints where indicated on the Drawings.
3. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
4. In water-bearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
5. Provide waterstops that are continuous and in longest lengths practical.
6. Set waterstops accurately to position and line as indicated on the Drawings.
7. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
8. Position the waterstop so that symmetrical halves of the waterstop are equally divided between the concrete pours. The center axis of the waterstop shall be coincident with the centerline of the joint.
9. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
10. Use wires at not more than 24 inches on centers near outer edge of the waterstop to tie waterstops into position.
11. Special clips may be used in lieu of wires, at contractor's option.
12. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.
13. When any waterstop is installed in the concrete on one side of a joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of sunlight during the entire exposure and until the exposed portion is embedded in concrete.
14. When placing concrete at waterstops in slabs, lift the edge of the waterstop while placing concrete below the waterstop. Manually force the waterstop against and into the concrete. Then cover the waterstop with fresh concrete.

B. Polyvinyl chloride waterstops:
   1. Install waterstops so that joints are watertight.
   2. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
      a. The material shall not be damaged by heat sealing.
      b. Make joints by overlapping then simultaneously cut the ends of the sections to be spliced so they will form a smooth even joint. Heat the cut ends with the splicing tool until the plastic melts. Press the 2 ends together until the plastic cools.
      c. The continuity of the waterstop ribs and tubular center axis shall be maintained.
      d. The splices shall have a tensile strength of not less than 60 percent of the unspliced materials tensile strength.
   3. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.
   4. Joints for crosses and tees shall be factory prefabricated by the manufacturer.

C. Joints:
   1. Construct construction, and expansion joints as indicated on the Drawings.
   2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

D. Hardboard:
   1. When indicated on the Drawings, face surface of joint filler with hardboard.
   2. Other facing materials may be used provided they furnish equivalent protection and the material is acceptable to ENGINEER.

3. Hold boards in place by nails, waterproof adhesive, or other means acceptable to the ENGINEER.

END OF SECTION

SECTION 03 20 00 - CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing steel and related items required for cast-in-place concrete.

B. Related Sections:
   1. Section 03 11 00 – Concrete Formwork.
   2. Section 03 30 00 – Cast-In-Place Concrete.

1.2 SUPERVISION

A. Workmanship: Provide qualified supervision at all times reinforcing work is in progress. Workmen shall be experienced iron workers.

B. Codes: Reinforcement placement and detailing shall comply with practice specified in the "Manual of Standard Practice for Detailing Reinforced Concrete Structures" publication ACI 315- latest edition of the American Concrete Institute or its latest revision, unless otherwise specified herein.

1.3 SUBMITTALS

A. Shop drawings: Shop drawings shall be prepared for all reinforcement required by the project. Shop drawings shall be logically and legibly prepared to permit reasonable ease of sorting, selecting, placing reinforcement as well as checking drawings. Preparer and fabricator shall be identified on the drawings.
   1. Reinforcement shall not be fabricated until the shop drawings have been processed, approved and returned.
   2. Check all shop drawings to verify reinforcement dimensions required by drawings are satisfied.
   3. Provide bar sizes, bar lengths, bar material, bar grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and lap lengths, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

B. Reinforcement shop drawings:
   1. Review of reinforcement shop drawings by the ENGINEER will be limited to general compliance with the Contract Documents.
   2. Submit reinforcement shop drawings in a complete package for each specific structure. Partial submittals will be rejected.

C. Changes to reinforcing steel contract drawing requirements:
   1. Indicate in separate letter submitted with shop drawings any changes of requirements indicated on the Drawings for reinforcing steel.
   2. Such changes will not be acceptable unless the ENGINEER has accepted such changes in writing.

1.4 PRODUCT HANDLING

A. Protection:
   1. Use all means necessary to protect reinforcement from dirt and other foreign substances before and after placing.
   2. Store in a neat manner in logical order, bundled, tagged, off the ground, and in an area adequately isolated.

3. Re-bundle to maintain identification when placing is interrupted.

B. Replacement: All damaged or improperly fabricated bars shall be replaced at the Contractor's expense.

PART 2 - PRODUCTS

2.1 CONCRETE REINFORCEMENT

A. General: All reinforcement shall be free from rust, loose mill scale, and other contaminants.

B. Wire bar supports located between reinforcing bars and face of concrete:
1. Stainless steel. Type 304 stainless steel bar supports.
2. Support reinforcing for concrete placed on ground using bar support chairs with Type 304 stainless steel plates for resting on ground welded to the chairs.

C. Concrete bar supports located between reinforcing bars and face of concrete:
1. Manufactured expressly for supporting reinforcing bars.
2. Manufactured with two annealed steel wires to securely tie concrete bar support to reinforcing steel.
3. Manufactured with minimum f'_c = 5,000 psi concrete.

2.2 WELDED WIRE REINFORCEMENT (WWR):

A. In accordance with ASTM A 185.

B. WWR may not be used in place of reinforcing bars unless accepted in writing by the Engineer.

C. Provide WWR in flat sheet form.

D. If WWR is used, provide WWR having cross-sectional area per linear foot of not less than cross-sectional area per linear foot of reinforcing bars indicated on the Drawings.

2.3 ACCESSORIES:
1. General: Accessories shall be subject to Engineer's approval.
2. Tie wire - 18 gauge annealed steel wire.
3. Number of chairs shall be adequate to prevent sag during steel and concrete placement.
4. Wall layer spacers shall be 1/4 inch round "Z" bar.
5. Horizontal layer spacers shall be wire bar supports or reinforcing bars bent to support top layer.
6. Dowel bar splicer:
   a. Dowel bar splicer shall be Richmond or approved equal, manufactured from standard specified rebar material, with NC threads and shop fabricated to specified dowel configurations.

PART 3 - EXECUTION

3.1 GENERAL

A. Reinforcing bars and welded wire fabric reinforcement: Verify that reinforcement is new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the work.

B. Other trades: Coordinate all work of other trades to avoid conflict with reinforcement.

C. Shop drawings: Check all shop drawings to verify dimensions required.

3.2 FABRICATING

A. General: Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice." Reinforcement shall be shop fabricated except where straight bars No. 5 or smaller are required.

B. Bending: All bending shall be by using bending jigs and mandrels. All bars shall be bent cold.

C. Cutting: Bars shall be cut by cold shearing. Torch cutting in the field may be permitted in special situations.

3.3 PREPARATION

A. Surface Preparation:
1. Reinforcing bars: Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean any bars having rust scale, loose mill scale, or thick rust coat.
2. Cleaning of reinforcement materials: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placement.

3.4 PLACING

A. General:
1. Accurately place all bars to meet tolerances as outlined in ACI 318 and tie in place before placing concrete, include dowels. Tie with 18 gauge steel wire.
2. Corner bars required for horizontal reinforcing. Unless otherwise noted on plans corner bars shall be same size and spacing as horizontal bar.
3. No field bending of bars will be allowed.

B. Clearance:
1. Preserve clearance between bars of 1 inch minimum, not less than one bar diameter or 1-1/3 times large aggregate, whichever is larger.
2. Provide following concrete coverage over reinforcing steel unless otherwise indicated on plans:
   a. Three inches above subgrade - in excavation.
   b. Two inches above subgrade - slab on fill.
   c. Two inches from form - walls exposed to water or earth and for slab over water.
   d. One and one-half inches from form - normal cover interior walls, beams, columns, etc.
   e. Three-fourths inch on top steel - interior slabs.
   f. One and one-half inches on top and bottom - exterior slab.
3. Lap all reinforcing bars as required by ACI 318-latest edition Class B as indicated on the drawings except where otherwise required by ACI.
4. Stagger splices except where otherwise shown.
5. Lap welded wire reinforcement a minimum of two spaces.

C. Dowels: All dowels shall be placed and securely anchored before placing concrete

D. Supports:
1. Provide a sufficient number to prevent sagging, to prevent shifting, and to support loads during construction; but in no case less than quantities and at locations as indicated in ACI 315.

2. Do not use brick, broken concrete masonry units, spalls, rocks, wood or similar materials for supporting reinforcing steel.
3. Do not use reinforcing bars that have less cover than required by the Contract Documents. Do not adjust location of reinforcement required by the Contract Documents to provide cover to these bars.
4. Wire chairs will not be accepted to hold reinforcing clearance on walls.

E. Tying of bar reinforcement:
1. Fasten bars securely in place with wire ties.
2. Tie bars sufficiently often to prevent shifting.
3. Provide at least 3 ties in each bar length.
4. Do not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity.
5. Tie slab bars at every intersection around periphery of slab.
6. Tie wall bars and slab bar intersections other than around periphery at not less than every fourth intersection, but at not greater than following maximum spacings:

Bar Size	Slab Bar Spacing Inches	Wall Bar Spacing Inches
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

7. After tying wire ties, bend ends of wire ties in towards the center of the concrete section.
   a. The cover for wire ties shall be the same as the cover requirements for reinforcing bars.

F. Openings and obstructions:
1. Place additional reinforcing around openings as shown on the drawings and standard details.
2. Bend reinforcing around obstructions. Place extra reinforcing where cutting is authorized. Engineer's approval required before cutting steel.
3. Consult Engineer on special situations.

G. Welded Wire Reinforcement:
1. Install necessary wiring, spacing chairs, or supports to keep welded wire fabric in place while concrete is being placed.
2. Bend fabric as indicated on the Drawings or required to fit work.
3. Unroll or otherwise straighten fabric to make flat sheet before placing in the Work.
4. Lap splice welded wire fabric as indicated on the Drawings.
5. If lap splice length is not indicated on the Drawings, splice fabric in accordance with ACI 318 and ACI 350.

H. Certification: Certify material and type of deformation.

I. Condition: All reinforcement shall be free from loose rust, dirt coating, oil, paint, or any foreign substance.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including concrete materials, concrete accessories, concrete mixture designs, placement procedures, and finishes, for the following:
   1. Footings.
   2. Foundation walls.
   3. Slabs-on-grade.
   4. Suspended slabs.
   5. Concrete toppings.
   6. Building frame members.
   7. Building walls.
   8. Hydraulic (liquid containing) structures.

B. Related Sections:
   1. Section 03 01 00 - Concrete Surface Repair
   2. Section 03 11 00 - Concrete Formwork
   3. Section 03 15 00 - Concrete Accessories
   4. Section 03 20 00 - Concrete Reinforcement
   5. Section 03 41 00 - Precast Concrete
   6. Section 03 60 00 - Grout
   7. Section 03 60 01 - Basin Bottom Grout
   8. Section 03 64 00 - Concrete Repair Crack Injection

1.2 REFERENCES

A. American Concrete Institute (ACI):
   1. ACI 301 – Specifications for Structural Concrete
   2. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials
   3. ACI 305 - Hot Weather Concreting Standard
   4. ACI 306 - Cold Weather Concreting Standard
   5. ACI 318 - Building Code Requirements for Structural Concrete and Commentary
   6. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary
   7. ACI 211.1 – Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
   8. ACI 302.1R – Guide for Concrete Floor and Slab Construction
   9. ACI 308.1 – Standard Specification for Curing Concrete
   10. Manual of Concrete Practice

B. ASTM International (ASTM):
   1. ASTM A615 – Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
   2. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   3. ASTM C33 - Standard Specification for Concrete Aggregates
   4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
   5. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
   6. ASTM C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

7. ASTM C88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
8. ASTM C94 - Standard Specification for Ready-Mixed Concrete
9. ASTM C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement
10. ASTM C117 - Standard Test Method for Materials Finer that 75-m (No. 200) Sieve in Mineral Aggregates by Washing
11. ASTM C123 - Standard Test Method for Lightweight Particles in Aggregate
12. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
13. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
14. ASTM C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate
15. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete
16. ASTM C150 - Standard Specification for Portland Cement
17. ASTM C156 - Standard Test Method for Water Loss [from a Mortar Specimen] Through Liquid Membrane-Forming Curing Compounds for Concrete
18. ASTM C157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete
19. ASTM C171 - Standard Specifications for Sheet Materials for Curing Concrete
20. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete
21. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
22. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
23. ASTM C231 – Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
24. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete
25. ASTM C295 – Standard Guide for Petrographic Examination of Aggregates for Concrete
26. ASTM C309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
27. ASTM C494 – Standard Specification for Chemical Admixtures for Concrete
28. ASTM C618 – Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
29. ASTM C881 – Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
30. ASTM C1064 – Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
31. ASTM C1059 – Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
32. ASTM C1077 – Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
33. ASTM C1116 – Standard Specification for Fiber-Reinforced Concrete
34. ASTM C1315 – Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
35. ASTM D448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction
36. ASTM D1751 – Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
37. ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness
38. ASTM E329 – Standard Specification for Agencies Engages in Construction Inspection, Testing, or Special Inspection
39. ASTM E1155 – Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers
40. ASTM E1643 – Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs
41. ASTM E1745 – Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

1.3 DEFINITIONS

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

B. Exposed Concrete: Concrete surface that can be seen inside or outside of structures regardless whether concrete is above water, dry at all times, or can be seen when structure is drained.

C. Hydraulic Structures: Liquid containing basins.

D. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations greater than 3/16", cracks 0.005" wide and larger as well as any crack that leaks for liquid containing basins and below grade habitable spaces; cracks 0.010" wide and larger in non-fluid holding structures, spalls, chips, air bubbles greater than ¾" in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form pop-outs, texture irregularities, and stains and other color variations that cannot be removed by cleaning.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Concrete Mixture Designs: For each concrete mixture.
1. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
2. Indicate amounts of mixing water to be withheld for later addition at Project site.
3. Submit Shrinkage Test Results for design mixtures. See 3.13 FIELD QUALITY CONTROL, E. Shrinkage Tests - 3 for shrinkage test requirements and limitations. Any Mix Design submitted without a Shrinkage Test will not be reviewed and will be returned to the Contractor as "Rejected".

C. Welding certificates.

D. Qualification Data: For manufacturer testing agency.

E. Material Certificates: For each of the following, signed by manufacturers:
1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Floor and slab treatments.
5. Bonding agents.
6. Adhesives.
7. Vapor retarders.
8. Semi-rigid joint filler.
9. Joint-filler strips.

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

G. Field quality-control test and inspection reports.

H. Course Aggregate Gradation.

I. Fine Aggregate Gradation.

J. One copy of each 30 consecutive strength test results and mix design used from a record of past performance or one copy of the laboratory trial mix design and results and one copy of the mix design proposed for each mixture and use under this contract. If the 30 consecutive strength tests are used, the test shall have been made within the 12 month period prior to this submittal.

K. Material Test Reports: for the following, from a testing agency acceptable to the ENGINEER, indicating compliance with requirements:
   1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

L. Ready-Mix concrete.
   1. Provide delivery tickets for ready-mix concrete or weigh-masters certificate per ASTM C94 including weights of cement and each size aggregate and amount of water added at the plant and record of pours. Record the amount of water added on the job on the delivery ticket. Water added at the plant shall account for moisture in both coarse and fine aggregate. If water is added on the job the total water content shall not exceed the water content of the approved design mix.
   2. Keep record showing time and place of each pour (placement) of concrete, together with transit-mix delivery slips certifying the contents of the pour (placement).
   3. Furnish records to Engineer upon request.

1.5 QUALITY ASSURANCE

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

B. Manufacturer Qualifications: A firm with a minimum of 5 years' experience in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
   2. The criteria hereinafter set out are solely for the purpose of establishing required mixture proportions and do not constitute a basis for confirming the adequacy of concrete strength.
      a. Required Average Strength Above Specified Compressive Strength: Proportions, including water-cement ratio, shall be established on the basis either of laboratory trial batches or of field experience with the materials to be employed. The proportions shall be selected to produce an average strength of 28 days exceeding the specified compressive strength by the amount indicated below, when both air content and slump are the maximums permitted by the Specifications.
      b. Determination of the required average strength shall be in accordance with ACI 318 "Building Code Requirements for Reinforced Concrete," except that if suitable data from trial batches or field experience cannot be obtained, permission will not be granted to base concrete proportions on the water-cement ratio limits set out in the above referenced code.
         1). Past Plant Performance: Proportions may be established on the actual field performance of the ready-mix producer. Where the concrete production facility has a record, based on at least 30 consecutive strength tests taken within the prior 12 months representing similar materials and conditions to those expected, the strength used as the basis for selecting proportions shall exceed the required f'c by at least:
            a). 400 psi if the standard deviation is less than 300 psi;
            b). 500 psi if the standard deviation is 300 to 400 psi;
            c). 700 psi if the standard deviation is 400 to 500 psi;
            d). 900 psi if the standard deviation is 500 to 600 psi;

e). 1,200 psi if the standard deviation is above 600 psi or unknown.

2). Strength data for determining standard deviation shall be considered to comply with the foregoing stipulations if they represent either a group of at least 30 consecutive tests or the statistical average of two groups totaling 30 or more tests. The tests used to establish standard deviation shall represent concrete produced to meet a specified strength or strengths within 1,000 psi of that specified for the proposed work. Changes in materials and proportions within the population of background tests shall not have been more closely restricted than they will be for the proposed work.

3). Strength data for determining standard deviation shall be considered to comply with the foregoing stipulations if they represent either a group of at least 30 consecutive tests or the statistical average of two groups totaling 30 or more tests. The tests used to establish standard deviation shall represent concrete produced to meet a specified strength or strengths within 1,000 psi of that specified for the proposed work. Changes in materials and proportions within the population of background tests shall not have been more closely restricted than they will be for the proposed work.

4). Laboratory Trial Batches: When the ready-mix producer does not have a record of past performance, the combination of materials and the proportions selected shall be determined from trial mixes having proportions and consistencies suitable for the work based on ACI 211.1-77.

a) When laboratory trial batches are used as the basis for selecting concrete proportions, strength tests shall be made in accordance with "Method of Test for Compressive Strength of Molded Concrete Cylinders" (ASTM C39) on specimens prepared in accordance with "Method of Making and Curing Test Specimens in the Laboratory" (ASTM C192). A curve shall be established showing the relationship between water-cement ratio (or cement content) and compressive strength. The curve shall be based on at least three points representing batches which produce strengths above and below that required. Each point shall represent the average of at least three specimens tested at 28 days or the earlier age designation.

b) The average strength required shall exceed the specified compressive strength by 1,200 psi.

c) The maximum permissible water-cement ratio (or minimum cement content) for the concrete to be used in the structure shall be that shown by the curve to produce the average strength indicated, but in no case shall the water-cement ratio exceed 0.42 by weight.

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

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

E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete."
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

3. ACI 350 "Code Requirements for Environmental Engineering Concrete Structures."
4. ACI 318 "Building Code Requirements for Reinforced Concrete."

F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

G. Pre-installation Conference: Conduct conference at Project site.
1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete subcontractor.
2. Review special inspection and testing and inspecting agency procedure for field quality control., concrete finishes and finishing, cold and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and re-shoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures and concrete protection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Available Products: Subject to compliance with requirements products that may be incorporated into the work include, but are not limited to products specified.
2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.2 FORM-FACING MATERIALS

A. See Section 03 11 00 CONCRETE FORMWORK for additional requirements.

B. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints. Furnish on exposed surfaces and interior surfaces.

C. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit. Permitted to furnish on below grade exterior surfaces

D. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

E. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

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

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

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

I. Form-Release Agent: As specified in Section 03 11 00 CONCRETE FORMWORK.

2.3 REINFORCEMENT ACCESSORIES

A. Expansion Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
   1. All dowels shall be placed and securely anchored before placing concrete. All dowels shall be parallel with each other and perpendicular to the joint.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
   1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic or CRSI Class 2 stainless-steel bar supports.
   2. Secure all reinforcement in place using steel chairs, supports, "A" bars and any other ACI approved product. Supports shall be spaced adequately to support the steel firmly in place.
   3. Charis will not be accepted to hold reinforcing clearance on walls.

C. General:
   1. Accessories shall be subject to Engineer's approval.
   2. Tie wire- 18 gauge steel wire. Ends of wire shall be bent towards the interior part of the wall.
   3. Support above forms with fabricated steel chairs. Number of chairs shall be adequate to prevent sag during steel and concrete placement.
   4. Wall layer spacers shall be 1/4" ROUND "Z" BAR.
   5. Horizontal layer spacers shall be stand.
   6. Dowel Bar Splicer:
      a. Dowel bar splicer shall be Richmond or approved equal, manufactured from standard specified rebar material with NC threads and shop fabricated to specified dowel configurations.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
   1. Portland Cement (Non-hydraulic Above Grade Structures): ASTM C150, Type I or II, or combination of Type I with fly ash.
   2. Portland Cement (Hydraulic and/or Below Grade Structures): ASTM C150 type II or combination of Type I with fly ash.
   3. Fly Ash: ASTM C618, Class C or F fly ash shall not exceed 15 percent of the cementitious materials, unless written approval is given by the Engineer.

B. Normal-Weight Aggregates: ASTM C33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1" nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Fine aggregate:
   a. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
   b. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances.
   c. In no case shall total exceed percent listed.

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C117	3
Shale or Chert	ASTM C123 ASTM C295*	1 1
Clay Lumps	ASTM C142	1

* Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale or chert. If the results of Test Method C123 are less than 1 percent, Test Method C295 is not required.

   d. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with ASTM C33.

4. Coarse aggregate:
   a. Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
   b. Not exceeding 15 percent by weight, of thin or elongated pieces having length greater than 5 times average thickness.
   c. Deleterious substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.
   d. Coarse aggregate shall be washed prior to combining in concrete mix.

Item	Test Method	Percent
Shale or chert	ASTM C123 ASTM C295**	1.25 1
Coal and lignite	ASTM C123	1/4
Clay lumps and friable particles	ASTM C142	1/4
Materials finer than Number 200 sieve	ASTM C117	1/2*

* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.

** Test Method C 123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C 295 is used to identify which of the lightweight particles are shale, chert, coal, or lignite. If the results of Test Method C 123 are less than 1.25 percent (the minimum combined percentage of shale, chert, coal and lignite), Test Method C 295 is not required.

5. Grading:

a. Aggregate for building elements and hydraulic structures: In accordance with ASTM C33, Size Number 57, except as otherwise specified or authorized in writing by the ENGINEER.

C. Water: ASTM C94 and potable (not recycled water).

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
   a. Bayer Corporation.
   b. ChemMasters.
   c. Conspec Marketing & Manufacturing Co., Inc.; a Dayton Superior Company.
   d. Davis Colors.
   e. Elementis Pigments, Inc.

2.6 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E1745, Class B. Include manufacturers' recommended adhesive or pressure-sensitive tape.
1. Products:
   a. Fortifiber Corporation: Moistop Ultra.
   b. Revan Industries Inc.; Vapor Block 10.
   c. Stego Industries, LLC; Stego Wrap, 15 mils.

B. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

2.7 FLOOR AND SLAB TREATMENTS

A. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or siliconate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.
1. Products:
   a. Burke by Edoco; Titan Hard.
   b. ChemMasters; Chemisil Plus.
   c. ChemTec international; ChemTec One.
   d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company
   e. Curecrete Distribution Inc.; Ashford Formula.
   f. Dayton Superior Corporation; Day-Chem sure Hard.
   g. Euclid Chemical Company (The); Euco Diamond Hard.
   h. Kaufman Products, Inc.; SureHard.
   i. L&M Construction Chemicals, Inc.; Seal Hard.
   j. Meadows, W. R., Inc.; Liqui-Hard.
   k. Metalcrete Industries; Floorsaver.
   l. Nox-Crete Products Group, Kinsman Corporation; Duranox.
   m. Symons Corporation, a Dayton Superior Company; buff Hard.

n. US Mix Products Company; US Spec Industraseal.
o. Vexcon Chemicals, Inc.; Vexcon StarSeal PS.

2.8 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
1. Products:
a. Axim Concrete Technologies; Cimfilm.
b. Burke by Edoco; BurkeFilm.
c. ChemMasters; Spray-Film.
d. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior company; Aquafilm.
e. Dayton Superior Corporation; Sure Film.
f. Euclid Chemical Company (The); Eucobar.
g. Kaufman Products, Inc.; Vapor Aid.
h. Lambert Corporation; Lambco Skin.
i. L&M Construction Chemicals, Inc.; E-Con.
j. MBT Protection and Repair, Div., of ChemRex; Confilm.
k. Meadows, W. R., Inc; Sealtight Evapre.
l. Metalcrete Industries; Waterhold.
m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
n. Sika Corporation, Inc.; SikaFilm.
o. Symons Corporation, a Dayton Superior Company; Finishing Aid.
p. Unitex; Pro-Film.
q. US Mix Products Company; US Spec Monofilm ER.
r. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.

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

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

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
1. Products
a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
b. Burke by Edoco; Aqua Resin cure.
c. ChemMasters; Safe-Cure Clear.
d. Conspec Marketing & Manufacturing co., Inc., a Dayton Superior Company; W.B. Resin cure.
e. Dayton Superior Corporation; Day Chem Rez cure (J-11-W).
f. Euclid Chemical Company (The); Kurez DR VOX.
g. Kaufman Products, Inc.; Thinfilm 420.
h. Lambert Corporation; Aqua Kure-Clear.
i. L&M Construction Chemicals, Inc.; L&M Cure R.
j. Meadows, W. R., Inc.; 100 Clear.
k. Nox-Crete Products Group, Kinsman Corporation; Resom Cire E/
l. Sykkmons Corporation, a Dayton Superior Company; Resi-Chem Clear Cure.
m. Tamms Industries, Inc., Horncure WB 30.
n. Unitex; Hydro cure 309.
o. US Mix Products Company; US Spec Maxcure Resin Clear.
p. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

F. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A. Compatible with penetrating liquid floor treatment for surfaces specified to receive penetrating liquid floor treatment.
   1. Products:
      a. Burke by Edoco; Cureseal 1315 WB.
      b. ChemMasters; Polyseal WB.
      c. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Sealcure 1315 WB
      d. Euclid Chemical Company (The); Super Diamond Clear VOX.
      e. Kaufman Products, Inc.; Sure Cure 25 Emulsion.
      f. Lambert Corporation; UV Safe Seal.
      g. L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
      h. Meadows, W. R., Inc.; Vocomp-30.
      i. Metalcrete Industries; Metcure 30.
      j. Symons Corporation, a Dayton Superior Company; Cure 7 Seal 31 Percent E.
      k. Tamms Industries, Inc.; LusterSeal WB 300.
      l. Unitex; Hydro Seal 25.
      m. US Mix Products Company; US Spec Radiance UV-25.
      n. Vexcon Chemicals, Inc.; Vexcon Starseal 1315.

2.9 RELATED MATERIALS

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

B. Semi-rigid Joint Filler: Two-component, semi-rigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D2240.

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

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

2.10 REPAIR MATERIALS

A. See Sections 03 01 00, CONCRETE SURFACE REPAIR SYSTEMS and 03 64 00, CONCRETE REPAIR CRACK INJECTION.

2.11 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
   1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage by weight of cementitious materials other than Portland cement in concrete as follows:
   1. Fly Ash: ASTM C 618 Class C; 15 percent of cementitious materials maximum, unless written approval is given by the Engineer.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement for non-hydraulic structures and 0.10 percent by weight of cement for hydraulic structures.

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

2.12 CONCRETE MIXTURES

A. Proportion normal-weight concrete mixture as follows for all structural elements:
   1. Minimum Compressive Strength: 4,500 psi at 28 days.
   2. Maximum Water-Cementitious Materials Ratio: 0.42.
   3. Minimum Cementitious Materials Content: 535 lb. /cu yd.
   4. Slump Limit: 8-inches Max for concrete with verified slump of 2 to 4-inches before adding high range water-reducing admixture or plasticizing admixture per ACI 301.
   5. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery.

      a. Concrete for interior, above grade, non-hydraulic slabs does not require air entrainment.

B. Proportion normal-weight concrete mixture as follows for all non-structural elements:
   1. Minimum Compressive Strength: 3,000 psi at 28 days.
   2. Maximum Water-Cementitious Materials Ratio: 0.45.
   3. Slump Limit: 8 inch for concrete with verified slump of 2" to 4": before adding high-range water-reducing admixture or plasticizing admixture per ACI 301.
   4. Air content: 5 1/2%, ±1.5% at point of delivery.

2.13 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M and ASTM C1116, and furnish batch ticket information.
   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

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

PART 3 - EXECUTION

3.1 FORMWORK: See Section 03 11 00, CONCRETE FORMWORK.

3.2 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturers' recommended tape.

3.3 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer/Owner
   1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
   2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
   3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
   4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
   5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
   6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one fourth of concrete thickness as follows:
   1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
   2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
   1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
   2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants," are indicated.
   3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.4 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Engineer.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
   1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
   2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
   3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
   1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
   2. Maintain reinforcement in position on chairs during concrete placement.
   3. Screed slab surfaces with a straightedge and strike off to correct elevations.
   4. Slope surfaces uniformly to drains where required.
   5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
   2. All embedded items such as wall pipes, embed frames, steel guide rails, channels, etc. (not including conduit and reinforcing) shall be considered "massive embedments" and are required to be kept above 32 deg F during placement and for the first 48 hours after placement. Contractor shall take the necessary measures; including insulated blankets, heated blankets, and heaters; to insure items are kept above 32 deg F. All other methods shall be submitted to the Engineer for approval.
   3. Do not use frozen materials or materials containing ice or snow.
   4. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Top 12-inches of subgrade shall be thawed prior to concrete placement. Contractor is responsible for verifying that the temperature for the top 12-inches of subgrade is above 32 deg F.
   5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 305.1 and as follows:
   1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is included in total amount of mixing water. Using liquid nitrogen to cool concrete is contractor's option, but liquid nitrogen should not replace water.

2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
3. All other methods shall be submitted to the Engineer for approval.

3.5 CONCRETE WALL FINISHES

A. Type W-1 (Ordinary Wall Finish or Coating):
1. Patch tie holes.
2. Knock off projections.
3. Patch defective areas.

B. Type W-2 (Smooth Wall Finish):
1. Patch tie holes.
2. Grind off projections, fins, and rough spots.
3. Patch defective areas and repair rough spots resulting from form release agent failure or other reasons to provide smooth uniform appearance.

C. Type W-5 (Finish for Painting):
1. Patch tie holes.
2. Grind off projections, fins, and rough spots.
3. Patch and repair defective areas as specified for Type W-2.
4. Apply paint or coating system as specified in Section 09 90 00 Painting and Protective Coatings.

3.6 CONCRETE SLAB FINISHES

A. General:
1. Finish slab concrete per the requirements of ACI 302.1R
2. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
3. Do not use "Jitterbugs" or other special tools designed for the purpose of forcing coarse aggregate away from the surface and allowing a layer of mortar, which will be weak and cause surface cracks or de-lamination, to accumulate.
4. Do not dust surface with dry materials.
5. Use evaporation retardant.
6. Round off edges of slabs with a steel edging tool, except where a cove finish is shown. Steel edging tool radius shall be 1/4" for slabs subject to wheeled traffic.

B. Type S-1 (Steel Troweled Finish):
1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation, use evaporation retardant.
2. 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.
3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
5. Burnish surface with an additional troweling. Final troweling shall produce a ringing sound from trowel.
6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
7. Power Finishing:
   a. An approved power machine may be used in lieu of hand finishing in accordance with directions of machine manufacturer.
   b. Do not use power machine when concrete has not attained the necessary set to allow finishing without introducing high and low spots in slab.
   c. Do first steel troweling for slab S-1 finish by hand.

C. Type S-2 (Wood Float Finish):
   1. Finish slabs to receive fill and mortar setting beds by screeding with straight edges to bring surface to required finish plane.
   2. Wood float finish to compact and seal surface.
   3. Remove laitance and leave surface clean.
   4. Coordinate with other finish procedures.

D. Type S-3 (Underside Elevated Slab Finish): When forming is removed, grind off projections on underside of slab and patch defective areas, including small shallow air pockets where schedule of concrete finishes requires painting or protective coating.

E. Type S-5 (Broomed Finish):
   1. Finish as specified for Type S-1 floor finish, except omit final troweling and finish surface by drawing a fine-hair broom lightly across the surface.
   2. Broom in same direction and parallel to expansion joints, or, in the case of inclined slabs, perpendicular to scope, except for round roof slab, broom surface in radial direction.

F. Type S-6 (Sidewalk Finish):
   1. Slope walks down 1/4" per foot away from structures, unless otherwise shown.
   2. Strike off surface by means of strike board and float with wood or cork float to a true plane, then flat steel trowel before brooming.
   3. Broom surface at right angles to direction of traffic or as shown.
   4. Lay out sidewalk surfaces in blocks, as shown or as directed by Engineer, with a grooving tool.

G. Type S-7: The top surfaces of basins in which raking mechanisms are to be installed
   1. Slabs shall be finished by sweeping in cement grout with the mechanism. The cement grout to be used shall be composed of one part Portland cement and two parts sand.
   2. The sweeping-in process shall be performed under the supervision of a factory representative of the equipment manufacturer.
   3. The slab upon which the grout is to be applied shall receive a Type S-5 finish except that after leveling and floating, it shall be raked in such a manner as to provide a good bond for the grout. Raking shall develop a pattern with a depth of 1/4" every 2". Before grout is deposited on the slab, it shall be thoroughly cleaned, wet down with clean water and lightly dusted with neat cement immediately prior to placement of the grout.

3.7 SCHEDULE OF CONCRETE FINISHES

A. Form Tolerances: As specified in Section 03 11 00, CONCRETE FORMWORK.

B. Provide concrete finishes as scheduled:

Area	Type of Finish	Required Form Tolerances
EXTERIOR WALL SURFACES		
Above grade/exposed (above a point 12" below finish grade)	W-2	W-B
Backfilled (below a point 12" below final grade)	W-1	W-A
INTERIOR WALL SURFACES		
Hydraulic Structures including tanks, pump stations, flow channels, junction boxes, and basins	W-5	W-A
Buildings, pipe galleries, and other dry areas	W-5	W-B
EXTERIOR SLABS		

Exposed Roof slab or Slab-on-grade for non-hydraulic structures	S-5	
Roof slab or Top of Wall for Hydraulic Structures	S-1	
Other water holding tanks and basins	S-1	
Stairs and landings	S-5	
Sidewalks	S-6	
Other exterior slabs/pads	S-1	
Top surfaces of basins in which raking mechanisms are to be installed	S-7	
INTERIOR SLABS		
Non-Hydraulic areas such as pipe galleries and slabs-on-grade	S-1	
Hydraulic channels / Water Holding Structures	S-1	
Underside of elevated slabs	S-3	
Slabs to receive fill and mortar setting beds	S-2	

3.8 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
      a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
      b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
      c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
   3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
      a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
   4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
   1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
   2. Do not apply to concrete that is less than 28 days' old.
   3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.11 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
   1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semi-rigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.12 REPAIRING CONCRETE

A. General:
1. Any areas deemed as having excessive defects or considered to have a negative effect on the structural performance of the structure shall be removed to the extents approved by the Engineer. The Engineer has the option of calling for the removal of the entire section if the damage is such that a repair will not be a suitable option. All work required to correct the defect will be the responsibility of the Contractor and will be paid for by the Contractor.
2. Inject cracks as defined in 1.3.D Defective Areas with crack repair epoxy as specified in Section 03 64 00, CONCRETE REPAIR CRACK INJECTION.
3. Repair concrete surfaces defects as defined in 1.3.D Defective Areas using one of the materials specified in Section 03 01 00, CONCRETE SURFACE REPAIR SYSTEMS. Select system, submit for review, and obtain approval from Engineer prior to use.
4. Prior to starting the repair work, obtain quantities of color-matched repair material and manufacturer's detailed instructions for use to provide a structural repair with finish to match adjacent surface.
5. Develop repair techniques with material manufacturer.
6. Dress surface of repair that will remain exposed to view to match color and texture of adjacent surfaces. Repair of concrete shall provide a structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.

B. Tie Holes:
1. Fill with nonshrink grout as specified in Section 03 60 00, GROUT.
2. Match color of adjacent concrete.
3. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

C. Alternate Form Ties-Through-Bolts:
1. Seal through-bolt hole by sandblasting or mechanically cleaning and roughening entire interior surface of hole, coating roughened surface with bonding agent and driving elastic vinyl plug and then dry packing entire hole on each side of plug with nonshrink grout, as specified in Section 03 60 00, GROUT. Use only enough water to dry pack grout. Dry pack while bonding agent is still tacky or remove bonding agent by mechanical means and reapply new bonding agent.
2. Compact grout using steel hammer and steel tool to drive grout to high density. Cure grout with water.

D. Exposed Metal Objects:
1. Metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, shall be removed by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
2. Repair areas of chipped-out concrete per requirements of Section 03 01 00 CONCRETE SURFACE REPAIR SYSTEMS.

E. Blockouts at Pipes or Other Penetrations:
1. Meet details shown or submit proposed blockouts for review.
2. Use nonshrink, nonmetallic grout, Category I or II as specified in Section 03 60 00, GROUT.

3.13 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports. Payment of the testing and inspection agency shall be by the Contractor from the contract allowance for independent testing in accordance with Section 01 29 00, PAYMENT PROCEDURES.

B. Inspections:
1. Steel reinforcement placement.
2. Headed bolts and studs.
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.
6. Verification of concrete strength before removal of shores and forms from beams and slabs.

C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C31/C31M.
   a. Cast and laboratory cure two sets of three standard cylinder specimens for each composite sample.
   b. Cast and field cure two sets of three standard cylinder specimens for each composite sample.
6. Compressive-Strength Tests: ASTM C39/C39M; test one set of three laboratory-cured specimens at 7 days and one set of three specimens at 28 days.
   a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days. The third cylinder will be retained for subsequent testing if required by the Engineer.
   b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
7. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
8. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
9. Test results shall be reported in writing to Engineer, Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete

testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Engineer.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

D. Measure floor and slab flatness and levelness according to ASTM E 1155 48 hours after finishing. Specified overall values of flatness F(f)=25; and levelness F(L)=20; with minimum local values, F(f)=17 and F(L)=15.
   1. F(L) value only applies to elevated slabs after shoring has been removed.

E. Shrinkage Tests
   1. Drying shrinkage tests shall be performed for the trial batch indicated in Paragraph CONCRETE MIXTURES FOR HYDRAULIC ELEMENTS for the first placement of each class of concrete for all structures noted in paragraph CONCRETE MIXTURES FOR HYDRAULIC ELEMENTS, and during construction to insure continued compliance with these Specifications. Number of field test to be determined by Engineer or Engineer's Field Representative.
   2. Drying shrinkage specimens shall be 4" by 4" by 11" prisms with an effective gauge length of 10"; fabricated, cured, dried, and measured in accordance with ASTM C157 modified as follows: specimens shall be removed from molds at an age of 23 ±1 hours after trial batching, shall be placed immediately in water at 70 °F ±3 °F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73 °F ± 3 °F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 days. This length at age 7 days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 °F ±3 °F and 50% ±4% relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
   3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001" at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004", the results obtained from that specimen shall be discarded. Results of the shrinkage test shall be reported in graphical form Length Change (in) vs. Age (days) and Length Change (%) vs. Age (days) to the nearest 0.001% of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as indicated below.
      a. Shrinkage Limitation: The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.036% or 0.042%, respectively. The Contractor shall only use

a mix design for construction that has first met the trial batch shrinkage requirements.

b. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25%.

c. If the required shrinkage limitation is not met during construction, the Contractor shall immediately stop concrete placement and take any or all of the following actions at no additional cost to the Owner, for securing the specified shrinkage requirements. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water content; washing of aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions designed to minimize shrinkage or the effects of shrinkage. Concrete placement shall not resume until the shrinkage limitation has been met.

F. Water Leakage Tests: In accordance with ACI 350.1.

1. Purpose: Determine integrity and water tightness of finished concrete surfaces. Contractor shall perform and pay for all costs associated with water leakage tests. Report all test results to the Engineer.
2. All water-holding Structures:
   a. Perform leakage tests after concrete structure is complete and capable of resisting the hydrostatic pressure of the water test. The concrete shall have achieved its full design strength.
   b. Perform leakage test before backfill, brick facing, or other work that will cover concrete wall surfaces is begun.
   c. Install all temporary bulkheads, cofferdams, and pipe blind flanges, and close all valves. Inspect each to see that it provides a complete seal.
   d. Fill with water to test level shown, or maximum liquid level if no test level is given. Maintain this level for 72 hours prior to the start of the test to allow water absorption, structural deflection, and temperature to stabilize.
   e. Measure evaporation and precipitation by floating a partially filled, transparent, calibrated, open top container.
   f. Measure the water surface at two points 180° apart, when possible where attachments such as ladders exist, at 24-hour intervals. Using a sharp pointed hook gauge and fixed metal measure capable of reading to 1/100 of an inch. Continue the test for a period of time sufficient to produce at least 1/2" drop in the water surface based on the assumption that leakage would occur at the maximum allowable rate specified or for 72 hours whichever is the lesser time.

G. Acceptance Criteria:

1. Volume loss shall not exceed 0.075% of contained liquid volume in a 24-hour period, correcting for evaporation, precipitation, and settlement.
2. No damp spots or seepage visible on exterior surfaces. A damp spot is defined as sufficient moisture to be transferred to a dry hand upon touching.

H. Repairs When Test Fails: Dewater the structure; fill leaking cracks with crack repair epoxy as specified in Section 03 64 00 CONCRETE REPAIR CRACK INJECTION. Patch areas of damp spots previously recorded, and repeat water leakage test in its entirety until the structure successfully passes the test.

END OF SECTION

SECTION 03 41 00 – PRECAST CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast concrete required for this Project.
   2. Reinforcing.
   3. Accessories.

B. Related Sections:
   1. Section 03 11 00 – Concrete Formwork
   2. Section 03 20 00 – Concrete Reinforcement
   3. Section 03 30 00 – Cast-In-Place Concrete

1.2 QUALITY ASSURANCE

A. Qualifications of workmen:
   1. Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly trained and experienced in placing and erecting the type of concrete described herein and who shall direct all work performed under this Section.
   2. Precast subcontractor shall be experienced in constructing the type of precast material required for the project. Submit data for approval.
   3. For finishing of exposed surfaces of the concrete, use only thoroughly trained and experienced journeyman concrete finishers.
   4. Approval required in advance in accordance with Section 01 33 00 SUBMITTAL PROCEDURES.

B. Codes and Standards:
   1. Comply with all pertinent codes and regulations and publication ACI 301 of the American Concrete Institute, latest edition.
   2. Where provisions of pertinent codes and standards conflict with this Specification, the more stringent provisions shall govern.

1.3 SUBMITTALS

A. Materials list: Before any precast concrete is delivered to the construction site, submit to the Engineer in accordance with Section 01 33 00 SUBMITTAL PROCEDURES a complete list of all materials proposed to be furnished and installed under this portion of the work, showing manufacturer's name and catalog number for all items such as bond breaker, inserts, chairs, and conduits.

1.4 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation and to protect the installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

1.5 DESIGN

A. All design of pre-stressed members shall be done in strict accordance with procedures set forth in the current edition of ACI 318 "Building Code Requirements for Reinforced Concrete."

B. All precast structural concrete members shall be designed to meet requirements of the Building Code.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete:
1. Cement shall be Portland Cement conforming to ASTM C150, Portland Cement.
2. Aggregates shall conform in quality to ASTM C33 for heavyweight aggregate.
3. Heavyweight aggregates shall be graded crushed stone with a resulting unit weight of concrete of up to 155 pounds per cubic foot.
4. Water shall be clean and free of injurious and deleterious substances.
5. Concrete strength shall be minimum 5,000 psi at 28 days.

B. Steel:
1. Pre-stressing steel shall be high tensile strength uncoated seven wire strand which is low-relaxation strand or has been stress-relieved as a unit after the wires have been formed into a strand. It shall be manufactured and tested in accordance with ASTM A416. Either 250K or 270K strand may be used.
2. All reinforcing bars shall conform to the requirements of ASTM A615, Grade 60 as required.
3. Welded wire fabric shall conform to the requirements of ASTM A185.
4. Cast in plates shall conform to the requirement of ASTM A36, or A440 as required.

2.2 OTHER MATERIALS

A. All other materials not specifically described but required for a complete and proper installation of the work of this Section, shall be as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Inspections:
1. Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that the work of this Section may be performed in strict accordance with all pertinent codes and regulations, the original design, and the manufacturer's recommendations for the items being installed.

B. Discrepancies:
1. In the event of discrepancy, immediately notify the Engineer.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 QUALITY

A. Manufacturer of precast concrete shall be adequately equipped to form, place, and cure the required precast concrete, and shall have experience to produce precast concrete of required strength and water resistance.

3.3 PLACEMENT OF REINFORCEMENT

A. Place all reinforcement in strict accordance with the drawings and with the provisions of Section 03 20 00, CONCRETE REINFORCEMENT of these Specifications.

3.4 PLACEMENT OF CONCRETE

A. General:
   1. Concrete shall be placed and compacted by tamping or vibrating to produce a dense waterproof product.
   2. Finish all concrete surfaces in smooth finish to the tolerances described in Section 03 30 00, CAST-IN-PLACE CONCRETE of these Specifications.

B. Curing:
   1. Cure all concrete of this Section in strict accordance with the methods specified in Section 03 30 00, CAST-IN-PLACE CONCRETE or approved alternative.

3.5 OPENINGS

A. Locations and sizes of all openings 3 inches wide or larger to be cast into the members, if not shown on the contract drawings, must be supplied when shop drawings are submitted for approval. All other openings not so located shall be job cut by the various trades requiring them. All holes less than 3 inches in dimension through precast members are to be made by drilling or cutting in the field, by the various trades requiring them. However, field holes or cuts may not be made in the precast members without prior approval of the manufacturer.

3.6 ERECTION

A. Responsibility:
   1. The entire method and sequence of erection shall be the responsibility of the Contractor.

B. Alignment:
   1. Set all units in true alignment in all directions.

C. All precast concrete items with cracks or other flaws that will detract from the appearance, shall be replaced.

D. Grind to remove sharp edges.

END OF SECTION

DIVISION 9

FINISHES

SECTION 09 90 00 - PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Exposed, buried, and submerged metal, exposed PVC and CPVC, exposed FRP, and aluminum and dissimilar metals, to be protective painted, whether specifically mentioned or not, except as specified otherwise. Prime coat structural steel surfaces, as specified herein. Exterior concrete surfaces will not be protective painted except as specified herein. Interior concrete surfaces will be protective painted as specified herein.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American National Standards Institute (ANSI):
      a. Standard Colors for Color Identification and Coding.
      b. A13.1, Scheme for the Identification of Piping Systems.
   2. American Water Works Association (AWWA):
      a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot-Applied.
      b. C210, Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipelines.
      c. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
   3. NSF International (NSF): 61 Drinking Water System Components-Health Effects.
   4. National Association of Corrosion Engineers (NACE): Manual for Painter Safety.
   5. Occupational Safety and Health Act (OSHA).
   6. Steel Structures Painting Council (SSPC):
      a. QP1, Standard Procedure for Evaluating Qualifications of Painting Contractors.
      b. QP2, Standard Procedure for Evaluating the Qualifications of Painting Contractors to Remove Hazardous Paint.
      c. SP 1, Surface Preparation Specification No. 1, Solvent Cleaning.
      d. SP 2, Hand Tool Cleaning.
      e. SP 3, Power Tool Cleaning.
      f. SP 5, White Metal Blast Cleaning.
      g. SP 6, Commercial Blast Cleaning.
      h. SP 7, Brush-Off Blast Cleaning.
      i. SP 8, Pickling.
      j. SP 10, Near-White Blast Cleaning.
      k. SP 11-T, Power Tool Cleaning to Bare Metal.
      l. Guide No. 3, PA, Guide to Safety in Painting Applications.
      m. SP 13, Surface Preparation of Concrete.

1.3 DEFINITIONS

A. Terms used in this section:
   1. Coverage: Total minimum dry film thickness in mils, or square feet per gallon.
   2. FRP: Fiberglass Reinforced Plastic.
   3. HCl: Hydrochloric Acid.
   4. MDFT: Minimum Dry Film Thickness.
   5. MDFTPC: Minimum Dry Film Thickness per Coat.
   6. Mil: Thousandth of an inch.
   7. Military Specification-Paint.
   8. PSDS: Paint System Data Sheet.
   9. SFPG: Square Feet per Gallon.
   10. SFPGPC: Square Feet per Gallon per Coat.

11. SP: Surface Preparation.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Data Sheets:
      a. For each paint system, furnish a Paint System Data Sheet (PSDS), the Manufacturer's Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system. The PSDS form is appended to the end of this section.
      b. Submit required information on a system-by-system basis.
      c. Furnish copies of paint system submittals to the coating applicator.
      d. Indiscriminate submittal of Manufacturer's literature only is not acceptable.
      e. Schedule of proposed coating materials.
      f. Schedule of surfaces to be coated with each coating material.

B. Samples:
   1. Reference Panel:
      a. Prior to start of surface preparation, furnish a 4" by 4" steel panel for each grade of sandblast specified herein, prepared to specified requirements.
      b. Provide panel representative of the steel used; prevent deterioration of surface quality.
      c. Upon approval of Engineer, panel to be reference source for inspection.
      d. Unless otherwise specified, before painting work is started, prepare minimum 8" by 10" samples with type of paint and application specified on similar substrate to which paint is to be applied.
      e. Furnish additional samples as required until colors, finishes, and textures are approved.
      f. Approved samples to be the quality standard for final finishes.

C. Quality Control Submittals:
   1. Applicator's Qualification: List of references substantiating experience.
   2. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
   3. If the Manufacturer of finish coating differs from that of shop primer, provide both Manufacturers' written confirmation that materials are compatible.
   4. Manufacturer's written instructions and special details for applying each type of paint.
   5. Manufacturers' Certification of Proper Installation.

D. Contract Closeout Submittals: Special guarantee.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Applicator: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:
   1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
   2. Perform surface preparation and painting in accordance with recommendations of the following:
      a. Paint Manufacturer's instructions.
      b. SSPC-PA Guide No. 3, Guide to Safety in Paint Applications.
      c. Federal, state, and local agencies having jurisdiction.

C. Mockup:
1. Before proceeding with work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint Manufacturer.

B. Shipping:
1. Where pre-coated items are to be shipped to the site, protect coating from damage. Batten coated items to prevent abrasion.
2. Use nonmetallic or padded slings and straps in handling.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not apply paint in temperatures outside of Manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather.

B. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85%, or whenever surface temperature is less than 5° F above dew point of ambient air.

1.8 SPECIAL GUARANTEE

A. Furnish Manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the OWNER, removal and replacement of work specified in this Specification section found *defective* during a period of 1 year after the date of Substantial Completion.

B. Contractor and paint Manufacturer shall jointly and severally furnish guarantee.

PART 2 - PRODUCTS

2.1 PAINT AND COATINGS MANUFACTURERS

A. Nationally recognized Manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

B. Manufacturers:
1. Tnemec Coatings
2. Sherwin Williams
3. Quadex, Inc.
4. Sauereisen
5. Devoe Coatings, an Akzo Nobel Corporate brand.
6. Carboline Coatings Company
7. Or Approved Equal.

2.2 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating Manufacturer's recommendations for specific primer and coating system to be applied.

2.3 PAINT MATERIALS

A. General:
1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single Manufacturer shall be used in the work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and other additives: As recommended by Manufacturer of coating material.

B. Products:

Product	Definition
Tar Stop	Coating designed to prevent bleeding of black asphaltic varnish through finish paint; Shellac is a suitable alternate; not applicable for white and pastel colors
Anticorrosive Polyamide Epoxy Primer	Polyamide, anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Coal-Tar Epoxy	Amine or phenolic epoxy type: 70% volume solids minimum, suitable for immersion service
Organic Zinc Rich Primer	Converted epoxy, epoxy/phenolic or urethane type, minimum 10 pounds metallic zinc content per gallon
Rust Inhibitive Primer	Single Package steel primaers with anticorrosive pigment loading
Wash Primer	Vinyl butyral acid
Epoxy Nonskid (Aggregated)	Polyamide or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and non-shrinking,,surfacer, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
High Build Epoxy	Polyamide or polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat

1. High temperature coating 150 to 350 degrees Fahrenheit: As manufactured by one of the following:
   a. Carboline: Thermaline 4900.
   b. Dampney: Thermalox 245 Silicione – Zinc Dust
   c. PPG Amercoat: Amerlock 2/400 GFK.

2.4 MIXING

A. Multiple-Component Coatings:
1. Prepare using the contents of the container for each component as packaged by paint Manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint Manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at the site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Surface Preparation Verifications:
   1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of paint Manufacturer whose product is to be applied. The more stringent requirements shall apply.
   2. Provide Engineer minimum 7 days advance notice to start of shop or field surface preparation work and coating application work.
   3. Perform such work only in presence of Engineer, unless Engineer grants prior approval to perform such work in Engineer's absence.

B. Schedule inspection with Engineer in advance for cleaned surfaces and all coats prior to succeeding coat.

3.2 PREPARATION

A. Shop Blast Cleaning:
   1. Notify Engineer at least 7 days prior to start of shop blast cleaning to allow for inspection of the work during surface preparation and shop application of paints.
   2. Structural steel, metal doors and frames, metal louvers, and similar items, as reviewed by Engineer, may be shop prepared and primed.

B. Field Abrasive Blasting: Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed.

C. Protection of Items not to be painted:
   1. Remove, mask, or otherwise protect hardware, lighting fixtures, switch plates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
   2. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
   3. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
   4. Mask openings in motors to prevent paint and other materials from entering the motors.

3.3 PREPARATION OF SURFACES

A. Metal Surfaces:
   1. Where indicated, meet requirements of the following SSPC Specifications:
      a. Solvent Cleaning: SP 1.
      b. Hand Tool Cleaning: SP 2.
      c. Power Tool Cleaning: SP 3.
      d. White Metal Blast Cleaning: SP 5.
      e. Commercial Blast Cleaning: SP 6.
      f. Brush-Off Blast Cleaning: SP 7.
      g. Pickling: SP 8.
      h. Near-White Blast Cleaning: SP 10.
      i. Power Tool Cleaning to Bare Metal: SP 11.
      j. Surface Preparation of Concrete: SP 13.
   2. The words "solvent cleaning", "hand tool cleaning", "wire brushing" and "blast cleaning", or similar words of equal intent in these Specifications, or in paint manufacturer's specifications, refer to the applicable SSPC Specifications.
   3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating Manufacturers' recommendations for wet blast

additives and first coat application shall apply. If not otherwise required, contractor shall provide abrasive blast cleaning by means of sand blasting or high pressure water.

4. DeLavaud Process Ductile Iron Pipe:
   a. Use SSPC SP grades as guide only.
   b. For high performance (epoxy) coatings, follow recommendations of pipe and coating Manufacturers.
   c. The surface preparation and application of the primer and finish coats shall be performed by the pipe Manufacturer
   d. For conventional (alkyd) coatings, clean asphalt varnish supplied on pipe and apply one full coat of a tar stop before two full coats of the color coats specified.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
   a. Prepare such that there is:
      1) No undercutting or reverse ridges on weld bead.
      2) No weld spatter on or adjacent to weld or any other area to be painted.
      3) No sharp peaks or ridges along weld bead.
   b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
8. Pre-blast Cleaning Requirements:
   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
   b. Cleaning Methods: Steam, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
   c. Clean small isolated areas as above or solvent clean with suitable solvents and clean cloths.
9. Blast Cleaning Requirements:
   a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating Manufacturer's recommendations.
   b. Select type and size of abrasive to produce a surface profile that meets coating Manufacturer's recommendations for particular primer to be used.
   c. Use only dry blast cleaning methods, unless otherwise directed in writing by Engineer.
   d. Do not reuse abrasive material, except for designed recyclable systems. Must meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
   a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
   b. Paint surfaces the same day they are blasted. Re-blast surfaces that have started to rust before they are painted.

B. Galvanized Surfaces:
   1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
   2. Remove oil and grease by wiping or scrubbing the surface with a suitable solvent, rags and brushes. Use clean solvent and clean rags for the final wiping to avoid contaminating the surface.
   3. Obtain coating Manufacturer's recommendations for additional preparation that may be required.

C. Concrete Surfaces:
   1. Do not begin until 30 days after concrete has been placed.

2. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
3. Clean to remove loose concrete and provide a surface for binding according to SP-13 Surface Preparation of Concrete. Surface may not be cleaned by acid etching or open flame methods unless approved in writing by Engineer. Contractor must provide evidence that method will produce desired profile without causing damage to concrete member.
   a. Mechanical Surface Preparation Methods: (according to section 4 of SP-13)
      1) Dry abrasive blasting (sand blasting)
      2) Wet abrasive blasting
      3) Vacuum-assisted abrasive blasting
   b. Vacuum cleaning, air blast cleaning, and/or water cleaning as described by ASTM D4258 shall be used after the completion of one or more of the mechanical surface preparation methods listed above.
   c. Final surface preparation shall be as required by coatings manufacturer to insure proper adhesion of the coatings, as needed.
4. Contractor is responsible for coordinating and insuring that manufacturer's protective coatings are compatible with mortar repair or cement lining prior to submitting coatings.
5. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

D. Plastic Surfaces:
1. Hand sand plastic surfaces to be coated with a medium grit sandpaper to provide tooth for the coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

3.4 SURFACE CLEANING METHODS

A. Brush-off Blast Cleaning:
1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC-SP 7, Brush-off Blast Cleaning.
2. Abrasive: Either wet or dry blasting sand, grit, or nut shell.
3. Select various surface preparation parameters such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will approve acceptable trial blast cleaned area and will use area as a representative sample of surface preparation.
6. Repair or replace surfaces damaged by blast cleaning.

B. Acid Etching:
1. After pre-cleaning, spread the following solution by brush or plastic sprinkling can: 1 part commercial Muriatic acid reduced by 2 parts water by volume. Adding acid to water in these proportions gives an approximate 10% solution of HCl.
2. Application:
   a. Application Rate: Approximately 2 gallons per 100 square feet.
   b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
   c. Acid will react vigorously for a few minutes, during which time brushing is continued.
   d. After bubbling subsides (10 minutes), hose down the remaining slurry with high pressure clean water.
   e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
   f. Thoroughly rinse to remove any residual acid surface condition which can impair adhesion.
3. Ensure surface is completely dry before application of coating.

4. Apply acid etching, to obtain a "grit sandpaper" surface profile. If not, repeat treatment.

C. Solvent Cleaning:
1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods which involve a solvent or cleaning action.
2. Meets requirements of SSPC-SP 1.

3.5 APPLICATION

A. General:
1. Extent of Coating (Immersion): Coatings shall be applied to all internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
2. For coatings subject to immersion, obtain full cure for completed system. Consult coatings Manufacturer's written instructions for these requirements. Do not immerse coating for any purpose until completion of curing cycle.
3. Apply coatings in accordance with these Specifications and the paint Manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
4. Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
5. Sand wood and metal lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.

B. Galvanized Metal:
1. Concealed galvanized surfaces (behind building panels or walls) do not required painting unless specifically indicated herein.
2. Prepare surface and apply wash primer or coating Manufacturer's recommended coating. This primer will replace the required paint system's indicated primer.
3. Apply coating system appropriate for the exposure (intermediate/finish coats).

C. Shop Primed and Factory Finished Surfaces:
1. Schedule inspection with Engineer before shop priming or top-coating factory finished items delivered to site.
2. Prepare surfaces and spot prime using specified primer.
3. Apply mist coat of primer, 1-mil dry film thickness.
4. After welding, prepare and prime holdback areas as required for paint system. Apply primer in accordance with Manufacturer's instructions.

D. Manufacturer Applied Paint Systems:
1. Repair abraded areas on factory finished items as recommended by Manufacturer.
2. Carefully blend repaired areas into original finish.
3. Fusion Bonded Coatings: Provide appropriate liquid repair kits for field use.

E. Film Thickness:
1. Number of Coats: Minimum required without regard to coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in Manufacturers' products, and atmospheric conditions.
2. Maximum film build per coat shall not exceed coating Manufacturer's recommendations.

3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with the Specifications.
   c. All coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Thickness Testing:
   a. After repaired and recoated areas have dried sufficiently, final tests will be conducted by the Engineer.
   b. Measure coating thickness specified in mils with a magnetic type dry film thickness gauge.
   c. Test finish coat, except zinc primer, galvanizing, and elastomeric coatings in excess of 25 mils dry, for holidays and discontinuities with an electrical holiday detector.
   d. Holiday detect coatings in excess of 25 mils dry with high voltage units recommended by the coating manufacturer.
   e. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.

F. Porous Surfaces, Such As Concrete, Masonry:
1. Filler/Surfacer: Use coating Manufacturer's recommended product to fill air holes, bug holes, and other surface defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Finish Coat: Use coatings Manufacturer's recommended product.

G. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repair in accordance with recommendations of paint Manufacturer.
2. Apply finish coats, including touchup and damage-repair coats in a manner which will present a uniform texture and color-matched appearance.

H. Unsatisfactory Application:
1. If item has an improper finish color, or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface 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. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
4. Repair defects in accordance with written recommendations of coating Manufacturer.
5. Leave staging and lighting up until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

3.6 FIELD QUALITY CONTROL

A. Testing Gauges:
1. Provide a magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
2. Provide an electrical holiday detector, low voltage, wet sponge type to test finish coat, except zinc primer, high-build elastomeric coatings, and galvanizing, for holidays and discontinuities as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.

3. Provide a high voltage holiday detector for elastomeric coatings in excess of 25 mils dry film thickness. Unit to be as recommended by the coating Manufacturer.

3.7 MANUFACTURER'S SERVICES

A. Provide Manufacturer's representative at site in accordance with Section 01 79 00, DEMONSTRATION AND TRAINING, for installation assistance, inspection, and certification of installation.

3.8 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from the site or destroy in a legal manner.

C. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.9 PROTECTIVE COATINGS SYSTEMS

A. All finish coating colors to be submitted for Owner/Engineer selection and/or approval, as applicable.

B. System No. 1 Submerged Metal- General

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 5)	Polyamide, Anticorrosive Epoxy Primer	1 coat, 6 MDFT
	Polyamide High Build Epoxy	1 coat, 6 MDFT

C. System No.2 Submerged Metal- Domestic Sewage:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 5)	Prime in accordance with manufacturer's recommendations	5 MDFT minimum
	Coal Tar Epoxy	2 coats minimum, 20 MDFT

D. System No. 3 Exposed Metal-Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Polyamide, Anticorrosive Epoxy Primer	1 coat, 5 MDFT
	Polyamide High Build Epoxy	2 coats minimum, 15 MDFT

	Polyurethane Enamel	1 coat, 3 MDFT

E. System No. 4 Exposed Metal- General:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Polyamide, Anticorrosive Epoxy Primer	1 coat, 5 MDFT
	Polyamide High Build Epoxy	1 coat, 5 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

F. System No. 4A Exposed Metal-High Temperature (150 to 350 degrees Fahrenheit):

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	High Temperature Coating	Per coating manufacturer's instructions

G. System No. 5 Buried Metal-General:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast or Centrifugal Wheel. Blast (SP 10)	Standard Hot Coal-Tar Enamel -OR- Coal-Tar Epoxy -OR- Tape Coat System	AWWA C203 AWWA C210 AWWA C214
	For Acidic Soil, Brackish Water High Bacteria: Hot Coal-Tar, Double Felt	AWWA C203, App. A, Sec. Al.5
	For Highly Abrasive Soil, Brackish Water: Hot Coal-Tar, Fibrous Glass -OR- Tape Coat System	AWWA C203, App. A, Sec. A1.5 AWWA C214 with Double Outer Wrap

H. System No. 10 Galvanized Metal Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Wash Primer or	1 coat, 2 MDFT

Followed by Hand Tool (SP 2) or Power Tool (SP 3)	Coating Manufacturer's Recommendation	
		Remaining coats as required for exposure

I. System No. 11 Galvanized Metal Repair:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2), Power Tool (SP 3), or Brush-off Blast (SP 7)	Organic Zinc Rich Primer	1 coat, 3 MDFT Remaining coats as required for exposure

J. System No. 12 Skid-Resistant-Aluminum and FRP:

Surface Prep.	Paint Material	Min. Coats, Cover
Brush-off Blast (SP 7) or Plastic Surface Preparation	Epoxy Primer	1 coat, 2 MDFT minimum
	Epoxy Nonskid (Aggregated)	2 coats minimum, 18 MDFT

K. System No. 14 Exposed PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
Scarify	Polyamide High Build Epoxy	1 coat, 3 MDFT
	Poly Urethane Enamel	1 coat, 3 MDFT

L. System No. 15 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats. Cover
Solvent Clean (SP 1)	Wash Primer	1 coat, 1 MDFT
	Polyamide High Build Epoxy	1 coat, 10 MDFT

M. System No. 16 Existing Concrete/CMU - Repair:

Surface Prep.	Paint Material	Min. Coats. Cover
SP 13	Mortar Repair or Cement Lining or Epoxy Filler	As required to form a smooth surface profile or as shown on drawings
	Polyamide High Build Epoxy	2 coats minimum, 125 MDFT

N. System No. 17 New Concrete/CMU- Exterior (as required by application schedule):

Surface Prep.	Paint Material	Min. Coats. Cover
SP 13	Surface Repair Mortar or Epoxy Filler	As required to form a smooth surface profile or as shown on drawings
	Polyamide High Build Epoxy	1 coat, 10 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

O. System 18 Concrete/CMU- Interior or Immersion Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats. Cover
SP 13	Surface Repair Mortar or Epoxy Filler	As required to form a smooth surface profile or as shown on drawings
	Cycloaliphatic Amine High Build Epoxy	2 coats minimum, 20 MDFT

P. System 19 Concrete/CMU- Immersion Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats. Cover
SP 13	Surface Repair Mortar or Epoxy Filler	As required to form a smooth surface profile or as shown on drawings
	Modified Polyamine High Build Epoxy	3 coats minimum, 125 MDFT

Q. System No. 20 Concrete/CMU- Below Grade (as required by application schedule):

Surface Prep.	Paint Material	Min. Coats. Cover
SP 13	Surface Repair Mortar or Epoxy Filler	As required to form a smooth surface profile or as shown on drawings
	Polyamide High Build Coal Tar Epoxy	15 MDFT minimum

3.10 CHEMICAL RESISTANT COATING

A. Chemical Resistant Coating:

Surface Prep.	Paint Material	Min. Coats. Cover
In accordance with Article CONCRETE, Concrete Surface Preparation, this Section.	Primer and one trowel-applied coat of novolac epoxy resin with silica fillers.	Finished system thickness 250 mils minimum.

3.11 APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions, request clarification from Engineer before starting work in question.

B. System No. 1 Submerged Metal- General
1. Metal surfaces new and existing below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface that are part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel.
2. Pumps, motors, equipment items, and accessories identified in the technical specifications to be coated with this system.
   a. Interior surface of suction inlet and volute of submersible influent pumps. Apply coating prior to pump testing.
3. Exterior of submerged piping and valves other than stainless steel or PVC piping.
4. Submerged pipe supports and hangers.
5. Submerged stem guides.

C. System No. 2 Submerged Metal- Domestic Sewage: Use on the following items or areas:
1. Metal surfaces new and existing below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface that are a part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel.
2. Pumps, motors, equipment items, and accessories identified in the technical specifications to be coated with this system.
3. All submerged metal surfaces are to be coated, including those sections that will be concealed after installation of equipment.

D. System No. 3 Exposed Metal- Highly Corrosive: Use on the following items or areas:
1. All exposed structural steel, metal building structure, bolted connections, and other exposed metal structures that are part of the following areas:
   a. Headworks
   b. Primary Clarifiers
   c. Centrifuge area.
   d. Sludge Blend Tank & Building
2. Pumps, motors, equipment items, and accessories identified in the technical specifications to be coated with this system.
3. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
4. Valve and gate operator and stands.
5. Mechanical equipment supports, drive units, and accessories.

E. System No. 4 Exposed Metal- Mildly Corrosive: Use on the following items or areas:
1. Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as vaults, chemical rooms, and other similar areas.

2. Interior exposed structural steel, metal building structure, bolted connection and other exposed metal structures of electrical rooms.
3. Pumps, motors, equipment items, and accessories identified in the technical specifications to be coated with this system.
4. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
5. Valve and gate operator and stands.
6. Mechanical equipment supports, drive units, and accessories.
7. Insulated piping, Polyurethane topcoat not required.

F. System No. 4A Exposed Metal-High Temperature (150 to 350 degrees Fahrenheit): Use on the following areas or items:
1. Metal surfaces subject to temperatures ranging from 150 to 350 degrees Fahrenheit.
2. Blowers, blower piping, and blower accessories, pumps, motors, equipment items, and accessories identified in the technical specifications to be coated with this system.

G. System No. 5 Buried Metal- General: Use on the following items or areas:
1. Buried, below-grade portions of steel items, except buried stainless steel or ductile iron pipe.

H. System No. 10 Galvanized Metal Conditioning: Use on the following items or areas:
1. Galvanized surfaces requiring painting.
2. After application of System 10, apply finish coats as required for exposure.

I. System No. 11 Galvanized Metal Repair: Use on the following items or areas:
1. New or existing galvanized surfaces that are abraded, chipped, or otherwise damaged.

J. System No. 12 Skid-Resistant-Aluminum and FRP: Use on the following items or areas:
1. Checker plate at exterior and interior wet locations.
2. Aluminum plank at all exterior and interior accessible walking surfaces including, but not limited to:
   a. West Side Lift Station (walking surfaces only)
   b. Headworks and Grit Removal Area (all)
   c. Influent Splitter Box
   d. Primary Clarifier Splitter Box
   e. Centrate Pump Station
   f. WAS Storage Tank

K. System No. 14 Exposed PVC: Use on the following items or areas:
1. All exterior exposed-to-view PVC and CPVC surfaces, and FRP surfaces.

L. System No. 15 Aluminum and Dissimilar Metal Insulation: Use on the following items or areas:
1. Aluminum surfaces embedded or in contact with concrete, masonry, and other metals.
2. Stainless steel surfaces embedded in concrete.
3. Dissimilar metals for electrical insulation.
4. All other miscellaneous aluminum framing members and pipe supports.

M. System No. 16 Existing Concrete/CMU- Repair:
1. All surfaces as indicated on the drawings.
2. Interior surfaces of all liquid containing structures where concrete or CMU are indicated to be repaired or rehabbed, unless noted otherwise.
3. Exterior exposed surfaces noted to be repaired as required for architectural painting.
4. As required to repair/patch areas damaged or altered during construction.

N. System No. 17 New Concrete/CMU- Exterior (as indicated below only):

1. All surfaces as indicated on the drawings.
2. All exposed exterior surfaces shall receive coatings for moisture protection and architectural painting as indicated below:

O. System No. 18 Concrete/CMU- Interior or Immersion Mildly Corrosive:
1. All surfaces as indicated on the drawings.
2. Interior surfaces of rooms containing process piping and/or equipment only as indicated herein or on the drawings.
3. Secondary Clarifiers and Splitter Box
4. RAS/WAS Pump Station (wet well, dry pit, and CMU walls)
5. Sludge Blend Bldg (CMU Walls)
6. Outfall Box

P. System No. 19 Concrete/CMU- Immersion Highly Corrosive:
1. All surfaces as indicated on the drawings.
2. All areas indicated to be covered for odor control, as shown on the Facility 75 drawings.
3. Influent Splitter Box
4. Sludge Blend Tank
5. Interior Walls of Field Constructed Biofilter.

Q. System No. 20 Concrete/CMU- Below Grade (as indicated below only):
1. All surfaces as indicated on the drawings.
2. All unexposed below grade surfaces shall receive coatings for moisture protection as indicated below:
   a. Secondary Clarifiers and Splitter Box
   b. RAS/WAS Pump Station
   c. Aeration Basins and Splitter Box
   d. Outfall Box

R. Surfaces Not Requiring Protective Painting: Unless otherwise stated or shown, the following areas or items will not require protective painting or coating:
1. Reinforcing steel.
2. Nonferrous and corrosion-resistant ferrous alloys such as copper, bronze, Monel, aluminum, chromium plate, atmospherically exposed weathering steel, and stainless steel, except where:
   a. Required for electrical insulation between dissimilar metals.
   b. Aluminum and stainless steel are embedded in concrete or masonry, or aluminum is in contact with concrete or masonry.
   c. Color coding of equipment and piping is required.
3. Nonmetallic materials such as glass, PVC, wood, porcelain, and plastic (FRP) except as required for exposed-to-view PVC and CPVC, as required for FRP without integral UV resistant gel coat, and as required for architectural painting or color coding.
4. Pre-finished electrical items such as motor control centers, switchboards, switchgear, panelboards, transformers, disconnect switches (if pre-finished in OSHA yellow); except color coding of equipment is required.
5. Non-submerged electrical conduits attached to unpainted concrete surfaces.
6. Cathodic protection anodes.

3.12 COLORS

A. General: Provide manufacturer's full range of color charts to Owner/Owner's Representative for selection and/or approval. Provide colors as indicated in, Door and Hardware Schedule, Interior Finish Schedule, Exterior Finish Schedule, as shown on the drawings, as selected by Owner, and as designated herein.

B. Pipe Identification Painting:

1. Color code non submerged metal piping except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Piping Color Coding: In accordance with Piping Schedule.
3. On exposed stainless steel piping, apply color 24" in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9' on center.
4. Pipe Supports: Mild steel, painted No. 70 light gray as specified in ANSI 359-A, as manufactured by Tnemec Co., No. BJ45.

C. Proprietary identification of colors is for identification only. Selected Manufacturer may supply matches.

D. Equipment Colors:
1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
2. Paint equipment and piping one color as selected.
3. Paint non submerged portions of equipment the same color as the piping it serves, except as itemized below:
   a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
   b. Fire Protection Equipment and Apparatus: OSHA Red.
   c. Radiation Hazards: OSHA Purple.
   d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.
4. Fiberglass reinforced plastic (FRP) equipment with an integral colored gel coat does not require painting, provided the color is as selected.

END OF SECTION

PAINT SYSTEM DATA SHEET

Complete and attach Manufacturer's Technical Data Sheet to this PSDS for each coating system.

Paint System Number (from Spec):		
Paint System Title (from Spec):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

SECTION 09 90 30 – ARCHITECTURAL PAINTING AND PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes surface preparation, painting, and finishing of exposed interior and exterior items and surfaces.
   1. Surface preparation, priming, and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.

B. Paint exposed surfaces whether or not colors are designated in "schedules", except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.

C. Painting includes field painting exposed pipes and ducts, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment, including switch gear and distribution cabinets and panel covers where exposed in finished spaces as directed by Architect.

D. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
   1. Prefinished items not to be painted, include the following factory-finished components:
      a. Toilet enclosures.
      b. Acoustic materials.
      c. Light fixtures.
   2. Concealed surfaces not to be painted include wall or ceiling surfaces in the following generally inaccessible areas:
      a. Attic spaces and spaces above ceilings.
      b. Furred areas.
      c. Utility tunnels.
      d. Pipe spaces.
      e. Duct shafts.
   3. Finished metal surfaces not to be painted include:
      a. Anodized aluminum.
      b. Stainless steel.
      c. Chromium plate.
      d. Bronze.
      e. Brass.
      f. Copper.
   4. Operating parts not to be painted include moving parts of operating equipment such as the following:
      a. Valve and damper operations.
      b. Linkages.
      c. Sensing devices.
      d. Motor and fan shafts.
   5. Labels: Do not paint over Underwriter's Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.2 DEFINITIONS

A. "Paint" includes coating systems materials, primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

1.3 SUBMITTALS:

A. Product Data: Submit five (5) copies of manufacturer's technical information for each material proposed for use.
   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 coating material proposed for use.
   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. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOC's),

B. Samples for Initial Color Selection Purposes: Submit manufacturer's standard color charts.
   1. After color selection, the Architect will furnish color names and/or numbers for surfaces to be coated.

C. Submit samples on the following substrates for the Architect's review of color and texture only:
   1. Stained Wood: Provide 4- by 8-inch samples of stained wood finish on actual wood surfaces, including running trim, veneered plywood and doors as selected by the Architect.

D. Product Data Sheets and MSDS for each product to be used as required by the U.S.G.B.C. as proof that each product meets the requirements of either Green Seal's GS-11 or GC-03 documents. This is a requirement in order to receive the possible one point for Credit 4.2 for Low-Emitting Materials in the Indoor Environmental Quality section of the Leadership in Energy and Environmental Design initiative of the U.S. Green Building Council.

1.4 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
   1. Notify the Architect of problems anticipated using the materials specified, and over substrates primed by others.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the job site in the manufacturer's original packages and containers bearing manufacturer's name and label. Identify color name and/or number.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45°F (7°C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

C. 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.

1.6 JOB CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50°F and 90°F.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45°F and 95°F.

C. Do not apply paint in snow, rain, fog, or mist, when the relative humidity exceeds 85 percent, at temperatures less than 5°F above the dew point, or to damp or wet surfaces.

1.7 APPROVALS

A. Products of other manufacturers proposed as equivalent quality must be submitted for written approval of the architect five (5) days prior to the bid date.

B. Supporting technical data, samples, published specifications and the like must be submitted for comparison.

C. Contractor will warrant that proposed substitutions, if accepted, will provide performance equivalent to the materials specified herein.

D. If approved, substitution products will be set forth by Addenda; otherwise, products specified shall be provided.

1.8 SPECIAL GUARANTEE

A. Furnish Manufacturer's extended guarantee or warranty, with OWNER named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the OWNER, removal and replacement of work specified in this Specification section found *defective* during a period of 1 year after the date of Substantial Completion.

B. Contractor and paint Manufacturer shall jointly and severally furnish guarantee.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products of one of the following:
1. PPG Industries, Pittsburgh Paints (Pittsburgh).
2. Pratt and Lambert (P & L).
3. The Sherwin-Williams Company (S-W).
4. Benjamin Moore

2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide primers, finish coat materials, and related materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.

B. Material Quality: Provide the manufacturer's best-quality trade sale 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 certificated of performance for proposed substitutions.

C. Colors: Provide color selections made by the Architect from the manufacturer's full range of standard colors. Up to eight different colors may be selected by the Owner.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Surfaces receiving paint must be thoroughly dry before paint is applied.
   1. Do not begin to apply paint until unsatisfactory conditions have been corrected.
   2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. See Quality Assurance, Paragraph 1.4 above.

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, or provide surface-applied protection prior to surface preparation and painting. Remove these items, if necessary, to completely paint the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by 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 prior to cleaning. 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 the manufacturer's instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and reprime. Notify Architect in writing about anticipated problems using the specified finish-coat material with substrates primed by others.
   2. 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 paste. Sand smooth when dried.
      b. Prime, stain, or seal wood to be painted immediately upon delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases and paneling.
      c. When transparent finish is required, backprime with spar varnish.
      d. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately upon delivery.
   3. Ferrous Metals: Clean ungalvanized ferrous metal surfaces that have not been shop-coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning cleaning methods that comply with recommendation of the Steel Structures Painting Council (SSPC).

a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

4. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

D. Materials Preparation: Carefully mix and prepare paint materials according to manufacturer's directions.
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. Remove film and, if necessary, strain material before using.
3. Use only thinners approved by the paint manufacturer and only within recommended limits.
4. Carefully mix and prepare paint materials according to manufacturer's directions.

3.3 APPLICATION

A. General: Apply paint according to manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
1. Provide finish coats that are compatible with primers used.
2. The number of coats and the film thickness required are the same regardless of the application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. Sand between applications where sanding is required to produce a smooth even surface according to the manufacturer's directions.
3. Apply additional coats if undercoats, stains, or other conditions show through final coat of paint until paint film is of uniform finish, color, and appearance. Give special attention to ensure that surfaces, including edges, corners, crevices, welds, and exposed fasteners, receive a dry film thickness equivalent to that of flat surfaces.
4. The term exposed surfaces includes areas visible when permanent or built-in fixtures, 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, where visible through registers or grilles with a flat, nonspecular black paint.
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 same as exterior faces.
9. Sand lightly between each succeeding enamel or varnish coat.
10. Omit primer on metal surfaces that have been shop-primed and touch-up painted.

C. 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. Allow sufficient time between successive coats to permit proper drying. Do not recoat 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.

D. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to the manufacturer's directions.
   1. Brushes: Use brushes best suited for the material applied.
   2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wood 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.

E. Minimum Coating Thickness: Apply materials no thinner than the manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.

F. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed to view in occupied spaces.

G. Mechanical items exposed to view in occupied spaces to be painted include, but are not limited to, the following:
   1. Piping, pipe hangers, and supports.
   2. Ductwork.
   3. Supports.

H. Electrical items to be painted include, but are not limited to, the following:
   1. Exposed conduit and fittings in the finished areas of the buildings only.
   2. Switch gear and panel covers in finished areas of the building only.

I. 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.

J. Stipple Enamel Finish (Hollow Metal doors, other flat metal surfaces and other surfaces as directed by Architect): 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. Pigmented (Opaque) Finishes: Completely cover to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, and other surface imperfections will not be acceptable.

L. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats.

M. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with specified requirements.

3.4 CLEANING

A. Cleanup: At the end of each work day, remove empty cans, rags, rubbish and other discarded paint materials from the work area in conformance with the Construction Waste Management Plan.

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.

3.5 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 acceptable to 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.

C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINT SCHEDULE

A. Ferrous Metal: Provide the following finish systems over ferrous metal. Primer is not required on shop-primed items.
1. Low-Luster Acrylic Finish:
a. Primer: Pittsburgh® Paints; 90-712 Series Pitt-Tech® Int/Ext Industrial DTM Primer/Finish Enamel (123 g/L VOC Compliant as anti-corrosive product); 2.0 to 3.0 Dry Mils.
b. Intermediate: Pittsburgh® Paints; 90-474 Series Pitt-Tech® Int/Ext Satin DTM Industrial Enamels (227 g/L VOC Compliant as anti-corrosive product); 2.0 to 3.0 Dry Mils.
c. Finish Coat: Pittsburgh® Paints; 90-474 Series Pitt-Tech® Int/Ext Satin DTM Industrial Enamels (227 g/L VOC Compliant as anti-corrosive product); 2.0 to 3.0 Dry Mils.

B. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated metal surfaces:
1. Low-Luster Acrylic Finish:
a. Primer: Pittsburgh® Paints; 90-712 Series Pitt-Tech® Int/Ext Industrial DTM Primer/Finish Enamel (123 g/L VOC Compliant as anti-corrosive product); 2.0 to 3.0 Dry Mils.
b. Intermediate: Pittsburgh® Paints; 90-474 Series Pitt-Tech® Int/Ext Satin DTM Industrial Enamels (227 g/L VOC Compliant as anti-corrosive product); 2.0 to 3.0 Dry Mils.
c. Finish Coat: Pittsburgh® Paints; 90-474 Series Pitt-Tech® Int/Ext Satin DTM Industrial Enamels (227 g/L VOC Compliant as anti-corrosive product); 2.0 to 3.0 Dry Mils.

3.7 INTERIOR PAINT SCHEDULE

A. General: Provide the following paint systems for the various substrates indicated. (Pittsburgh Paints and other manufacturer's trade names and/or numbers are listed as standard of quality).
1. Gypsum Board (Latex as directed):
1st Coat: Speedhide Interior Latex Sealer Quick Drying, 6-2.
2nd Coat: Speedhide Interior Wall Eggshell Latex, 6-411.
3rd Coat: Same as Second Coat.
2. Gypsum Board (Enamel as directed):
1st Coat: Speedcraft Interior Latex Sealer 5-2.
2nd Coat: Speedhide Interior Enamel Semi-Gloss Latex, 6-500.
3rd Coat: Same as Second Coat

3. Hollow Metal Doors and Door Frames:
   1st Coat: Pitt-Tech Interior/Exterior Primer/Finish DTM Enamel 90-712.
   2nd Coat: Speedhide Interior Enamel Wall and Trim Semi-Gloss Oil, 6-1110.
   3rd Coat: Same as Second Coat.
4. Concrete Floor:
   Primer/Sealer: Degussa Kure-N-Seal.
5. Plywood Backboards (In Telephone/Data Room 41):
   1st Coat: Speedhide Interior Fire Retardant Flat Latex, 42-7.
   2nd Coat: Speedhide Interior Fire Retardant Flat Latex, 42-7.
   3rd Coat: None.
   Must achieve a 3 to 5 mil DFT with two coats.
6. Casework, wood and/or hardboard
   1st Coat: Speedhide Latex Enamel Undercoater, 6-855.
   2nd Coat: Speedhide Interior Semi-Gloss Latex, 6-500.
   3rd Coat: Same as Second Coat.

END OF SECTION

SECTION 09 91 23 – INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. All labor, materials, and equipment necessary for painting and finishing exposed interior items and surfaces.

B. Related Sections:
   1. Section 01 33 00 – Submittal Procedures.

1.2 GENERAL

A. Surface preparation, priming, and finish coats specified in this section are in addition to shop priming and surface treatment specified under other sections.

B. All painting at the site of the work is hereby defined as field painting and shall be under the observation of the Engineer to the extent that he shall determine where and when painting meets specification. All surfaces to be painted shall have their readiness for painting approved by the Engineer before work is started.

C. Certain items which will be subjected to immersion in water or sewage in the finished work as described and as set out hereinafter shall not receive a shop coat of primer or paint but shall receive in the field the specified surface preparation, primer, and finish paint coats as specified herein. Items so specified for painting entirely in the field, but delivered to the job site already primed, shall be sandblasted to remove any coatings applied in the shop and then receive the coatings specified.

D. Items specified for shop priming shall receive one (1) shop coat of the primer specified. In all cases, shop primer shall be compatible with the field coat specified and be from the same manufacturer. If not, it shall be field blasted and re-primed. Contractor shall provide written confirmation that the shop primer is from the same manufacturer as the subsequent coatings. The Contractor shall have sole responsibility of ensuring that all coatings are coordinated and that coatings and surfaces do not conflict with one another

E. Paint exposed surfaces whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Owner will select from standard colors or finishes available.

F. Painting includes surface preparation and field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, primed metal surfaces of mechanical and electrical equipment and other interior items as determined by the Engineer.

G. All metal surfaces to be painted shall be sound, clean and free of harmful scale, rust, dirt, oil, grease, moisture, or any other foreign matter that might, in any way, lessen the life or usefulness of the coating.

H. All metal shall be smooth and free from blisters, rough corners, pits, dents, or other imperfections before painting. Pits and dents shall be filled and the metal ground smooth where required.

I. Shop coated surfaces shall be thoroughly cleaned before the application of subsequent paint coats in the field.

J. Paints and similar materials shall be mixed in vessels of adequate capacity. All paints shall be thoroughly stirred before being taken from the containers, shall be kept stirred while using, and all ready-mixed paints shall be applied exactly as received from the manufacturer without addition of any kind of a drier or thinner except as permitted or directed by the Engineer.

K. In all cases, paints and coatings shall be applied according to manufacturer's recommendations.

L. Surfaces of exposed members inaccessible after erection shall be cleaned and painted before erection.

M. No painting shall be done when the temperature is below 50°F or until moisture on the surfaces to be painted has completely disappeared.

N. Painting found defective shall be removed and the surface repainted as directed by the Engineer.

O. Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
   1. Prefinished items not to be painted include the following factory-finished components:
      a. Pre-finished building components.
      b. Finished mechanical and electrical equipment.
      c. Light fixtures.
      d. Switchgear.
      e. Distribution cabinets.
   2. Concealed surfaces not to be painted include wall or ceiling surfaces in the following generally inaccessible areas:
      a. Foundation spaces.
      b. Furred areas.
      c. Utility tunnels.
      d. Pipe spaces.
      e. Duct shafts.
   3. Finished metal surfaces not to be painted include:
      a. Anodized aluminum.
      b. Stainless steel.
      c. Chromium plate.
      d. Copper.
      e. Bronze.
      f. Brass.
      g. Cast iron grates and pipes.
   4. Operating parts not to be painted include moving parts of operating equipment such as the following:
      a. Valve and damper operators.
      b. Linkages.
      c. Sensing devices.
      d. Motor and fan shafts.
   5. Labels: Do not paint over Underwriter's Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
   6. Aluminum and galvanized members shall not be painted except where specifically noted on drawings and specifications.

P. This section shall apply to all interior or submerged equipment and components contained in these specifications or otherwise shown on the drawings that may be subject to coatings as directed by the Engineer:

1.3 DEFINITIONS

A. "Paint" includes coating systems materials, primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate, or finish coats.

1.4 SUBMITTALS

A. All submittals shall be in accordance with Section 01 33 00, SUBMITTAL PROCEDURES.

B. Submit copies of manufacturer's specifications, including paint label analysis and application instructions for each material specified. Submit Color Charts (minimum of 3 originals) for each material type specified for color selection by Engineer. Do not work until colors are selected and final approval is given.

C. After colors have been selected and submittals have been approved submit to Engineer written verification that a copy of each manufacturer's instructions has been distributed to the paint applicator responsible for this portion of the work prior to applicator beginning work.

1.5 JOB SAMPLE AND FINAL COLOR SELECTION

A. Job samples if required by the Engineer shall be prepared for final color approval prior to beginning this portion of the work.

B. If color(s) are unacceptable, Contractor shall prepare additional sample(s) based upon new selection(s).

1.6 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

C. Notify the Engineer of problems anticipated using the materials specified.

D. Material Quality: Provide the manufacturer's best quality trade sale paint material of the various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

E. Proprietary names used to designate colors or materials are not intended to imply that products named are required or to exclude equal products of other manufacturers.

F. Comply with governing codes and regulations. Provide products of acceptable manufacturers which have been in satisfactory use in similar service for three years. Use experienced installers. Comply with VOC and environmental regulations.

1.7 JOB CONDITIONS

A. Apply water-based and solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 deg F (10 deg C) and 100 deg F (32 deg C).

B. Do not apply paint in when the relative humidity exceeds 85 percent, at temperatures less than 5 deg F (3 deg C) above the dew point, or to damp or wet surfaces.

C. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by the manufacturer during application and drying periods.

D. Apply epoxy Coatings in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers:
1. Tnemec Company, Inc.
2. Devoe & Raynolds
3. Glidden Co.
4. Benjamin Moore
5. Pratt and Lambert
6. Sherwin Williams
7. Or approved equal.

B. First-line commercial-quality products shall be required for all coating systems.

2.2 PAINTS

A. The paints and paint products listed below are as manufactured by Tnemec Company, Inc., and are intended to establish standards of quality, or equal products shall be reviewed by the Engineer. Paint products for this project shall be equal in all respects to the products listed. *No request for substitution will be considered which decreases the film thickness designated and/or the number of coats to be applied, or which offers a change from the generic type of coating specified.* Any request for substitution shall contain the full name of each product, descriptive literature, directions for use, generic type, nonvolatile content by volume, and a list of at least ten (10) applications where each of the coatings has been used on new construction and has rendered satisfactory service for at least three (3) years. Submitted paint system shall be used throughout entire project.
1. 66-Color Hi-Build Epoxoline
2. 90-97 Tneme Zinc
3. 69-Color Hi-Build Epoxoline II
4. 2H-Color Hi-Build Tneme Gloss
5. 291-Color CRU Urethane
6. 130 Envirofill-6602
7. 51-792 PVA Sealer
8. 36 Undercoater

B. Each coat shall have the minimum dry film thickness indicated. All coats of paint for any particular surface shall be from the same manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which painting will be performed for compliance with requirements for application of paint. Do not begin paint application until unsatisfactory conditions have been corrected.

B. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.2 PREPARATION

A. General: Listing below does not necessarily imply that each and every substrate condition listed will be encountered in this Project. Perform all preparation and cleaning procedures in strict accordance with the paint manufacturer's instructions and as herein specified, for each particular substrate condition.
   1. Remove all hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for the complete painting of the items and adjacent surfaces. Following completion of painting of each space or area, reinstall the removed items by workmen skilled in the trades involved.
   2. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Schedule cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
   3. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operations in each space or area, have items reinstalled by workers skilled in the trades involved.
   4. At existing areas to be repainted, remove blistered or peeling paint to sound substrates. Remove chalk deposits and mildew and wash all surfaces with mild detergent. Perform related minor preparation including caulk and glazing compounds. Spot prime bare areas before priming and painting as specified.

B. Surface Preparation: Clean and prepare surfaces to be painted in accordance with the manufacturer's instructions for each particular substrate condition and as specified.
   1. Provide barrier coats over incompatible primers or remove and re-prime. Notify Engineer in writing of problems anticipated with using the specified finish-coat material with substrates primed by others.

C. Cementitious Materials: 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.
   1. Determine the alkalinity and moisture content of the surfaces to be painted by performing appropriate tests. If the surfaces are found to be sufficiently alkaline to cause blistering and burning of the finish paint, correct this condition before application of paint.
   2. Do not paint over surfaces where the moisture content exceeds 8%, unless otherwise permitted in the manufacturer's printed directions.

D. Concrete Floors: Acid etch or scarify all surfaces to create a surface profile similar to medium grit sandpaper (more than one application of acid may be required to obtain this degree of surface profile). Rinse all surfaces until a neutral pH is obtained. All surfaces shall be clean and dry.

E. Structural and Miscellaneous Ferrous Metals (non process): Clean non-galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with recommendations of the Steel Structures Painting Council.

1. Clean non-galvanized, ferrous surfaces that have not been shop-coated of all oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning, complying with Steel Structures Painting Council (SSPC) - SP3.
2. Touch-up shop-applied prime coats which have damaged or bare areas. Wire-brush, solvent clean, and touch-up with the same primer as the shop coat.
3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by the paint manufacturer, and touch up with the same primer as the shop coat.

F. Surface Preparation Ferrous Metals (Process Equipment): Surface preparation of all ferrous metal to be primed in the shop shall have all rust, dust and scale, as well as all other foreign substances, removed by blasting (Black Beauty or equal) or pickling. Cleaned metal shall be primed or pre- treated immediately after cleaning to prevent new rusting. All ferrous metals not primed in the shop shall be sandblasted in the field prior to application of the primer, pretreatment or paint. Grades of sandblasting shall be as indicated for the specific application below and shall conform to the following definitions:

1. White Metal Blast - NACE No. 1 or SSPC-SP-5
2. Near White Metal Blast - NACE No. 2 or SSPC-SP-10
3. Commercial Blast - NACE No. 3 or SSPC-SP-6
4. Brush Off Blast - NACE No. 4 or SSPC-SP-7

Unless otherwise specified, surface preparation shall be equivalent to NACE No. 2.

G. Galvanized Surfaces: Clean galvanized surfaces with non-petroleum-based solvents so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.

1. Clean free of oil and surface contaminants with an acceptable non-petroleum based solvent. Approximately 24 hours before application of prime coat (and immediately after cleaning), chemically treat surfaces with a phosphoric acid or copper sulphate solution, applied according to directions of manufacturer of paint being used.

H. Materials Preparation: Carefully mix and prepare paint materials in accordance with manufacturer's directions.

1. Maintain containers used in mixing and application of 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. Remove film and, if necessary, strain material before using.
3. Use only thinners approved by the paint manufacturer, and only within recommended limits.

I. Tinting: Tint each undercoat a lighter shade to facilitate identification of each coat where multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

A. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

B. Apply paint with brush, roller, spray, or other acceptable practice in accordance with the manufacturer's directions. Use brushes best suited for the type of material being applied. Use

rollers of carpet, velvet back, or high pile sheep wool as recommended by the paint manufacturer for material and texture required.

C. The number of coats and paint film thickness required is the same regardless of the application method. Do not apply succeeding coats until the previous coat has completely dried. Sand between each enamel or varnish coat application with fine sandpaper.

D. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, until the paint film is of uniform finish, color and appearance. Give special attention to insure that all surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.

E. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.

F. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint, before final installation of equipment.

G. Paint the back sides of access panels, removable or hinged covers to match the exposed surfaces.

H. Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects due to insufficient sealing.

I. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

J. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.

K. Omit primer on metal surfaces that have been shop-primed and touch up painted.

L. Brush Application: Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable. Neatly draw all glass and color break lines. Brush apply all primer or first coats, unless otherwise permitted to use mechanical applicators.

M. Mechanical Applicators: Use mechanical methods for paint application only when permitted by governing ordinances and trade union regulations. If permitted, limit to only those surfaces impracticable for brush applications.

N. Limit roller applications (generally) to interior wall and ceiling finishes for second and third coats. Apply each roller coat to provide the equivalent hiding as brush-applied coats.

O. Confine spray application (generally) to metal framework, siding, decking, wire mesh and similar surfaces where hand brush work would be inferior and other surfaces specifically recommended by paint manufacturer.

P. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush applied coats. Do not double back with spray equipment for the purpose of building up film thickness of two coats in one pass.

Q. Scheduling Painting: Apply first coat to surfaces that have been cleaned, retreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

R. Allow sufficient time between successive coats to permit proper drying. Do not recoat until paint has dried to where it feels firm, and does not deform or feel sticky under moderate thumb pressure and where application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

S. Mechanical and Electrical Work: Painting mechanical and electrical work is limited to items exposed in mechanical equipment rooms and in occupied spaces. Mechanical items to be painted include but are not limited to:
1. Piping, pipe hangers, and supports.
2. Heat exchangers.
3. Tanks.
4. Ductwork.
5. Insulation.
6. Supports.
7. Motors and mechanical equipment.

T. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

U. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

3.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the job site in the 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. Federal Specification number, if applicable.
4. Manufacturer's stock number and date of manufacture.
5. Contents by volume, for pigment and vehicle constituents.
6. Thinning instructions.
7. Application instructions.
8. Color name and number.

B. Store materials not in use in tightly covered containers in a well- ventilated area at a minimum ambient temperature of 45 deg F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

C. 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.

3.5 FIELD QUALITY CONTROL

A. The Owner reserves the right to invoke test procedures at any time and as often as the Owner deems necessary during the period when paint is being applied.

B. The Owner will engage the services of an independent testing laboratory to sample the paint material being used. Samples of material delivered to the project will be taken, identified, sealed, and certified in the presence of the Contractor.

C. The testing laboratory will perform appropriate tests for the following characteristics as required by the Owner:
1. Quantitative materials analysis.

2. Abrasion resistance.
3. Apparent reflectivity.
4. Flexibility.
5. Washability.
6. Absorption.
7. Accelerated weathering.
8. Dry opacity.
9. Accelerated yellowness.
10. Recoating.
11. Skinning.
12. Color retention.
13. Alkali and mildew resistance.

D. If test results show material being used does not comply with specified requirements, the Contractor may be directed to stop painting, remove noncomplying paint, pay for testing, repaint surfaces coated with rejected paint, and remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two coatings are noncompatible. **The DFT shall be confirmed.**

3.6 REQUIRED CONDITION OF COMPLETED WORK

A. Must match approved samples for color, texture and coverage. Remove, refinish, or repaint work not in compliance with specified requirements.

3.7 CLEANING

A. At the end of each work day, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

B. Upon completion of painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or damage adjacent finished surfaces.

C. At the completion of work of other trades, touch-up and restore all damaged or defaced painted surfaces.

3.8 PROTECTION

A. Protect work of other trades, whether to be painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as acceptable to Engineer. Provide "wet paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.9 PAINT SCHEDULE

A. The number of coats shall be not less than called for hereunder. Letter designations of various coats of paint refer to the same letter designation of paints given in the preceding subsection. Colors to be selected by the Owner from the standard color line of each particular paint type and manufacturer.

B. Coating Systems:

Coat	Tnemec Product	Dry Film Thickness (Mils)

Steel - Tanks, Pipes, and Equipment

Note: Manufacturer's Standard Paint System if pump motor is not attached to pump. Contractor to touch up all areas damaged during shipment and installation.

1. Interior Exposure

1st Coat:	90 – 97 Tneme Zinc	2.0 to 3.0
2nd Coat:	69- Color Hi-Build Epoxoline II	6.0 to 8.0

Steel - Structural & Miscellaneous Metal, Bar Joists, Metal Doors, and Trim (Shop Primed)

1. Interior Exposure

1st Coat:	90 – 97 Tneme Zinc	2.0 to 3.0
2nd Coat:	69-Color Hi-Build Epoxoline II	6.0 to 8.0

Ductile Iron, Galvanized Steel, and Non-Ferrous Metals

1. Interior Exposure

1st Coat:	66-Color Hi-Build Epoxoline	4.0 to 6.0
2nd Coat:	66-Color Hi-Build Epoxoline	4.0 to 6.0

Concrete, Dense

1. Interior Exposure Excluding Floors

Surface Prep:	Brush-Off Blast Cleaning	
1st Coat:	69-Color Hi-Build Epoxoline II	6.0 to 8.0
2nd Coat:	69-Color Hi-Build Epoxoline II	6.0 to 8.0

Concrete Floors

Surface Prep:	Acid etch or mechanical scarification	
1st Coat*:	66-Color Hi-Build Epoxoline	2.0 to 3.0
2nd Coat**:	66-Color Hi-Build Epoxoline	2.0 to 3.0
3rd Coat:	291-Color CRU Urethane	2.0 to 3.0

* Thin first coat 20% with Series 41-4 Thinner.

** Broadcast sand into second coat at a rate of 2 lbs per 100 square feet for a non-skid finish.

Porous Masonry

1. Interior Exposure

Surface Prep:	Surface shall be clean and dry	
1st Coat:	130 Envirofill-6602	75 to 100 sq.ft./gal.
2nd Coat:	69-Color Hi-Build Epoxoline II	6.0 to 8.0
3rd Coat:	69-Color Hi-Build Epoxoline II	6.0 to 8.0

Gypsum Wallboard

1. Interior Exposure

Surface Prep:	Surface shall be clean and dry	
1st Coat:	51-792 PVA Sealer	1.0 to 2.0
2ndCoat:	66-Color Hi-Build Epoxoline	2.0 to 3.0
3rd Coat:	66-Color Hi-Build Epoxoline	2.0 to 3.0

Wood

1. Interior Exposure

Surface Prep:	Surface shall be clean and dry	
1st Coat:	36 Undercoater	2.0 to 3.5
2nd Coat:	2H-Color Hi-Build Tneme-Gloss	1.5 to 3.5
3rd Coat:	2H-Color Hi-Build Tneme-Gloss	1.5 to 3.5

PVC Pipe

1. Interior Exposure

Surface Prep:	Scarify by sanding	
1st Coat:	66-Color Hi-Build Epoxoline	2.0 to 4.0
2nd Coat:	66-Color Hi-Build Epoxoline	2.0 to 4.0

3.10 MEASUREMENT AND PAYMENT

A. All items of this section shall not be measured for separate payment but shall be considered subsidiary to the lump sum price bid for the associated item and schedule.

END OF SECTION

SECTION 09 97 23 – CONCRETE OR MASONRY COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Interior coating systems for concrete inverted siphon structures, concrete pump station wet wells, and miscellaneous concrete structures.

B. Related sections:
   1. Section 33 39 13 – Concrete Manholes
   2. Section 03 41 00 – Precast Concrete

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition.
   1. ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
   2. ASTM D 4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coating by Notched Gages
   3. ASTM D 4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
   4. ASTM D 4787 – Standard Practice for Continuity Verification of Liquid or Sheet Lining Applied to Concrete Substrates

B. Other Standards, latest edition.
   1. ICRI Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays
   2. NACE No. 6 / SSPC SP-13 – Surface Preparation of Concrete

1.3 SUBMITTALS

A. General: Submit listed submittals in accordance with conditions of the Contract and section entitled Submittals.

B. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation requirements, and application instructions.

C. Color Samples: Submit manufacturer's color samples showing full range of standard colors.

D. Manufacturer's Quality Assurance:
   1. Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.
   2. Submit a list of at least 5 completed projects of similar size and similar waste stream where coating has been applied. Include for each project:
      a. Project name and location.
      b. Name, address, and phone number of owner.
      c. Name of applicator.
      d. Name of engineer.
      e. Approximate area of coatings applied.
      f. Date of completion.

E. Applicator's Quality Assurance:

1. The applicator must be trained and certified/approved by the coating system manufacturer.
2. Submit a list of at least 5 completed projects of size and complexity similar to this Work where applicator has spray applied 100% solids epoxies. Include for each project:
   a. Project name and location.
   b. Name, address, and phone number of owner.
   c. Name of contractor.
   d. Name of engineer.
   e. Name of coating manufacturer and product applied.
   f. Approximate area of coatings applied.
   g. Date of completion.
3. Submit certification that each foreman to be utilized on this project has overseen the application of 50,000 square feet of 100% solids epoxy coatings in the last three years, 30,000 square feet of which shall have been applied in manholes. Certification for each foreman shall include the following information for each applicator company for which each foreman worked:
   a. employees' name;
   b. project names and descriptions;
   c. name, address, and telephone of contact person for each applicator company worked for;
   d. name, address, phone number of contact person for each project owner;
   e. years experience and amount of coating applied.
4. Submit certification that the "nozzle men" to be utilized on this project each have a minimum of two years experience and have spray applied a minimum of 30,000 square feet of 100% solids epoxy coatings in the last two years, 20,000 square feet of which shall have been applied in manholes. Certification for each "spray man" to be utilized shall include the following information for each applicator company for which each "spray man" worked:
   a. employees' name;
   b. project names and descriptions;
   c. name, address, and telephone of contact person for each applicator company worked for;
   d. name, address, phone number of contact person for each project owner;
   e. years experience and amount of coating applied.
5. Submit certification that at least two-thirds of the crew to be utilized on this project has a minimum of two years experience applying 100% solids epoxy coatings. Certification for each crew member to be utilized shall include the following information for each applicator company for which each employee worked:
   a. employees' name;
   b. project names and descriptions;
   c. name, address, and telephone of contact person for each applicator company worked for;
   d. name, address, phone number of contact person for each project owner;
   e. primary role(s) and years experience in each role applying 100% solids epoxies.
6. Other, equivalent documentation will be considered for approval at Engineer's discretion.

F. Manufacturer's Field Report: Provide copy of report from manufacturer's representative confirming that the surfaces to which coating is to be applied are in a condition suitable to receive same.

G. Warranty:
   1. Material Warranty: A written guarantee of 5 years submitted to the City for the specified project shall be provided by the Manufacturers of the Coatings and Repair Products, if different manufacturers.
   2. Workmanship Warranty: A written guarantee of at least 2 years shall be provided by the Applicator against any shortcoming in Workmanship.

1.4 QUALITY ASSURANCE

A. Mock-Ups: Prepare a separate 10 foot x 10 foot flat concrete panel for use as a mock-up for each "spray man" using materials, tools, equipment, and procedures intended for actual surface preparation and application. Panel shall be placed to present a vertical surface during application of coating. Obtain Engineer's concurrence of acceptability of each mock-up. The mock-ups are to establish minimum standards by which the coating and its application will be judged and therefore shall be retained and stored by Contractor until the project is completed.
   1. Pre-Installation Conference: Prior to beginning coating operations, a meeting will be held with Contractor, coating sub-contractor, Engineer, Owner's representative, and coating manufacturer's representative to verify and review the following:
      a. Project requirements for coating as set out in Contract Documents.
      b. Manufacturer's product data including application instructions.
      c. Substrate conditions and procedures for substrate preparation and coating installation. Applicator shall be familiar with the overall condition of structures to be coated prior to the conference.
   2. Technical Consultation: The coating manufacturer's representative shall provide technical consultation on coating application.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:
   1. Coating or material name.
   2. Manufacturer.
   3. Color name and number.
   4. Batch or lot number.
   5. Date of manufacture.
   6. Mixing instructions.

B. Storage:
   1. Store materials in a clean dry area away from open flame, heat, and strong oxidants. Store materials within temperature range as recommended by manufacturer.
   2. Keep containers sealed until ready for use.
   3. Do not use materials beyond manufacturer's shelf life limits.

C. Handling: Protect materials during handling and application to prevent damage or contamination. Handle materials according to their material safety data sheets.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Coating System:
   1. The coating system shall be a spray applied 100% solids epoxy coating which forms a monolithic coating covering all interior surfaces of the structures specified to be coated.
   2. The bonding strength of the finished coating shall exceed the point of concrete failure according to ASTM D4541.
   3. The coating system shall be designed for hydrostatic loading and shall be continuously bonded to all brick, mortar, concrete, chemical sealant, grout, pipe, and other surfaces inside the manhole.
   4. When cured, the system shall form a continuous, tight fitting, hard, impermeable, pinhole-free coating that is suitable for water system service and chemically resistant to any chemicals, bacteria, or vapors normally found in the influent water.
   5. The coating shall effectively seal the interior surfaces of the manhole and prevent any penetration or leakage of groundwater infiltration.

6. Acceptable coating manufacturers shall be:
   a. Raven
   b. Sauereisen
   c. Tnemec
   d. Warren
   e. Approved Equal

B. Repair Materials and Primers:
   1. Acceptable patching, filling, repairing, and priming systems shall be as recommended by the coating manufacturer and shall be certified to be compatible with and provide adequate bonding to both the substrate and coating system.

C. Conductive Underlayment:
   1. Acceptable conductive underlayments, as necessary to facilitate high-voltage holiday testing, shall be as recommended by the coating manufacturer and shall be certified by the coating manufacturer to be compatible with and provide adequate bonding to the substrate, any repair or primer materials, and coating system.

D. Equipment:
   1. All equipment for surface cleaning, surface preparation, and coating application shall be approved for use by the coating manufacturer.
   2. Spray equipment for application of the coating system shall be airless.

E. Non-skid Materials:
   1. Non-skid material shall be "8-12" dry sand as manufactured by APAC or approved equal.

PART 3 - EXECUTION

3.1 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.2 AREA PREPARATION

A. All structures to be coated shall be readily accessible to applicator.

B. Appropriate actions shall be taken to comply with local, state, and federal regulatory and other applicable agencies with regard to environment, health, and safety.

C. Active flows shall be dammed, plugged, or diverted as required to ensure that the cleaning, preparation, and coating may be performed or applied to the entirety of the surfaces specified to be coated and shall remain dammed, plugged, or diverted until the coating manufacturer's recommended cure time for immersion service has been accomplished.

D. Surface cleaning, surface preparation, and coating application shall not commence until the concrete substrate has properly cured for a minimum of 28 days.

E. The temperature of the surface to be coated shall be maintained within the range recommended by the manufacturer. Prior to and during application, care should be taken to avoid exposure of structure be coated to direct sunlight or other intense heat sources. Application of preparation or coating materials shall not be performed when the concrete surface temperature is rising or

in direct sunlight to avoid blistering due to thermal expansion of trapped air or moisture in the substrate.

F. Applicator shall inspect all surfaces specified to receive a coating prior to surface cleaning and preparation. Applicator shall notify Engineer of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair or coating materials.

3.3 SURFACE PREPARATION

A. All contaminants including oil, grease, waxes, form release, curing compounds, efflorescence, sealers, salts, incompatible existing coatings, and other contaminants shall be removed.

B. A water drop test shall be utilized to test the concrete surface for the presence of hydrophobic contaminants. A droplet of water is placed on the concrete surface and its wetting behavior is observed. If the water droplet flattens and "wets out" the concrete surface, it is likely that the concrete is not contaminated. If the water droplet beads up on the surface like rain on a freshly waxed car, it is likely that the concrete is contaminated.

C. Suitable surface cleaning methods for removing oils, grease, and other chemicals from the substrate are low pressure detergent/degreaser water cleaning and low pressure hot water cleaning.

D. Surface preparation shall achieve surfaces that are sound, clean, smooth, even, and free of laitance, fins, protrusions, chemical contaminants, dust, and standing water. Surface preparation shall also result in a concrete surface profile (CSP) as recommended by the coating manufacturer.

E. Suitable surface preparation methods are abrasive blasting and water jetting. Surface preparation procedures shall be in accordance with ICRI Guideline No. 03732 and NACE No. 6 / SSPC SP-13.

F. All surfaces shall be inspected during and after surface preparation and prior to application of the coating system. Any evidence of remaining contamination or laitance shall be removed by additional cleaning or surface preparation before proceeding with the application of the coating.

G. Application of Repair Materials:
   1. Areas where structural steel has been exposed or removed shall be repaired as acceptable to the Engineer and surface shall be built out to full-thickness to match adjacent surfaces.
   2. All areas where the existing surface is more than ½ inch less than the thickness of the original surface will be built out to full-thickness to match adjacent surfaces.
   3. All structural cracks, voids, bugholes, and honeycombs shall be filled and floated with an approved repair material.
   4. All bituminous or elastomeric joint sealants or gaskets shall be coated with an approved material.
   5. Approved repair materials shall be trowel or spray applied using proper equipment to specified surfaces. Repair materials shall be applied and prepared to provide a surface with a profile equivalent to the ICRI concrete surface profile (CSP) recommended by the coating manufacturer.
   6. Repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds may not be used unless approved by the coating manufacturer for compatibility with the specified system.
   7. Application of the repair materials, if not performed by the coating applicator, shall be observed by the applicator's representative to ensure proper finishing for suitability to receive the coating system.

3.4 APPLICATION OF COATING SYSTEM

A. Prior to application of any coating, the conductivity of the concrete shall be tested for each structure to be coated. The test shall be performed in accordance with ASTM D4787. If the test indicates the concrete provides an insufficient ground, a conductive underlayment shall be applied prior to any coating.

B. Prior to application of any coating, a moisture test shall be performed on the walls and repaired areas as recommended by the manufacturer.

C. Application procedures shall conform to the recommendations of the coating manufacturer, including material handling, mixing, environmental controls during application, safety, equipment, pressure settings, and application techniques.

D. For concrete surfaces that do not require rehabilitation, the coating shall be applied to average and minimum uniform dry film thicknesses as follows or as approved by Engineer:

Product	Average Thickness (mils)	Minimum Thickness (mils)
Raven - 405	100	80
Tnemec - Perma-Glaze No. 435	100	80

E. For concrete surfaces that require rehabilitation, the coating shall be applied to average and minimum uniform dry film thicknesses as follows or as approved by Engineer:

Product	Average Thickness (mils)	Minimum Thickness (mils)
Raven - 405	125	100
Tnemec - Perma-Glaze No. 435	125	100

F. Do not use mixed coatings exceeding manufacturer's recommended pot life.

G. The spray applied coating, including any recommended basecoat or primer, shall be applied according to the manufacturer's recommended number of coat applications.

H. The benches shall be coated to the same average and minimum thicknesses as required for the walls except the benches shall have non-skid materials included in the coating system. The benches shall be made non-skid in accordance with manufacturer recommended procedures and shall have a final texture similar to 10 grit sandpaper.

I. The elapsed time between succeeding coats shall be as specified by manufacturer.

J. Any solvents left in the equipment shall be completely removed before applying coating to the designated surfaces.

K. No application shall be made to frozen surfaces or if freezing is expected to occur inside the structure within a time period detrimental to the uncured coating.

L. Applied coatings shall be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.5 FIELD QUALITY CONTROL

A. Contractor's Services:

1. Verify coatings and other materials are as specified.
2. Verify surface preparation and application are as specified.
3. Verify wet film thickness of each coat using wet film gages and total dry film thickness of the coating system by dry film testing as described below.
4. Coating Defects:
   a. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
   b. Check for holidays on interior surfaces using holiday detector as described in Paragraph 3.6.
5. Report:
   a. Submit written reports describing inspections made and actions taken to correct nonconforming work.
   b. Report nonconforming work not corrected.
   c. Submit copies of report to Engineer and Contractor.

B. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.6 TESTING AND INSPECTION

A. A wet film thickness gage, conforming to ASTM D 4414, shall be used during coating application to ensure a uniform thickness during application.

B. After the coating system has set hard to the touch it shall be inspected by the Engineer, verifying the following:
1. The coating system's cured thickness. Measurement shall be obtained from a specimen retrieved by the applicator by physically cutting through the coating (by drilling or coring).
2. No groundwater infiltration
3. All pipe connections are open and clear
4. No evident cracks, voids, pinholes, uncured spots, lifts, delamination, blisters, or other type of defects.
5. No "runs" or "sags" not in conformance with the standard set by the mock-ups or that affect the performance of the coating system.

C. Holiday Testing:
1. Holiday testing shall be performed according to ASTM D 4787 and these specifications. After the elapsed time recommended by the coating manufacturer, the coating shall be inspected with high-voltage holiday detection equipment. An induced holiday shall be made onto the coated concrete surface and serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of minimum specified (not average) film thickness applied but shall be increased if it is insufficient to detect the induced holiday. All detected holidays shall be marked. Holidays shall be repaired by abrading the coating system surface with grit paper or other hand tooling method, completely opening the holiday. After abrading and cleaning, additional coating material shall be hand applied to the repair area. All touch-up/repair procedures shall follow the recommendations of the coating system manufacturer. Repaired areas shall be allowed to cure, as recommended by the manufacturer, before being retested.

D. Pull-off Testing:
1. Measurement of bond strength of the coating system to the substrate shall be made at a minimum of three locations on each coated structure and along different sections of the structure (i.e. corbel, wall, bench). Bond strength shall be measured in accordance with ASTM D 4541, Method E and these specifications. A minimum of three 20mm dollies shall be fixed to the coated surface at locations selected by the Engineer. Test failures shall be documented as failure within the concrete, failure within the coating, or failure at

the coating/concrete interface. The following criteria shall be used to evaluate the test results:

a. Failure of the dolly adhesive shall require retesting.

b. Failure at the coating/concrete interface with less than 20% of substrate adhered to the coating and less than 200 psi pull-off strength shall be deemed coating adhesion failure and the contractor shall remove all coating not meeting minimum requirements, re-perform surface preparation procedures, and recoat the failed surfaces, at no additional cost to the Owner.

2. Low pull-off strength values (less than 250 psi) may require additional testing/evaluation to determine potential adhesion defects at the sole discretion of the Owner.

3. The Owner shall further evaluate any areas detected to have inadequate adhesion. Further adhesion testing may be performed to determine the extent of potentially deficient bonded areas and repairs shall be made in accordance with the manufacturer's recommendations.

E. A final visual inspection shall be made by the Engineer and applicator. Any deficiencies in the finished system shall be marked and repaired by the coating applicator according to the manufacturer's recommendations.

3.7 WARRANTY INSPECTIONS

A. Inspection of the coated structures shall be performed after the first year of service. Owner will set date for inspections.

B. Inspection shall be attended by Owner, Contractor, Engineer, and manufacturer's representative.

C. Coating defects found shall be evaluated by a qualified inspector and the coating manufacturer to determine the cause of the failure and propose repair procedures. Contractor shall coordinate repair of deficiencies in coating systems in accordance with recommended repair procedures, at no additional cost to the Owner.

END OF SECTION

SECTION 09 97 26.13 – INTERIOR COATINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Interior coating systems for concrete sewer manholes and other concrete structures as indicated, specified, or as directed by the Engineer.

1.2 RELATED SECTIONS

A. Section 33 39 13.13 – Pre-Cast Concrete Manholes

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition.

ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method

ASTM D 4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coating by Notched Gages

ASTM D 4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

ASTM D 4787 – Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates

ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

ATSM D 695 –Standard Test Method for Compressive Properties of Rigid Plastics

ASTM D 638 –Standard Test Method for Tensile Properties of Plastics

ASTM D4541–Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

B. Other Standards, latest edition.

ICRI Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

NACE No. 6 / SSPC SP-13 – Surface Preparation of Concrete

1.4 SUBMITTALS

A. General: Submit listed submittals in accordance with conditions of the Contract and Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation requirements, and application instructions.

C. Color Samples: Submit manufacturer's color samples showing full range of standard colors.

D. Manufacturer's Quality Assurance:

1. Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.
2. Submit a list of at least 5 completed projects of similar size and similar waste stream where coating has been applied. Include for each project:
   a. Project name and location.
   b. Name, address, and phone number of owner.
   c. Name of applicator.
   d. Name of engineer.
   e. Approximate area of coatings applied.
   f. Date of completion.

E. Applicator's Quality Assurance:

1. The applicator must be trained and certified/approved by the coating system manufacturer.
2. Submit a list of at least 5 completed projects of size and complexity similar to this Work where applicator has spray applied 100% solids epoxies. Include for each project:
   a. Project name and location.
   b. Name, address, and phone number of owner.
   c. Name of contractor.
   d. Name of engineer.
   e. Name of coating manufacturer and product applied.
   f. Approximate area of coatings applied.
   g. Date of completion.
3. Submit certification that each foreman to be utilized on this project has overseen the application of 50,000 square feet of 100% solids epoxy coatings in the last three years, 30,000 square feet of which shall have been applied in manholes. Certification for each foreman shall include the following information for each applicator company for which each foreman worked:
   a. employees' name;
   b. project names and descriptions;
   c. name, address, and phone number of contact person for each applicator company worked for;
   d. name, address, phone number of contact person for each project owner;
   e. years experience and amount of coating applied.
4. Submit certification that the "nozzle men" to be utilized on this project each have a minimum of two years experience and have spray applied a minimum of 30,000 square feet of 100% solids epoxy coatings in the last two years, 20,000 square feet of which shall have been applied in manholes. Certification for each "spray man" to be utilized shall include the following information for each applicator company for which each "spray man" worked:
   a. employees' name;
   b. project names and descriptions;
   c. name, address, and phone number of contact person for each applicator company worked for;
   d. name, address, phone number of contact person for each project owner;
   e. years experience and amount of coating applied.
5. Submit certification that at least two-thirds of the crew to be utilized on this project has a minimum of two years experience applying 100% solids epoxy coatings. Certification for each crew member to be utilized shall include the following information for each applicator company for which each employee worked:
   a. employees' name;

b. project names and descriptions;
c. name, address, and phone number of contact person for each applicator company worked for;
d. name, address, phone number of contact person for each project owner;
e. primary role(s) and years experience in each role applying 100% solids epoxies.

6. Other, equivalent documentation will be considered for approval at Engineer's discretion.

F. Manufacturer's Field Report: Provide copy of report from manufacturer's representative confirming that the surfaces to which coating is to be applied are in a condition suitable to receive same.

G. Warranty:

1. Material Warranty: A written guarantee of 5 years submitted to the City for the specified project shall be provided by the Manufacturers of the Coatings and Repair Products, if different manufacturers.
2. Workmanship Warranty: A written guarantee of at least 2 years shall be provided by the Applicator against any shortcoming in Workmanship.

1.5 QUALITY ASSURANCE

A. Pre-Installation Conference

1. Pre-Installation Conference: Prior to beginning coating operations, a meeting will be held with Contractor, coating sub-contractor, Engineer, Owner's representative, and coating manufacturer's representative to verify and review the following:
   a. Project requirements for coating as set out in Contract Documents.
   b. Manufacturer's product data including application instructions.
   c. Substrate conditions and procedures for substrate preparation and coating installation. Applicator shall be familiar with the overall condition of structures to be coated prior to the conference.
2. Technical Consultation: The coating manufacturer's representative shall provide technical consultation on coating application.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:

1. Coating or material name.
2. Manufacturer.
3. Color name and number.
4. Batch or lot number.
5. Date of manufacture.
6. Mixing instructions.

B. Storage:

1. Store materials in a clean dry area away from open flame, heat, and strong oxidants. Store materials within temperature range as recommended by manufacturer.
2. Keep containers sealed until ready for use.
3. Do not use materials beyond manufacturer's shelf life limits.

C. Handling: Protect materials during handling and application to prevent damage or contamination. Handle materials according to their material safety data sheets.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Coating System:

1. The coating system shall be a spray applied 100% solids epoxy coating which forms a monolithic coating covering all interior surfaces of the structures specified to be coated.
2. The bonding strength of the finished coating shall exceed the point of concrete substrate failure according to ASTM D4541.
3. The coating system shall be designed for hydrostatic loading and shall be continuously bonded to all brick, mortar, concrete, chemical sealant, grout, pipe, and other surfaces inside the manhole.
4. When cured, the system shall form a continuous, tight fitting, hard, impermeable, pinhole-free coating that is suitable for sewer system service and chemically resistant to any chemicals, bacteria, or vapors normally found in domestic sewage and sewage from the Fayetteville Industrial Park.
5. The coating shall effectively seal the interior surfaces of the manhole and prevent any penetration or leakage of groundwater infiltration.
6. Acceptable coating manufacturers shall be:
   a. Raven
   b. Warren
   c. Approved Equal
7. The epoxies shall meet the following minimum requirements:
   a. Flexural strength according to ASTM D790 6,000 psi
   b. Compressive strength according to ASTM D695 8,000 psi
   c. Tensile strength according to ASTM D638 4,000 psi
   d. Tensile elongation according to ASTM D638 4%

B. Repair Materials and Primers:

1. Acceptable patching, filling, repairing, and priming systems shall be as recommended by the coating manufacturer and shall be certified to be compatible with and provide adequate bonding to both the substrate and coating system.

C. Conductive Underlayment:

1. Acceptable conductive underlayments, as necessary to facilitate high-voltage holiday testing, shall be as recommended by the coating manufacturer and shall be certified by the coating manufacturer to be compatible with and provide adequate bonding to the substrate, any repair or primer materials, and coating system.

D. Equipment:

1. All equipment for surface cleaning, surface preparation, and coating application shall be approved for use by the coating manufacturer.
2. Spray equipment for application of the coating system shall be airless.

E. Non-skid Materials:
1. Non-skid material shall be "8-12" dry sand as manufactured by APAC-Arkansas, Arkhola Division or approved equal.

PART 3 - EXECUTION

3.1 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.2 AREA PREPARATION

A. All structures to be coated shall be readily accessible to applicator.

B. Appropriate actions shall be taken to comply with local, state, and federal regulatory and other applicable agencies with regard to environment, health, and safety.

C. Active flows shall be dammed, plugged, or diverted as required to ensure that the cleaning, preparation, and coating may be performed or applied to the entirety of the surfaces specified to be coated and shall remain dammed, plugged, or diverted until the coating manufacturer's recommended cure time for immersion service has been accomplished.

D. Surface cleaning, surface preparation, and coating application shall not commence until the concrete substrate has properly cured for a minimum of 28 days.

E. The temperature of the surface to be coated shall be maintained within the range recommended by the manufacturer. Prior to and during application, care should be taken to avoid exposure of structure be coated to direct sunlight or other intense heat sources. Application of preparation or coating materials shall not be performed when the concrete surface temperature is rising or in direct sunlight to avoid blistering due to thermal expansion of trapped air or moisture in the substrate.

F. Applicator shall inspect all surfaces specified to receive a coating prior to surface cleaning and preparation. Applicator shall notify Engineer of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair or coating materials.

3.3 SURFACE PREPARATION

A. All contaminants including oil, grease, waxes, form release, curing compounds, efflorescence, sealers, salts, incompatible existing coatings, and other contaminants shall be removed.

B. A water drop test shall be utilized to test the concrete surface for the presence of hydrophobic contaminants. A droplet of water is placed on the concrete surface and its wetting behavior is observed. If the water droplet flattens and "wets out" the concrete surface, it is likely that the concrete is not contaminated. If the water droplet beads up on the surface like rain on a freshly waxed car, it is likely that the concrete is contaminated.

C. Suitable surface cleaning methods for removing oils, grease, and other chemicals from the substrate are low pressure detergent/degreaser water cleaning and low pressure hot water cleaning.

D. Surface preparation shall achieve surfaces that are sound, clean, smooth, even, and free of laitance, fins, protrusions, chemical contaminants, dust, and standing water. Surface preparation shall also result in a concrete surface profile (CSP) as recommended by the coating manufacturer.

E. Suitable surface preparation methods are abrasive blasting and water jetting. Surface preparation procedures shall be in accordance with ICRI Guideline No. 03732 and NACE No. 6 / SSPC SP-13.

F. All surfaces shall be inspected during and after surface preparation and prior to application of the coating system. Any evidence of remaining contamination or laitance shall be removed by additional cleaning or surface preparation before proceeding with the application of the coating.

G. Application of Repair Materials:
1. Areas where structural steel has been exposed or removed shall be repaired as acceptable to the Engineer and surface shall be built out to full-thickness to match adjacent surfaces.
2. All areas where the existing surface is more than ½" less than the thickness of the original surface will be built out to full-thickness to match adjacent surfaces.
3. All structural cracks, voids, bug holes, and honeycombs shall be filled and floated with an approved repair material.
4. All bituminous or elastomeric joint sealants or gaskets shall be coated with an approved material.
5. Approved repair materials shall be trowel or spray applied using proper equipment to specified surfaces. Repair materials shall be applied and prepared to provide a surface with a profile equivalent to the ICRI concrete surface profile (CSP) recommended by the coating manufacturer.
6. Repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds may not be used unless approved by the coating manufacturer for compatibility with the specified system.
7. Application of the repair materials, if not performed by the coating applicator, shall be observed by the applicator's representative to ensure proper finishing for suitability to receive the coating system.

3.4 APPLICATION OF COATING SYSTEM

A. Prior to application of any coating, the conductivity of the concrete shall be tested for each structure to be coated. The test shall be performed in accordance with ASTM D4787. If the test indicates the concrete provides an insufficient ground, a conductive underlayment shall be applied prior to any coating.

B. Prior to application of any coating, a moisture test shall be performed on the walls and repaired areas as recommended by the manufacturer.

C. Application procedures shall conform to the recommendations of the coating manufacturer, including material handling, mixing, environmental controls during application, safety, equipment, pressure settings, and application techniques.

D. For concrete surfaces that do not require rehabilitation, the coating shall be applied to average and minimum uniform dry film thicknesses as follows or as approved by Engineer:

Product	Average Thickness (mils)	Minimum Thickness (mils)
Raven - 405	100	80

E. For concrete surfaces that require rehabilitation, the coating shall be applied to average and minimum uniform dry film thicknesses as follows or as approved by Engineer:

Product	Average Thickness (mils)	Minimum Thickness (mils)
Raven - 405	125	100

F. Do not use mixed coatings exceeding manufacturer's recommended pot life.

G. The spray applied coating, including any recommended basecoat or primer, shall be applied according to the manufacturer's recommended number of coat applications.

H. The benches shall be coated to the same average and minimum thicknesses as required for the walls except the benches shall have non-skid materials included in the coating system. The benches shall be made non-skid in accordance with manufacturer recommended procedures and shall have a final texture similar to 10 grit sandpaper.

I. The elapsed time between succeeding coats shall be as specified by manufacturer.

J. Any solvents left in the equipment shall be completely removed before applying coating to the designated surfaces.

K. No application shall be made to frozen surfaces or if freezing is expected to occur inside the structure within a time period detrimental to the uncured coating.

L. Applied coatings shall be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.5 FIELD QUALITY CONTROL

A. Contractor's Services:
1. Verify coatings and other materials are as specified.
2. Verify surface preparation and application are as specified.
3. Verify wet film thickness of each coat using wet film gages and total dry film thickness of the coating system by dry film testing as described below.
4. Coating Defects:
   a. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
   b. Check for holidays on interior surfaces using holiday detector as described in Paragraph 3.6.
5. Report:
   a. Submit written reports describing inspections made and actions taken to correct nonconforming work.
   b. Report nonconforming work not corrected.
   c. Submit copies of report to Engineer and Contractor.

B. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating systems.

3.6 TESTING AND INSPECTION

A. A wet film thickness gage, conforming to ASTM D4414, shall be used during coating application to ensure a uniform thickness during application.

B. After the coating system has set hard to the touch it shall be inspected by the Engineer, verifying the following:
1. The coating system's cured thickness. Measurement shall be obtained from a specimen retrieved by the applicator by physically cutting through the coating (by drilling or coring).

2. No groundwater infiltration
3. All pipe connections are open and clear
4. No evident cracks, voids, pinholes, uncured spots, lifts, delamination, blisters, or other type of defects.
5. No "runs" or "sags" not in conformance with the standard set by the mock-ups or that affect the performance of the coating system.

C. Holiday Testing:
1. Holiday testing shall be performed according to ASTM D 4787 and these specifications. After the elapsed time recommended by the coating manufacturer, the coating shall be inspected with high-voltage holiday detection equipment. An induced holiday shall be made onto the coated concrete surface and serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of minimum specified (not average) film thickness applied but shall be increased if it is insufficient to detect the induced holiday. All detected holidays shall be marked. Holidays shall be repaired by abrading the coating system surface with grit paper or other hand tooling method, completely opening the holiday. After abrading and cleaning, additional coating material shall be hand applied to the repair area. All touch-up/repair procedures shall follow the recommendations of the coating system manufacturer. Repaired areas shall be allowed to cure, as recommended by the manufacturer, before being retested.

D. Pull-off Testing:
1. Measurement of bond strength of the coating system to the substrate shall be made at a minimum of three locations on each coated structure and along different sections of the structure (i.e. corbel, wall, bench). Bond strength shall be measured in accordance with ASTM D4541, Method E and these specifications. A minimum of three 20mm dollies shall be fixed to the coated surface at locations selected by the Engineer. Test failures shall be documented as failure within the concrete, failure within the coating, or failure at the coating/concrete interface. The following criteria shall be used to evaluate the test results:
   a. Failure of the dolly adhesive shall require retesting.
   b. Failure at the coating/concrete interface with less than 20% of substrate adhered to the coating and less than 200 psi pull-off strength shall be deemed coating adhesion failure and the contractor shall remove all coating not meeting minimum requirements, re-perform surface preparation procedures, and recoat the failed surfaces, at no additional cost to the Owner.
   c. Low pull-off strength values (<250 psi) may require additional testing/evaluation to determine potential adhesion defects at the sole discretion of the Owner.
   d. The Owner shall further evaluate any areas detected to have inadequate adhesion. Further adhesion testing may be performed to determine the extent of potentially deficient bonded areas and repairs shall be made in accordance with the manufacturer's recommendations.

E. A final visual inspection shall be made by the Engineer and applicator. Any deficiencies in the finished system shall be marked and repaired by the coating applicator according to the manufacturer's recommendations.

3.7 WARRANTY INSPECTIONS

A. Inspection of the coated structures shall be performed after the first year of service. Owner will set date for inspections.

B. Inspection shall be attended by Owner, Contractor, Engineer, and manufacturer's representative.

C. Coating defects found shall be evaluated by a qualified inspector and the coating manufacturer to determine the cause of the failure and propose repair procedures. Contractor shall coordinate repair of deficiencies in coating systems in accordance with recommended repair procedures, at no additional cost to the Owner.

END OF SECTION

SECTION 09 97 26.23 - EXTERIOR COATINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Exterior Coating systems for concrete sewer manholes and concrete structures.

1.2 RELATED SECTIONS

A. Section 33 39 13.13 – Pre-Cast Concrete Manholes

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition.

ASTM D 4263 – Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

ASTM D 4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coating by Notched Gages

B. Other Standards, latest edition.

ICRI Guideline No. 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

NACE No. 6 / SSPC SP-13 – Surface Preparation of Concrete

1.4 SUBMITTALS

A. General: Submit listed submittals in accordance with conditions of the Contract and Section 01 33 00 – Submittal Procedures.

B. Product Data: Submit manufacturer's product data for each coating, including generic description, complete technical data, surface preparation, and application instructions.

C. Manufacturer's Quality Assurance:
1. Submit manufacturer's certification that coatings comply with specified requirements and are suitable for intended application.

D. Applicator's Quality Assurance:
1. Submit certification that the foreman to be utilized on this project has overseen the application of 30,000 square feet of similar coatings in the last three years.

E. Manufacturer's Field Report: Provide copy of report from manufacturer's representative confirming that the surfaces to which coating is to be applied are in a condition suitable to receive same.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
1. Specialize in manufacture of coatings with a minimum of 10 years successful experience.
2. Able to demonstrate successful performance on comparable projects.

B. Applicator's Qualifications:

1. Experienced in application of specified coatings for a minimum of 5 years on projects of similar size and complexity to this Work.

C. Pre-Installation Conference: Prior to beginning exterior coating operations, a meeting will be held with Contractor, coating sub-contractor, Engineer, Owner's representative, and coating manufacturer's representative to verify and review the following:
   1. Project requirements for coating as set out in Contract Documents.
   2. Manufacturer's product data including application instructions.
   3. Substrate conditions and procedures for substrate preparation and coating installation. Applicator shall be familiar with the overall condition of structures to be coated prior to the conference.

D. Technical Consultation: The coating manufacturer's representative shall provide technical consultation on coating application.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying:
   1. Coating or material name.
   2. Manufacturer.
   3. Color name and number.
   4. Batch or lot number.
   5. Date of manufacture.
   6. Mixing and thinning instructions.

B. Storage:
   1. Store materials in a clean dry area away from open flame, heat, and strong oxidants. Store materials within temperature range as recommended by manufacturer.
   2. Keep containers sealed until ready for use.
   3. Do not use materials beyond manufacturer's shelf life limits.

C. Handling: Protect materials during handling and application to prevent damage or contamination. Handle materials according to their material safety data sheets.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Coating System:
   1. The coating system shall be designed for hydrostatic loading and shall be continuously bonded to all brick, mortar, concrete, chemical sealant, grout, pipe, and other surfaces outside the manhole.
   2. When cured, the system shall form a continuous, tight fitting, hard, impermeable, pinhole free coating that effectively seals the exterior surfaces of the concrete structures and prevents any infiltration of groundwater through the coating.
   3. Acceptable exterior coating systems shall be:
      a. Kop Coat – Bitumastic Black Solution
      b. Tnemec – 46-465 H.B. Tnemecol
      c. Approved Equal

B. Repair Materials:
   1. Acceptable repair materials shall be as recommended by the coating manufacturer and shall provide adequate bonding to the substrate and coating system.

C. Equipment:
   1. All equipment for surface cleaning, surface preparation, and coating application shall be approved for use by the coating manufacturer.

PART 3 - EXECUTION

3.1 PROTECTION OF SURFACES NOT SCHEDULED TO BE COATED

A. Protect surrounding areas and surfaces not scheduled to be coated from damage during surface preparation and application of coatings.

B. Immediately remove coatings that fall on surrounding areas and surfaces not scheduled to be coated.

3.2 AREA PREPARATION

A. All structures to be coated shall be readily accessible to applicator.

B. Appropriate actions shall be taken to comply with local, state, and federal regulatory and other applicable agencies with regard to environment, health, and safety.

C. Surface cleaning, surface preparation, and coating application shall not commence until the concrete substrate has properly cured for a minimum of 28 days.

D. The temperature of the surface to be coated shall be maintained within the range recommended by the manufacturer. Concrete surfaces that have been in direct sunlight must be shaded for 24 hours prior to application of coating materials. Prior to and during application, care should be taken to avoid exposure of structure be coated to direct sunlight or other intense heat sources. Application of coating materials shall not be performed when the concrete surface temperature is rising or in direct sunlight to avoid blistering due to thermal expansion of trapped air or moisture in the substrate.

E. Applicator shall inspect all surfaces specified to receive a coating prior to surface cleaning and preparation. Applicator shall notify Engineer of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair or coating materials.

3.3 SURFACE PREPARATION

A. All contaminants including oil, grease, waxes, form release, curing compounds, efflorescence, sealers, salts, and other contaminants shall be removed.

B. A water drop test shall be utilized to test the concrete surface for the presence of hydrophobic contaminants. A droplet of water is placed on the concrete surface and its wetting behavior is observed. If the water droplet flattens and "wets out" the concrete surface, it is likely that the concrete is not contaminated. If the water droplet beads up on the surface like rain on a freshly waxed car, it is likely that the concrete is contaminated.

C. Suitable surface cleaning methods for removing oils, grease, and other chemicals from the substrate are low pressure detergent/degreaser water cleaning and low pressure hot water cleaning.

D. Surface preparation shall achieve surfaces that are sound, clean, smooth, even, and free of laitance, fins, protrusions, chemical contaminants, dust, and standing water. Surface preparation shall also result in a surface with a neutral pH and a concrete surface profile (CSP) as recommended by the coating manufacturer.

E. Suitable surface preparation methods are abrasive blasting and water jetting. Surface preparation procedures shall be in accordance with ICRI Guideline No. 03732 and NACE No. 6 / SSPC SP-13.

F. All surfaces shall be inspected during and after surface preparation and prior to application of the coating system. Any evidence of remaining contamination or laitance shall be removed by additional cleaning or surface preparation before proceeding with the application of the coating.

G. Application of Repair Materials:
   1. All structural cracks, voids, bugholes, and honeycombs shall be filled and floated with an approved repair material.
   2. Approved repair materials shall be trowel or spray applied using proper equipment to specified surfaces. Repair materials shall be applied and prepared to provide a surface with a profile equivalent to the ICRI concrete surface profile (CSP) recommended by the coating manufacturer.
   3. Repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds may not be used unless approved by the coating manufacturer for compatibility with the specified system.
   4. Application of the repair materials, if not performed by the coating applicator, shall be observed by the applicator's representative to ensure proper finishing for suitability to receive the coating system.

3.4 APPLICATION OF COATING SYSTEM

A. Exterior coating system shall be applied to a total minimum dry film thickness of 30 mils.

B. Application procedures shall conform to the recommendations of the coating manufacturer, including material handling, mixing, environmental controls during application, allowable moisture levels, safety, equipment, pressure settings, and application techniques.

C. Do not use mixed coatings exceeding manufacturer's recommended pot life.

D. The coating materials must be applied by a certified or approved installer of the coating system.

E. The spray applied coating, including any recommended basecoat or primer, shall be applied to the manufacturer's recommended average and minimum dry film thicknesses and number of coat applications.

F. The elapsed time between succeeding coats shall be as specified by manufacturer.

G. No application shall be made to frozen surfaces or if freezing is expected to occur inside the structure within a time period detrimental to the uncured coating.

H. Applied coatings shall be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.

3.5 FIELD QUALITY CONTROL

A. Contractor's Services:
   1. Verify coatings and other materials are as specified.
   2. Verify surface preparation and applications are as specified.
   3. Verify dry mil thickness of each coat and total dry mil thickness of each coating system are as specified using wet film and dry film gauges.
   4. Coating Defects:

a. Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.

5. Report:
   a. Submit written reports describing inspections made and actions taken to correct nonconforming work.
   b. Report nonconforming work not corrected.
   c. Submit copies of report to Engineer and Contractor.

B. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for surface preparation and application of coating system.

3.6 TESTING AND INSPECTION

A. A wet film thickness gage, conforming to ASTM D4414, shall be used during coating application to ensure a monolithic coating and uniform thickness during application.

END OF SECTION

DIVISION 22

PLUMBING

SECTION 22 05 00 - PLUMBING GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Provide equipment, labor, material, etc., required to make a complete working installation as shown or as specified.

B. Equipment and materials used in the work shall be:
1. In accordance with the contract documents.
2. The best quality and grade for the use intended.
3. New and unused.
4. The manufacturer's latest standard or current model.

C. All equipment and method shall be installed and connected in accordance with the best engineering practices and in accordance with the manufacturer's recommendations.

D. Mechanical work includes, but is not limited to:
1. Make arrangements with local utility company for services as shown or specified.
2. Obtain all permits and inspections including: Building permits, health department permits and sewer tap permits.
3. Disconnect, remove and re-install mechanical services located on or crossing through contract limits, above or below grade, obstructing construction of project or conflicting with completed project or any applicable codes.
4. Modify, extend or tie-into existing mechanical services or systems.
5. Complete alterations and additions to the domestic water distribution system.
6. Provide cutting of pavement, sidewalks, driveways, etc., excavating, trenching, shoring and de-watering. Provide backfill material and perform backfilling.
7. Restore site to original condition or new final grades. Provide paving, concrete, seed, or sod.
8. Complete alterations and additions to the domestic hot and cold water system. Provide sanitary rinse and flush.
9. Complete alterations and additions to the interior sanitary sewer.
10. Provide roofing including flashing, and counter flashing for roof mounted equipment; roof penetrations and supports for work in this Division, unless noted otherwise.

1.2 UTILITY CONNECTIONS

A. Arrange with local utility companies for utility service connections, taps, meters and installation. Pay all fees and charges (if any) necessary for the utility services shown on the drawings or listed in the specifications.

B. It is the responsibility of the Contractor to re-confirm with the Utility Companies, prior to bidding, that locations, arrangements, line sizes, pressures, interruptions, shut downs, etc. are in accordance with their regulations and requirements.

C. If the utility company requirements are at variance with these drawings and specifications, this Contractor shall include the utility company requirements in his work without additional cost to the Owner.

D. Obtain from Utility Company any additional charges for service of type, size and location called for. Include charges in bid to be paid by Contractor to appropriate party. Provide payment of these charges so as to allow logical progression of construction and avoid delay of completion.

E. Should cost above not be available prior to bid, submit with bid a letter signed by responsible Utility Company personnel stating that cost is not available. Prime Contractor shall submit letter with his bid to Owner. Cost will then be omitted from contract and become responsibility of Owner.

F. Furnish with shop drawings a signed document from each utility company describing location and type of service to be supplied and requirements for service. Document shall be signed by the appropriate responsible representative of the respective utility company.

1.3 WORK NOT INCLUDED

A. Electrical wiring and conduits shown on the electrical drawings.

B. Asbestos removal.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. Electrical: Division 26.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. Obtain and pay for all permits required for the work. Comply with all ordinances pertaining to work described herein.

B. Install the work under this Division in accordance with drawings and specifications and the standards and codes (latest edition) that apply to this work. In the event of a conflict, install work in accordance with the most stringent code requirements determined by Engineer.

C. Arrange, pay for and complete work to pass required tests by agencies having authority over work. Deliver to Engineer Certificates of Inspection and approval issued by authorities.

1.6 QUALIFICATION OF CONTRACTOR

A. Has completed minimum two projects same size and scope in past five (5) years.

B. This qualification applies to Sub-Contractors.

C. Use workmen experienced in their respective trade. Submit qualifications of Superintendent for review.

D. Owner reserves right to reject bid of any Contractor failing to meet these qualifications.

1.7 GENERAL JOB REQUIREMENTS

A. Drawings and Specifications:
   1. Drawings and specifications are complementary. Work called for by one is binding as if called for by both.
   2. Drawings are drawn to a small scale and are diagrammatic only. The drawings indicate size and general arrangement of equipment.
   3. Do not scale drawings for exact locations. Refer to dimensional plans. Field measurements take precedence.

B. Provide all necessary offsets, elbows and fittings in piping as required to avoid conflict with work of other trades. Maintain proper headroom and clear passageways to allow adequate access

and working clearances for equipment dampers, valves, etc. This shall be done at no additional cost to the Owner.

C. Visit to Site/Work in other Division:
1. Examine not only the plans and specifications for this Division, but plans and specifications of the other Divisions of work and visit the site to become acquainted with existing conditions. Execution of Contract is evidence that Contractor has examined all drawings and specifications, and that all conditions which have a bearing in any way on the manner of installing the work in this Division are known. Later claims for labor and materials required due to difficulties encountered will not be recognized.

D. Underground Utilities/Concealed Utilities:
1. All utilities and services, whether shown on the drawings or not, shall be suitably protected and maintained, and any damages thereto shall be promptly repaired. Owner shall be advised immediately of any damages sustained. If any extra expense is incurred due to the existence of buried utilities not shown on the drawings, or the location of which is not made known to the Contractor, the contract price shall be adjusted in accordance with the General Conditions. The Contractor shall advise the Owner three (3) days in advance of any operation which could possibly disrupt any underground utility. The Contractor shall utilize locator services to mark any underground utilities in the area he is working in, and shall make any other measure deemed necessary to avoid utility disruption.

E. Definitions:
1. Concealed: Materials or systems not visible. Work installed above a ceiling, furred behind a wall or enclosed in a chase.
2. Exposed: Materials or systems that is visible. Work installed in a room without a ceiling. Work not enclosed by walls.
3. Provide: Furnish, install and make complete.
4. Install: Receive, unload, move into place, and make connections.
5. Work: Materials completely installed and connected.
6. ADC: Air Diffusion Council.
7. AGA: American Gas Association.
8. AMCA: Air Movement and Control Association.
9. ANSI: American National Standard Institute.
10. API: American Petroleum Institute.
11. ARI: American Refrigeration Institute.
12. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
13. ASME: American Society of Mechanical Engineers.
14. ASTM: American Society of Testing Materials.
15. AWS: American Welding Society.
16. FM: Association of Factory Mutual Fire Insurance Company.
17. International: Building Code, Gas Code, Mechanical Code, Plumbing Code, Energy Code.
18. MSS: Manufacturer's Standard Society of the Valve and Fittings Industry, Inc.
19. NEC: National Electrical Code.
20. NEMA: National Electrical Manufacturer's Association.
21. NFPA: National Fire Protection Association.
22. NRCA: National Roofing Contractors Association.
23. NSF: National Sanitation Foundation.
24. OSHA: Occupational Safety and Health Act.
25. PDI: Plumbing Drainage Institute.
26. PFMA: Power Fan Manufactures Association.
27. SMACNA: Sheet Metal and Air Conditioning Contractors National Association.
28. UL: Underwriters Laboratories.

F. Workmanship, Warranty and Acceptance:
   1. Work under this Division shall be first class with emphasis on neatness and workmanship.
   2. Install work using competent mechanics, under supervision of foreman, all duly certified by local authorities. Installation subject to Engineer's observation, final approval, and acceptance. Engineer may reject unsuitable work.
   3. Furnish Engineer written warranty, stating that if workmanship and/or materials executed under this Division are proven defective within one (1) year after final acceptance, such defects and other work damaged will be repaired and/or replaced.
   4. In event that project is occupied or system placed in operation in several phases at Owner's request, warranty will begin on date each system or item of equipment is accepted by Owner.

G. Observations of Work and Demonstration of Operation:
   1. When observations are scheduled, provide sufficient personnel to expedite removal of access doors, cover plates, manholes covers, etc.
   2. Contractor to assist Engineer in demonstration of operation of new systems to satisfaction of Owner. Contractor to have manpower available for demonstration of systems where requested by Owner.

H. Materials and Substitutions:
   1. All materials shall be new. All materials and equipment, for which a UL Standard, an AGA approval, an AWWA standard, FM listing or ASME requirements is established, shall be so approved and labeled or stamped.
   2. Wherever in these specifications products are specified by manufacturer's name, bids shall be based on the named products. Where more than one manufacturer's name is mentioned, the one first listed establishes the standard for that product. If the bidder desires to submit a product of a manufacturer other that listed first, it must be the equivalent of the one listed first.
   3. The drawings are based on the use of products specified and listed first. If any revision in piping, ductwork, conduit work, foundations, anchor bolts, connections, etc., is required by other named products or approved substitutions, it shall be the Contractor's responsibility to make such revisions at no additional expense to the Owner.
   4. If any bidder desires to submit products of manufacturers not listed, he may submit a request for prior approval to the Engineer no later than 10 days prior to the bid date. If the Engineer decides to accept the manufacturers, they will be listed as "Approved" by written addendum.
   5. If the manufacturers are not listed as approved either by addendum or in the specifications, they will not be accepted.

I. Shop and Erection Drawings:
   1. Shop drawings shall be submitted on a timely basis to allow adequate lead time for review, resubmission if necessary, manufacture and delivery to allow access of material to project at correct time based on schedule established by Engineer/Contractor. On each shop drawing include the specification section that applies to that submittal. Include complete descriptive data with dimensions, operating data and weight for each item of equipment. Carefully examine shop drawings to assure compliance with drawings and specifications prior to submittal to Engineer. Shop drawings and submittals shall bear the stamp of approval of the Contractor as evidence that the drawings have been checked by him. Drawing submitted without this stamp of approval will not be considered and will be returned for proper resubmission.
   2. Drawings larger than 8-1/2" x 11", submit three (3) copies and one (1) reproducible of each drawing. Engineer will retain two (2) copies and return one (1) reproduction and one (1) copy to Contractor. Contractor is responsible for copying for distribution.

3. 8-1/2" x 11" drawings in brochure: Submit six (6) original copies for review. Engineer (and) Engineer will retain two (2) copies and return four (4) copies to Contractor. Division 01 "General Conditions" take precedence over this specification.
4. Review of shop drawings does not relieve Contractor of responsibility for errors and omissions in shop drawings. Contractor's responsible for meeting the requirements of the contract documents.
5. Contractor is responsible for dimensions and sizes of equipment. Inform Engineer in writing of equipment differing from that shown.
6. Prepare erection drawings when required by Engineer. Investigate thoroughly all conditions affecting work and indicate on drawing. Engineer will review erection drawings before work commences.

J. Operating and Maintenance Manuals:
1. Provide maintenance and operating manuals bound in 8-1/2" x 11" hardback, three-post binders. Manuals shall contain written instructions for each system, shop drawings, schematic drawings, equipment catalog cuts, manufacturer's instructions, manufacturer's warranties, and valve tag list.
2. Arrange information in the following sequence: title of job, Owner, address, date of submittal, name of Contractor, name of Engineer, index, shop drawings, operating instruction, Contractor's purchase order numbers, supplier's name and address, date of start-up of each piece of equipment and valve tag list.
3. Submit one (1) copy for review. Make required corrections, and submit two (2) record copies.

K. Record Drawings:
1. Provide Record Drawings as noted in Section 01 77 00.

1.8 PROTECTION AND STORAGE

A. Provide warning lights, bracing, shoring, rails, guards and covers necessary to prevent damage or injury.

B. Protect all equipment and materials, from damage by weather, entrance of water or dirt. Cap open piping, use plastic covers made for that purpose. Do not use rags or construction debris.

C. Avoid damage to materials and equipment in place. Repair, or remove and replace damaged work and materials.

D. Protect all surfaces from weld spatter, solder and cutting oil.

E. Deliver equipment and materials to job site in original, unopened, labeled container. Store to prevent damage and injury. Store ferrous materials to prevent rusting. Store finished materials and equipment to prevent staining and discoloring. Store materials affected by condensation in warm dry areas. Provide heaters. Storage space on site and in building designated by Owner/Engineer.

END OF SECTION

SECTION 22 05 29 PROCESS SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following hangers and supports for mechanical system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe positioning systems.
   7. Equipment supports.

B. Related Sections include the following:
   1. Section 23 31 13 – Metal Ducts
   2. Section 40 23 39 – Process Piping - General

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.3 REFERENCES

A. A. Manufacturer's Standardization Society (MSS):
   1. 1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.
   2. 2. SP-69 - Pipe Hangers and Supports - Selection and Application.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment.

D. Design Responsibility:
   1. The manufacturer of all pipe support systems, all pipe hangers systems, and preformed channel pipe support systems shall be considered the designer of the support systems.
   2. Prepare design calculations utilizing the design criteria included in these Specifications.
   3. Prepare detailed Shop Drawings illustrating the layout of the support system and identifying the components of the support system.

E. Design Criteria:
   1. Include live, dead, and seismic loads associated with piping, valves, and appurtenances. Consider the content of the pipes in load calculations.
   2. Minimum Gauge Thickness: 12 gauge.
   3. Allowable Stress of Channels:

a. a. Steel Channels: The lesser of 25,000 pounds per square inch, or 0.66 times yield stress of steel.
b. Stainless Steel Channels: 0.66 times the yield stress of the stainless steel alloy.

4. Maximum Deflection: 1/240 of span.
5. Allowable Column Loads: As recommended by manufacturer in published instruction for column's unsupported height and "K" value for calculating effective column length of not less than 1.0.
6. Future Loads:
   a. Support systems indicated on the Drawings may include spaces intended to accommodate future pipes.
   b. Assume such spaces are occupied by 6-inch diameter ductile iron pipes. Only the number of pipes that would physically fit into the space need be considered.
   c. Include the weight of the pipe contents in determining future loads. Assume pipe contents are water.
7. Seismic Design Criteria: As specified in Section 01612 as specified for mechanical equipment.
8. Spacing of Supports: As required to comply with design requirements but not more than 5 feet.

F. Supports below the top of walls of water bearing structures: Use Type 316 stainless steel for support system components.
   1. Supports in other locations: Use hot-dipped galvanized components unless other materials are specifically indicated on the Drawings.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Pipe positioning systems.
   4. Non-metallic pipe hangers and supports.

B. Shop Drawings:
   1. Show fabrication and installation details and include calculations for the following:
      a. Trapeze pipe hangers. Include Product Data for components.
      b. Metal framing systems. Include Product Data for components.
      c. Equipment supports.
   2. Drawings of piping support system, locating each support, brace, hanger, guide, component and anchor. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
   3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

C. Welding certificates.

D. Contract Closeout Submittals: Maintenance information on piping support system.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel and ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."

3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
5. ASME Boiler and Pressure Vessel Code: Section IX.

C. Design Preformed Channel Pipe Support System for Loads in Accordance with Applicable Provisions of:
1. AISC Manual of Steel Construction.
2. AISI Cold-Formed Steel Design Manual.

D. Product Standards:
1. Pipe Support Components: Conform to MSS SP-69.
2. Pipe Support Materials: Conform to MSS SP-58.

1.7 DESIGN REQUIREMENTS

A. General:
1. Contractor shall be responsible for the design, size, and location of process piping support systems in accordance with the requirements specified herein and in general conformance with the Drawings and the Design Details. The design shall be provided by a company specifically specializing in the design of support systems. The pipe support system design company shall demonstrate that they have at least five years of experience in pipe support design and have successfully completed at least three designs in the previous year. The Contractor shall provide Certification of Compliance with these requirements.
1. Seismic Load: See Specification Section 01 81 02 and structural notes found on the Drawings.
2. Piping smaller than 30": Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Piping 30" and larger: Support systems have been designed for piping shown.
4. Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89.

B. Pipe Support Systems:
1. Support Load: Dead loads imposed by weight of pipes filled with water, except air and gas pipes, plus insulation and capable of supporting combined weight of supported systems, system contents, and test water.
2. Safety Factor: Minimum of 5.
3. Maximum Support Spacing and Minimum Rod Size:
a. Steel or Ductile Iron Piping:

Pipe Size	**Maximum Support/ Hanger Spacing**	**Minimum Rod Size Single Rod Hangers**
1-inch & smaller	6 feet	1/4-inch
1-1/2-inch thru	8 feet	1/4-inch
2-1/2-inch		
3-inch & 4-inch	10 feet	3/8-inch
6-inch	12 feet	3/8-inch
8-inch	12 feet	1/2-inch
10-inch & 12-inch	14 feet	5/8-inch
14-inch	16 feet	3/4-inch
16-inch & 18-inch	16 feet	7/8-inch

Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
20-inch	18 feet	1-inch
24-inch	18 feet	1-1/4-inch
30-inch & larger	As shown on Drawings	As shown on Drawings

b. Copper Piping:
Maximum Support Spacing: 2 feet less per size than listed for steel pipe, with 1" and smaller pipe supported every 5 feet.
Minimum Hanger Rod Sizing: Same as listed for steel pipe.

c. Plastic and Fiberglass Piping:
Maximum support spacing: As recommended by manufacturer for flow temperature in pipe.
Minimum Hanger Rod Sizing: Same as listed for steel pipe.

d. Stainless Steel Piping:

SST Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
1-inch thru 4-inch	8 feet	1/4-inch
6-inch	8 feet	3/8-inch
8-inch & 10-inch	10 feet	1/2-inch
12-inch	10 feet	1/2-inch
14-inch & 16-inch	12 feet	5/8-inch
18-inch & 20-inch	14 feet	3/4-inch
24-inch	14 feet	7/8-inch

C. Framing Support System:
1. Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
2. Column Members: Size in accordance with Manufacturer's recommended method.
3. Support Loads: Calculate using weight of pipes filled with water.
4. Maximum Spans:
   a. Steel and Ductile Iron Pipe, 3" Diameter and Larger: 10-foot centers, unless otherwise shown.
   b. Other Pipelines and Special Situations: May require supplementary hangers and supports.
5. Electrical Conduit Support: Include in design of framing support system.

D. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

E. Vertical Sway Bracing: 10-foot maximum centers, or as shown.

F. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show that they are adequate for additional load, or if they are strengthened to support the additional load.

PART 2 - PRODUCTS

2.1 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.

B. Special support and hanger details are shown for cases where standard catalog supports are inapplicable.

C. Materials:
1. Wetted and Submerged: Stainless steel.
2. Atmospheric Exposed: Galvanized or painted steel in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.
3. Corrosive Areas: FRP
4. Stainless Steel (Type 304 or 316): Use in all submerged locations, above water level but below top of wall inside water bearing structures, and where specifically indicated on the Drawings:
   a. Shop-Fabricate: At the shop, perform pickling and passivation on all surfaces inside and out.
   b. Field welding is prohibited.
5. Hot-Dip Galvanized Steel: Use in areas other than above and where specifically indicated on the Drawings. Hot-dip galvanize pipe supports after fabrication.
6. Plastic, aluminum, FRP, and other miscellaneous materials: Use where specifically indicated on the Drawings.
7. Non-metallic pipe support systems shall be used in areas where exposed to reactive chemicals such as chemical pumping area and chemical storage area.
8. Fiberglass Resin: Corrosion resistant premium grade vinylester.
9. Injection Molded Components: Polyurethane thermoplastics.
10. Flame Spread of Fiberglass:
    a. Vinylester Fiberglass (Series VF): Class 1, ASTM E 84.
    b. Polyurethane: V-O UL 94V.
11. Physical Properties of Fiberglass:

	Longitudinal	Transverse
Tensile Strength	37,500 pounds per square inch, (psi)	10,000 pounds per square inch, (psi)
Tensile Modules	3.0 X 10^6 psi	1.0 X 10^6 psi
Flexural Strength	37,500 psi	14,000 psi
Flexural Modules	2.0 X 10^6 psi	1.0 X 10^6 psi
Compressive Strength	37,500 psi	20,000 psi
Shear Strength	6,000 psi	5,500 psi
Izod Impact	30 foot-pounds per square inch	5 foot-pounds per square inch

12. Surface Veil: Fiberglass channel shall have polyester surface veil over 100 percent of the surface to provide protection against degradation from ultraviolet light.
13. Touch-Up Resin:
    a. Manufacturers: One of the following or equal:
       1) Krylon, 7006-Satin Polyurethane Clear Finish.

2.2 MANUFACTURERS

A. The following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering products that may be incorporated into the Work include, but are not limited to, Manufacturers specified.

2.3 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. Empire Industries, Inc.
   3. ERICO/Michigan Hanger Co.
   4. Globe Pipe Hanger Products, Inc.
   5. Grinnell Corp.
   6. GS Metals Corp.
   7. National Pipe Hanger Corporation.

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.4 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. Power-Strut Div.; Tyco International, Ltd.
   3. Thomas & Betts Corporation.
   4. Tolco Inc.
   5. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. Clevis or Band Hangers: Insert and shield shall cover lower 180° of pipe.

G. Insert Length: Extend 2" beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. Masterset Fastening Systems, Inc.
   d. MKT Fastening, LLC.
   e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
   a. B-Line Systems, Inc.; a division of Cooper Industries.
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2.8 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:
1. C & S Mfg. Corp.
2. HOLDRITE Corp.; Hubbard Enterprises.
3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

2.11 PREFORMED CHANNEL PIPE SUPPORT SYSTEM

A. Fabricate preformed channel pipe support system using, as a minimum, parts specified below and meeting the requirements specified under Design Criteria.
   1. Manufacturers: One of the following or equal:
      a. Unistrut, Series P1000 or P1001; P5500 or P5501.
      b. Allied Support Systems, Power Strut, Figure PS-200 or PS-200 2TS; PS-150 or PS-150 2TS.
      c. B-Line Systems, Inc., Channel Type B22 or B22A; B12 or B12A.

B. Preformed Channel Concrete Inserts: Minimum 12 inches long.
   1. Manufacturers: One of the following or equal:
      a. Unistrut, Series P-3200.
      b. Allied Support Systems, Figure 282.
      c. B-Line Systems, Series B32I.

C. 90-Degree Angle Fittings:
   1. Manufacturers: One of the following or equal:
      a. Unistrut, P1026.
      b. Allied Support Systems, Power Strut, P603.

D. Pipe Straps:
   1. For Pipes 8 Inches in Diameter and Smaller: Use 2-piece universal strap with slotted hex head screw and nut.
      a. Manufacturers: One of the following or equal:
         1) 1) Unistrut, Series P1109 through P1126.
         2) 2) Allied Support Systems, PS1100.
         3) 3) B-Line Systems, Inc., Series B2000.
   2. For Pipes Greater Than 8 Inches in Diameter: Unless different material is otherwise indicated on the Drawings use 1-piece 1 inch wide by 1/8 inch thick steel strap, hot-dip galvanized after fabrication.
   3. For Stainless Steel Pipes: Use type of strap required for the pipe sizes specified above, but use Type 316 stainless steel materials.

E. Touch-Up Paint Galvanized Surfaces:
   1. Manufacturers: One of the following or equal:
      a. Galvinox, Galvo-Weld.

F. Touch-Up Paint for Painted Surfaces: Same formulation as factory paint.

G. Hot-dip galvanize support system components after fabrication to required length and shape.

H. Do not galvanize or paint stainless steel components.

2.12 NON-METALLIC PIPE SUPPORT SYSTEM

A. Manufacturers:
1. StrutTech, Redmond, Washington.
2. Unistrut, Wayne, Michigan.

B. Supply all materials from a single manufacturer with sole responsibility for the pipe support system.

C. The supplied system, including pipe clamps, shall be interchangeable with industry standard 1-5/8 inch steel and fiberglass channel framing systems.

D. Channel Framing:
1. All channel framing shall be supplied with integral notches 1 inch on center.
2. Locate notches on interior flange to prevent slippage of pipe clamps and fittings after installation.

E. Pipe Clamps:
1. Adjustable Type: Non-metallic and non-conductive.
2. Fixed Type:
   a. Pipe clamps for pipe less than 6 inches in diameter shall be non-metallic and non-conductive.
   b. Pipe clamps for pipe equal to and greater than 6 inches in diameter shall be fiberglass.

F. Channel Fittings:
1. Make fittings and post bases from glass-filled polyurethane or polyester.

G. Fasteners:
1. Make fasteners from one of the following materials:
   a. Glass-filled polyurethane.
   b. Vinylester fiberglass.

PART 3 - EXECUTION

3.1 GENERAL

A. Install support systems in accordance with MSS SP 69, Pipe Hangers and Supports-Selection and Application and MSS SP 89, Pipe Hangers and Supports-Fabrication and Installation, unless shown otherwise.

B. Support piping connections to equipment by pipe support and not by the equipment.

C. Support large or heavy valves, fittings, and appurtenances independently of connected piping.

D. Support no pipe from the pipe above it.

E. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

F. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

G. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing.

H. Install lateral supports for seismic loads at all changes in direction.

I. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.

J. Repair mounting surfaces to original condition after attachments are made.

3.2 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 °F pipes, NPS 4 to NPS 16, requiring up to 4" of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4" of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated stationary pipes, NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 8.
9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes, NPS 1/2 to NPS 2.
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 8.
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes, NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6" for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 °F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 °F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4".
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.3 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Fiberglass Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4" thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool Manufacturer. Install fasteners according to powder-actuated tool Manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to Manufacturer's written instructions.

G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

O. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
      c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
   2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180°.
      a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
   4. Shield Dimensions for Pipe: Not less than the following:
      a. NPS 1/4 to NPS 3-1/2: 12" long and 0.048" thick.
      b. NPS 4: 12" long and 0.06" thick.
      c. NPS 5 and NPS 6: 18" long and 0.06" thick.
      d. NPS 8 to NPS 14: 24" long and 0.075" thick.
      e. NPS 16 to NPS 24: 24" long and 0.105" thick.
   5. Pipes NPS 8 and Larger: Include wood inserts.
   6. Insert Material: Length at least as long as protective shield.
   7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.4 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.5 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and 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. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.6 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2".

3.7 PAINTING

A. Paint exposed surfaces immediately after erecting hangers and supports as specified in Section 09 90 00, PROTECTIVE PAINTING AND COATINGS.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 22 05 53 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Extent of mechanical identification work required by this section is indicated on drawings and/or specified in other sections.

B. Types of identification devices specified in this section include the following:
1. Painted Identification Materials.
2. Equipment Labels.
3. Plastic Pipe Markers.
4. Plastic Tape.
5. Underground-Type Plastic Line Marker.
6. Valve Tags.
7. Valve Schedule Frames.
8. Engraved Plastic-Laminate Signs.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

A. Product Data: Submit Manufacturer's technical product data and installation instructions for each identification material and device required.

B. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate the valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

C. Maintenance Data: Include product data and schedules in maintenance manuals; in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering mechanical identification materials which may be incorporated in the work include; but are not limited to, the following:
1. Allen Systems, Inc.
2. Brady (W.H.) Co.; Signmark Div.
3. Industrial Safety Supply Co., Inc.
4. Seton Name Plate Corp.

2.2 MECHANICAL IDENTIFICATION MATERIALS

A. General: Provide Manufacturer's standard products of categories and types required for each application as referenced in other sections. Selection is Installer's option where more than a single type is specified for applications but provide single selection for each product category.

2.3 PAINTED IDENTIFICATION MATERIALS

A. Stencils: Standard fiberboard stencils, prepared for required applications with letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 1-1/4" high letters for ductwork and not less than 3/4" high letters for access door signs and similar operational instructions.

B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, complying with ANSI A13.1 and/or Owner Selection for colors.

D. See Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

2.4 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Fasteners: Stainless-steel rivets or self-tapping screws
5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.5 PLASTIC PIPE MARKERS

A. Snap-On Type: Provide Manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.

B. Pressure-Sensitive Type: Provide Manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.

C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on un-insulated pipes subjected to fluid temperatures of 125 °F (52 °C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
1. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360° around pipe at each location, fastened by one of the following methods:
   a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
   b. Adhesive lap joint in pipe marker overlap.
   c. Laminated or bonded application of pipe marker to pipe (or insulation).
   d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

2. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:
   a. Laminated or bonded application of pipe marker to pipe (or insulation).
   b. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".
   c. Trapped-to-pipe (or insulation) application of semi-rigid type, with Manufacturer's standard stainless steel bands.

D. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with name as shown or specified.
   1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.6 PLASTIC TAPE

A. General: Provide Manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.

C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.7 UNDERGROUND-TYPE PLASTIC LINE MARKERS

A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

B. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.8 VALVE TAGS

A. Brass Valve Tags: Provide 19-gauge polished brass valve tags, with a stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
   1. Provide 1-1/2" diameter tags, except as otherwise indicated.
   2. Provide size and shape as specified or scheduled for each piping system.
   3. Fill tag engraving with black enamel.

B. Plastic Laminate Valve Tags: Provide Manufacturer's standard 3/32" thick engraved plastic laminate valve tags, with piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.
   1. Provide 1-1/2" sq. black tags with white lettering, except as otherwise indicated.
   2. Provide size, shape and color combination as specified or scheduled for each piping system.

C. Valve Tag Fasteners: Provide Manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

D. Access Panel Markers: Provide Manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.9 VALVE SCHEDULE FRAMES

A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.10 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.11 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

B. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:
   1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2" beyond ends of lettering.
   2. Stenciled markers, with lettering color complying with ANSI A13.1.
   3. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.
   4. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.
   5. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.
      a. Near each valve and control device.
      b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
      c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
      d. At access doors, manholes and similar access points which permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination.
      f. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
      g. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.5 UNDERGROUND PIPING IDENTIFICATION

A. General: During back-filling/top-soiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.6 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Contracting Officer.

C. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.7 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.8 EXTRA STOCK

A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

B. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION

SECTION 22 07 19 – PLUMBING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Plumbing piping insulation, jackets and accessories.
   2. Plumbing equipment insulation, jackets and accessories.

1.2 REFERENCES

A. Comply with appropriate standards
   1. Americans with Disabilities Act (ADA)
   2. ASTM International (ASTM)
      a. ASTM A240/A240M - Standard Specification for Chromium and Chromium- Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      b. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      c. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
      e. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic- Setting Thermal Insulating and Finishing Cement.
      f. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
      g. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      h. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      i. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
      j. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
      k. ASTM C578 - Standard Specification, Cellular Polystyrene Thermal Insulation.
      l. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
      m. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
      n. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
      o. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
      p. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
      q. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
      r. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
      s. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
      t. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
      u. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
      v. ASTM E223 – Standard Test Methods for Analysis of Sulfuric Acid.

1.3 SUBMITTALS

A. Product Data: Submit product description, thermal characteristics and list of materials and thickness and jackets for each service, and location.

B. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. LEED Submittal:
1. Product data for credit EQ4.1: For adhesives and sealants, including printed statement of VOC content.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by ENGINEER. Use materials indicated for the completed Work.
1. Piping Mockups:
   a. One 10-foot section of NPS 2 straight pipe.
   b. One each of a 90-degree threaded, welded, and flanged elbow.
   c. One each of a threaded, welded, and flanged tee fitting.
   d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
   e. Four support hangers including hanger shield and insert.
   f. One threaded strainer and one flanged strainer with removable portion of insulation.
   g. One threaded reducer and one welded reducer.
   h. One pressure temperature tap.
   i. One mechanical coupling.
2. Equipment Mockups: One tank or vessel.
3. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
4. Notify ENGINEER seven days in advance of dates and times when mockups will be constructed.
5. Obtain ENGINEER's approval of mockups before starting insulation application.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless ENGINEER specifically approves such deviations in writing.
7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed.

1.5 WARRANTY

A. Furnish one-year minimum.

B. Furnish five year manufacturer warranty for man-made fiber.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering products that may be incorporated into the Work include, but are not limited to, Manufacturers specified for glass fiber and mineral fiber insulation products:
      a. CertainTeed
      b. Johns Manville
      c. Owens-Corning

2.2 PIPE INSULATION

A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Operating Temperature Range: 0 to 850 degrees F.
   3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F.

B. TYPE P-2: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.23 at 75 degrees F.
   2. Operating Temperature Range: 0 to 850 degrees F.

C. TYPE P-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: 0 to 650 degrees F.
   3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
   4. Jacket Temperature Limit: minus 20 to 150 degrees F.

D. TYPE P-4: ASTM C612; semi-rigid, fibrous glass board noncombustible. Conform to ASTM C795 for application on Austenitic stainless steel.
   1. Thermal Conductivity: 0.27 at 75 degrees F.

E. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.27 at 75 degrees F.
   2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

F. TYPE P-6: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
   1. Thermal Conductivity: 0.30 at 75 degrees F.
   2. Maximum Service Temperature: 300 degrees F.
   3. Operating Temperature Range: Range: Minus 58 to 300 degrees F.

G. TYPE P-7: ASTM C534, Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.

1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Maximum Service Temperature: 250 degrees F.
3. Operating Temperature Range: Range: Minus 58 to 250 degrees F.

H. TYPE P-8: ASTM C547, Type I or II, mineral fiber preformed pipe insulation, noncombustible.
1. Thermal Conductivity: 0.23 at 75 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Canvas Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric treated with fire retardant lagging adhesive.

I. TYPE P-9: ASTM C591, Type IV, polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.
1. Density: 4.0 pounds per cubic foot.
2. Thermal Conductivity: 180 day aged value of 0.19 at 75 degrees F.
3. Operating Temperature Range: Range: Minus 297 to 300 degrees F.
4. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 mils thickness and water vapor permeance of 0.02 perms.

J. TYPE P-10: ASTM C578, Type XIII, extruded polystyrene insulation, formed into shapes for use as pipe insulation.
1. Thermal Conductivity: 180 day aged value of 0.259 at 75 degrees F.
2. Operating Temperature Range: Range: Minus 297 to 165 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied film of 4 mils thickness and water vapor permeance of 0.02 perms.

K. TYPE P-11: ASTM C533; Type I, hydrous calcium silicate pipe insulation, rigid molded white; asbestos free.
1. Thermal Conductivity: 0.45 at 200 degrees F.
2. Operating Temperature Range: 140 to 1200 degrees F.

2.3 PIPE INSULATION JACKETS

A. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

B. PVC Plastic Pipe Jacket:
1. Product Description: ASTM D1785, one piece molded type fitting covers and sheet material, off-white color.
2. Thickness: 30 mil.
3. Connections: Brush on welding adhesive with VOC content of 50 g/l according to CFR 59, Subpart D (EPA Method 24).

C. ABS Plastic Pipe Jacket:
1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
2. Minimum service temperature: -40 degrees F.
3. Maximum service temperature of 180 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 30 mil.
6. Connections: Brush on welding adhesive.
7. Connections: Brush on welding adhesive with VOC content of 50 g/l according to CFR 59, Subpart D (EPA Method 24).

D. Aluminum Pipe Jacket:
1. ASTM B209.

2. Thickness: 0.020 inch thick sheet.
3. Finish: Smooth Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.2 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 1/2 inch wide; 0.015 inch thick aluminum. 0.020 inch thick stainless steel.

E. Stainless Steel Pipe Jacket:
1. ASTM A240/A240M OR ASTM 666 Type 304 stainless steel.
2. Thickness: 0.016 inch thick.
3. Finish: Smooth.
4. Metal Jacket Bands: 1/2 inch wide; 0.020 inch thick stainless steel.

F. Field Applied Glass Fiber Fabric Jacket System:
1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:
   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Blanket: 1.0 lb/cu ft density.
3. Indoor Vapor Retarder Finish:
   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.4 PIPE INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.

D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.

E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum single piece construction with self-adhesive closure. Thickness to match pipe insulation.

F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.

I. Adhesives: Compatible with insulation.

2.5 EQUIPMENT INSULATION

A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
1. Thermal Conductivity: 0.24 at 75 degrees F.
2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 1.65 pound per cubic foot.

B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft reinforced aluminum foil jacket.
1. Thermal Conductivity: 0.24 at 75 degrees F.

2. Operating Temperature Range: 0 to 450 degrees F.
3. Density: 3.0 pound per cubic foot.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

C. TYPE E-3: ASTM C612; semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.
3. Vapor Barrier Jacket: ASTM C1136, Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.
4. Jacket Temperature Limit: minus 20 to 150 degrees F.

D. TYPE E-4: ASTM C612; semi-rigid, fibrous glass board noncombustible.
1. Thermal Conductivity: 0.27 at 75 degrees F.
2. Operating Temperature Range: 0 to 650 degrees F.

E. TYPE E-5: ASTM C612, man-made mineral fiber, noncombustible, Classes 1-4.
1. Thermal Conductivity: 0.25 at 100 degrees F.
2. Maximum Service Temperature: 1200 degrees F.
3. Density: 4 pound per cubic foot.

2.6 EQUIPMENT INSULATION JACKETS

A. PVC Plastic Equipment Jacket:
1. Product Description: ASTM D1785, sheet material, off-white color.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 150 degrees F.
4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
5. Thickness: 30 mil.
6. Connections: Brush on welding adhesive with VOC content of 50 g/l according to CFR 59, Subpart D (EPA Method 24).

B. Aluminum Equipment Jacket:
1. ASTM B209.
2. Thickness: 0.020 inch thick sheet.
3. Finish: Embossed.
4. Joining: Longitudinal slip joints and 2 inch laps.
5. Fittings: 0.02 inch thick die shaped fitting covers with factory attached protective liner.
6. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum. 0.020 inch thick stainless steel.

C. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

D. Vapor Retarder Jacket:
1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

E. Field Applied Glass Fiber Fabric Jacket System:
1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
2. Glass Fiber Fabric:
   a. Cloth: Untreated; 9 oz/sq yd weight.
   b. Blanket: 1.0 lb/cu ft density.
3. Indoor Vapor Retarder Finish:
   a. Cloth: Untreated; 9 oz/sq yd weight.

b. Vinyl emulsion type acrylic, compatible with insulation, black white color.

2.7 EQUIPMENT INSULATION ACCESSORIES

A. Vapor Retarder Lap Adhesive: Compatible with insulation.

B. Covering Adhesive Mastic: Compatible with insulation.

C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.

E. Adhesives: Compatible with insulation.

2.8 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.
1. Manufacturers:
   a. Childers Products, Division of ITW; CP-97.
   b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.
   c. Marathon Industries, Inc.; 290.
2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
1. Products: Subject to compliance with requirements, provide one of the following available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Products, Division of ITW; CP-96.
   b. Foster Products Corporation, H. B. Fuller Company; 81-33.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Manufacturers:
   a. Aeroflex USA Inc.; Aeroseal.
   b. Armacell LCC; 520 Adhesive.
   c. Foster Products Corporation, H. B. Fuller Company; 85-75.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers:
   a. Childers Products, Division of ITW; CP-82.
   b. Foster Products Corporation, H. B. Fuller Company; 85-20.
   c. Marathon Industries, Inc.; 225.
2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Manufacturers:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. Marathon Industries, Inc.; 225.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

G. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Manufacturers:
      a. Dow Chemical Company (The); 739, Dow Silicone.
      b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. Speedline Corporation; Speedline Vinyl Adhesive.
   2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.9 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content that meets the requirement of the South Coast Air Quality Management District Rule #1168. VOC limits to be per amendment date 1/7/05.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Manufacturers:
      a. Childers Products, Division of ITW; CP-35.
      b. Foster Products Corporation, H. B. Fuller Company; 30-90.
      c. Marathon Industries, Inc.; 590.
   2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.
   4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
   5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
   1. Manufacturers:
      a. Childers Products, Division of ITW; CP-30.
      b. Foster Products Corporation, H. B. Fuller Company; 30-35.
      c. Marathon Industries, Inc.; 501.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   3. Service Temperature Range: 0 to 180 deg F.
   4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   1. Manufacturers:
      a. Childers Products, Division of ITW; Encacel.
      b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
      c. Marathon Industries, Inc.; 570.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   3. Service Temperature Range: Minus 50 to plus 220 deg F.
   4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   5. Color: White.

6. For outdoor aluminum finish, use 60-39 mastic.

2.10 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products - Manufacturers:
   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.
   c. Marathon Industries, Inc.; 405.
2. Joint Sealant for Polystyrene Products - Manufacturers:
   a. Childers Products, Division of ITW; CP-70.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45/30-46.
   c. Marathon Industries, Inc.; 405.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:
1. Manufacturers:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Manufacturers:
   a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.11 FIELD APPLIED FABRIC-REINFORCING MASH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
1. Manufacturers:
   a. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
1. Manufacturers:
   a. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for equipment and pipe.
   1. Manufacturers:
      a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.12 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd..
   1. Manufacturers:
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.13 SECUREMENTS

A. Bands:
   1. Manufacturers:
      a. Childers Products; Bands.
      b. PABCO Metals Corporation; Bands.
      c. RPR Products, Inc.; Bands.
   2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with closed seal.
   3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with closed seal.
   4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
   5. Copper clad annealed steel wire having a minimum 16 gauge thickness.

B. Insulation Pins and Hangers:
   1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.
      a. Manufacturers:
         1) AGM Industries, Inc.; CWP-1.
         2) GEMCO; CD.
         3) Midwest Fasteners, Inc.; CD.
   2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
      a. Manufacturers:
         1) AGM Industries, Inc.; CWP-1.
         2) GEMCO; Cupped Head Weld Pin.
         3) Midwest Fasteners, Inc.; Cupped Head.
   3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
      a. Manufacturers:
         1) AGM Industries, Inc.; RC-150.
         2) GEMCO; R-150.
         3) Midwest Fasteners, Inc.; WA-150.
      b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
   4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
      a. Manufacturers:

1) GEMCO.
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.080-inch nickel-copper alloy.
1. Manufacturers:
a. C & F Wire.
b. Childers Products.
c. PABCO Metals Corporation.

2.14 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 INSTALLATION - PIPING SYSTEMS

A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.

B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. For penetrations of assemblies with fire resistance rating greater than one hour. See all sections in Division.

C. Piping Systems Conveying Fluids Below Ambient Temperature:
1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

D. Glass Fiber Board Insulation:
1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

E. Polyisocyanurate Foam Insulation Extruded Polystyrene Insulation:
1. Wrap elbows and fitting with vapor retarder tape.
2. Seal butt joints with vapor retarder tape.

F. Hot Piping Systems 140 degrees F or less:
   1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
   3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

G. Inserts and Shields:
   1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
   2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
      a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
      b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
   3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

H. Insulation Terminating Points:
   1. Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the control valve.
   2. Condensate Piping: Insulate entire piping system and components to prevent condensation.

I. Closed Cell Elastomeric Insulation:
   1. Push insulation on to piping.
   2. Miter joints at elbows.
   3. Seal seams and butt joints with manufacturer's recommended adhesive.
   4. When application requires multiple layers, apply with joints staggered.
   5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.

K. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.

L. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

M. Heat Traced Piping Interior to Building: As recommended by Heat Trace System Manufacturer.

N. Heat Traced Piping Exterior to Building: As recommended by Heat Trace System Manufacturer.

O. Prepare pipe insulation for finish painting.

3.2 INSTALLATION - EQUIPMENT

A. Factory Insulated Equipment: Do not insulate.

B. Exposed Equipment: Locate insulation and cover seams in least visible locations.

C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

D. Equipment Containing Fluids Below Ambient Temperature:
1. Insulate entire equipment surfaces.
2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
4. Finish insulation at supports, protrusions, and interruptions.

E. Equipment Containing Fluids 140 degrees F Or Less:
1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
3. Finish insulation at supports, protrusions, and interruptions.

F. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

G. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal equipment.

H. Cover insulation with aluminum jacket.

I. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.

J. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

K. Prepare equipment insulation for finish painting.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies.

3.4 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Domestic Hot Water Supply and Recirculation	P-1	1-1/4 inches and smaller 1-1/2 inches and larger	1.0 2.0
Domestic Hot Water Supply and Recirculation systems with domestic water temperature maintenance cable	P-1	1 inch and smaller 1-1/4 inches to 2 inches 2-1/2 inches and larger	1.0 1.5 2.0
Domestic Cold Water (Exposed)	P-1 or P-5	1-1/4 inches and smaller 1-1/2 inches and larger	0.75 1.0
Deionized Water	P-1 or P-5	All sizes	1.0

B. Drainage Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches

Storm Piping (horizontal above ground within building)	P-1 or P-5	All sizes	1.0
Sanitary Sewer Piping (Exposed)	P-1 or P-5	All sizes	1.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Roof Drain Bodies	E-2	1.0
Domestic Hot Water Storage Tanks	E-1 E-2	2.0
Domestic Water Storage Tanks	E-1, E-2,	2.0
Domestic Water Booster Pump Bodies	E-5	1.0
Water Softeners and Tanks	E-1, E-2,	2.0

3.5 DOMESTIC WATER HEAT EXCHANGER INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation shall be the following:
1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

B. Round, concealed breeching and connector insulation shall be the following:
1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

C. Rectangular, exposed breeching and connector insulation shall be the following:
1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

D. Rectangular, concealed breeching and connector insulation shall be the following:
1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

3.6 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Grease Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches thick.

3.7 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

SECTION 22 11 00 - VALVES, HYDRANTS AND ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Valves
   2. Fire Hydrants
   3. Valve Boxes
   4. Related Items

B. Related sections:
   1. Section 40 23 39: Process Piping – General
   2. Section 40 23 43: Process Valves
   3. Section 40 24 00: Process Piping Specialties
   4. Section 40 92 16: Valve and Gate Operators

1.2 QUALITY CONTROL

A. Supervision:
   1. Provide full time supervisor trained and familiar with the work to be undertaken.

B. Workmanship:
   1. All workmen shall be skilled and experienced in the specified work.

1.3 SUBMITTALS

A. Original drawings, prepared by Contractor, subcontractor, supplier or distributor, which illustrate some portion of the Work; showing fabrication, layout, setting or erection details.

B. Identify details by reference to sheet and detail numbers shown on Contract Drawings.

C. Reproductions for submittals:
   1. Opaque diazo prints or blueprints.

D. Manufacturer's standard schematic drawings:
   1. Modify drawings to delete information which is not applicable to project.
   2. Supplement standard information to provide additional information applicable to project.

E. Manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations, and other standard descriptive data.
   1. Clearly mark each copy to identify pertinent materials, products or models.
   2. Show dimensions and clearances required.
   3. Show performance characteristics and capacities.
   4. Show wiring diagrams and controls.

PART 2 - PRODUCTS

2.1 VALVES

A. Gate valves 16 inches and smaller:

1. All gate valves shall comply with requirements of "Standard Specifications for Resilient Seated Gate Valves for Ordinary Water Works Service" AWWA C509 except as amended herein. All valves shall be resilient seated wedge type.
2. All gate valves unless noted otherwise on the plans shall have ends of standard mechanical joints conforming to ASA Spec. A21.11. Flanged end valves shall conform to ASA Spec. B16.1.
3. All gate valves shall be mounted in the line in a vertical position unless noted otherwise on the plans.
4. All gate valves shall be provided with "O" rings for sealing of the valve stem.
5. All gate valves shall be equipped with 2 inch square operating nuts. Valves shall close on clockwise rotations.
6. All valves shall be designed for operation at a working pressure of not less than 200 psi.

B. Butterfly valves 18 inches and larger:
1. Butterfly valves for buried service shall be furnished to meet AWWA C504 Class 150B requirements.
2. Materials shall be:
   a. Body - Cast Iron ASTM A126, Class B.
   b. Shaft - Stainless Steel 18-8, Type 304
   c. Disc - Iron for AWWA 150B Service.
   d. Seat - Buna-N rubber stainless steel trimmed.
3. Operator:
   a. Buried valves shall be equipped with a suitably sized gear actuator and 2 inch square nut operator. The body shall have mechanical joint ends. Retainer glands are to be used when installed on DIP.

2.2 FIRE HYDRANTS

A. All fire hydrants shall comply with requirements of "AWWA Standard for Fire Hydrants for Ordinary Water Works Service" C502 except as amended herein.

B. All hydrants shall have replaceable "breakable" sections. Hydrants shall be compression type closing with line pressure. Hydrants shall have inlet connection of 6 inch size with standard flange connection for direct bolting to auxiliary gate valve.

C. All hydrants shall have two hose outlets with National Standard 2-1/2 inch hose threads, and on 4-1/2 inch steamer connection with National Standard threads. Operating nut shall conform to National Standard measurements.

D. Valve opening shall be 5-1/4 inch.

E. Hydrant valve shall open on counter-clockwise rotation of the operating nut.

F. Hydrants shall be painted a finish coat of red above the ground line.

G. Burial depths for hydrants will and may vary, but shall not be less than 4 feet. The steamer connection shall not be less than 12 inches nor greater than 24 inches above finish grade. The contractor shall furnish and install all spool pieces as may be necessary to adjust hydrants to the proper height.

2.3 VALVE BOXES

A. Traffic areas:
1. Valve boxes shall be Clay & Bailey, or equal, three-piece, slip type 5-1/4 inch shaft for roadway service. Cover shall have the word "Water" cast on its top.

B. Non-traffic areas:
   1. Use 6 inch PVC C1.160 and extend 24 inches above grade. Install Clay and Bailey 2194 cover and 1108 lid.

2.4 TAPPING SLEEVES

A. Tapping sleeves shall be as manufactured by the Mueller Co. or M & H Valve & Fitting Co. for 150 psi working pressure. Sizes and number shall be as indicated on the plans. Joints shall be mechanical joint suitable for the pipe to be tapped. Outlet shall be flanged ASA B 16.1.

B. Valves for tapping sleeves shall be as per 2.01 A in this section except that end connection shall be flanged and mechanical joint.

2.5 AIR RELEASE VALVES

A. The air release valve shall operate (open) while pressurized, allowing entrained air to escape from the water pipeline, pump or reservoir tank, thru the air release orifice. After entrained air escapes thru the air release orifice, the valve orifice shall be closed by a needle mounted on the compound lever mechanism, energized by a CONCAVE FLOAT to prevent water from escaping. The air release valve will then stay closed until more air accumulates in it and the opening cycle will repeat automatically.

B. The needle shall be Buna-N for tight shut-off and be resilient to prevent seepage due to pipeline or pump vibrations.

C. The air release valve compound internal level mechanism shall be all Bronze. All other internals must be stainless steel. The stainless steel float must be CONCAVE and sufficiently buoyant to operate water and be SPURT FREE.

D. The valve shall withstand 500 psi test pressure and have a 3/16 inch orifice for operating (opening) pressure up to 150 psi. The venting capacity @ 150 psi shall be 55 CFFAM.

E. Valve to be APCO Model 1 inch - 200A Air Release Valve, as manufactured by Valve & Primer Corporation, Schaumburg, Illinois, U.S.A.

2.6 LOCATING WIRE

A. No. 12 bare copper wire shall be installed in the trench above the water main.

2.7 SERVICE CONNECTIONS

A. Service pipe:
   1. The pipe from the main to the meter holding device shall be 1-inch rigid plastic pipe SDR 13.5 for 315 pounds working pressure and shall conform to the preceding specifications for plastic pipe or polyethylene service tubing (ASTM). If polyethylene tubing is used, Ford No. 82 stainless steel insert sleeves shall be used on each pack joint end. All service line installed in highway right-of-way shall be type K copper and subject to approval by the ODOT.

B. Meter holding device:
   1. The meter holding device shall provide a complete mounting for the installation of and the holding of the water meter so that the line of flow through the meter shall be 18 inches above the lower edge of the meter box.
   2. The copper meter yoke shall be provided with an inverted ground key angle valve or shut-off valve on the inlet side. On the customer side of the setter, a check valve is to be

serviceable, spring loaded and one seat of resilient material. Check valve shall be guaranteed and tested to withstand a vacuum or external pressure test of 10.8 psia (22 in Hg) for 1 hour with no leakage. Each end of the yoke shall be provided with a combination tailpiece with inside I.P. thread. The yoke shall provide a copper, brass, or bronze passage entirely through the meter box with the exception of the meter. The construction shall be such that the meter may be removed without removing the meter holding device, and the footing or the discharge leg of the yoke shall extend at least 18 inches from the centerline of the meter box. Setter shall have a pack joint for PVC on each end. The meter holding device shall be a Ford Meter Box Co. Model V92-18 coppersetter, or approved equal.

C. Service saddle:
   1. Service saddle for main line shall be Ford S71. Corporation stop shall be 3/4 inch male IPS by 3/4 inch pack joint for PVC.

D. Service meter:
   1. Meters furnished under these specifications shall be product of a manufacturer with at least 5 years experience in meter manufacturing for the American Water Works market. Meter shall be of the positive displacement type for cold water service, of split-case design with provision for frost protection and must be either notating disk or oscillating piston type.
   2. Meters shall comply with A.W.W.A. Standard C700-95 for accuracy, capacity, pressure loss and dimensions.
   3. Meters may be either mechanically or magnetically driven with sealed registers. Meters with stuffing box, spindle and packing gland will not be acceptable.
   4. Meters shall be readily adaptable to remote readout capability designed and manufactured for the brand of meter being bid.
   5. Meters shall carry a minimum 5 year warranty against defective materials and workmanship and shall be Kent C.700, Sensus, Neptune, Badger or approved equal.
   6. The body cases shall be of high quality bronze with the manufacturer's serial number imprinted thereon and have raised markings to indicate the direction of flow.
   7. A hinged cover bearing the name of the manufacturer in raised letters shall be provided for the register glass. Thread protectors shall be supplied for the connection ends and the cases shall have provisions for wire sealing the meter body. Cases must be capable of withstanding working pressures of 150 psi.
   8. Registers shall be straight-reading in U.S. Gallons, sealed to prevent fogging and to prevent fluid contact with water being measured and with provision for test reading the flow to within 0.1 gallon. Register components shall be constructed of corrosion resistant material.

E. Meter box:
   1. The meter box to be used on this project shall be of PVC Plastic, 18 inch in diameter and not less than 36 inches in length. Boxes shall be "Sono-Loc" as manufactured by SONOCO Company, Hartsville, S.C.

F. Meter box cover:
   1. The meter box covers shall be of cast iron construction of a good quality cast iron at least 50 percent of which shall be new pig. It shall be constructed to fit on the meter box with lugs extended into the box to prevent displacement of the cover. Cover shall be Clay & Bailey, D2210 with lifting lugs or approved equal.
   2. The lid shall be held to the body with lugs and shall lock therein with a bronze or bronze-bushed worm lock. The box cover shall be not less than 4 inches high.

G. Cover:
   1. The trench for service lines shall provide not less than 36 inches of cover and shall be not less than 6 inches in width.

H. Meter box location:

1. Excavation for the meter boxes shall be made at the location indicated by the Engineer.

I. Boring under street roadways for service connections:
1. Where it is necessary to go under streets and paved roadways with service connections, it will be accomplished by boring unless special permission for trenching is secured.

2.8 CAP EXISTING SERVICE TAP

A. Materials:
1. Materials to be used to cap an existing service line connection on a main shall be a Smith-Blair 242 repair clamp with stainless steel bolt.

PART 3 - EXECUTION

3.1 VALVES AND VALVE BOXES

A. Valves and valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped for a distance on each side of the box of 4 feet at the top of the pipe and 2 feet measured at the top of the trench.

B. Each valve shall be inspected before installation to ensure that all foreign substances have been removed from within the valve body, and shall be opened and closed to see that all parts are in first-class working condition.

3.2 FIRE HYDRANTS

A. Hydrants shall be set at such an elevation that the minimum pipe cover is provided throughout the length of the branch supply line and that the nozzles are at least 12 inches and not more than 24 inches above the ground.

B. Each hydrant shall be set on a concrete foundation not less than 18 inches square and 6 inches thick. To prevent the hydrant from blowing off the supply connection, the bowl of each hydrant shall be blocked against the end of the trench with precast concrete blocks, or it shall be tied to the pipe with suitable rods or clamps.

C. Hydrant drainage shall be provided by installing around the hydrant, and below the top of the hydrant supply pipe, not less than 7 cubic feet of a mixture of two parts gravel or crushed stone retained on a 3/4 inch screen to one part of coarse sand.

D. All hydrants shall stand plumb. Hydrants with pumper nozzles shall have their hose nozzles parallel with, and the pumper nozzle perpendicular to, the curb line. Hydrants having hose nozzles 90 degree apart shall be set so that the line bisecting the angle between the nozzles is perpendicular to the curb line. Hydrants located behind curbs where the sidewalks extend close to, or abut against, the curb shall be set that no portion of the pumper or hose nozzle caps will be less than 6 inches nor more than 12 inches from the gutter face of the curb. Where set in a parking between the curb and sidewalk, or between the sidewalk and property line, no portion of the hydrant or nozzle cap shall be within 6 inches of the sidewalk.

E. Immediately before installation of a hydrant, the following operations shall be performed: (a) the hydrant shall be carefully inspected; (b) the hydrant interior shall be thoroughly cleaned; (c) the hydrant shall be opened and closed as many times as may be necessary to determine if all parts are in proper working order, with valves seating properly and the drain valve operating freely; and

(d) the packing gland checked to determine if the packing is in place and the gland nut properly tightened.

END OF SECTION

SECTION 22 11 16 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. The work required under this section includes all work necessary for a complete installation of domestic water piping inside the building to 5 feet outside the building, and sanitary waste piping to a point as indicated on the drawings.

B. The work of this section is subject to the requirements of the Plumbing General Section.

C. Related sections include:
1. Section 22 13 16, Sanitary Waste and Vent Piping.
2. Section 40 23 43, Process Valves

1.2 SUBMITTALS

A. Submit schedule of pipe and fittings for each service.

1.3 CODES AND STANDARDS

A. International Plumbing Code, 2009

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to design drawings for approximate locations of pipe and for pipe size.

B. Domestic Water Piping:
1. Water piping within building:
a. 3 inch and smaller shall be copper tube, type "L" hard temper, ASTM.
2. Piping below ground:
a. 2" and smaller type "K" soft temper; ASTM B-88.

C. Sanitary Waste and Vent Piping:
1. In addition see Specification Section 22 13 16 – SANITARY WASTE AND VENT PIPING.
2. Schedule 40 PVC-DWV ASTM D-2665 using solvent cement ASTM D2564, for below slab and above slab.
3. No-Hub Cast Iron meeting CISPI Standards for all above and/or below slab piping, as called for in the Drawings.

D. Fittings - Domestic Water Piping:
1. Wrought copper, solder type, ASTM B-75, ANSI B16.22

E. Fittings - Sanitary Waste and Vent Piping:
1. Below ground:
a. Schedule 40 PVC-DWV, ASTM D-2855 using solvent cement ASTM D-2564

F. Unions:
1. Solder unions shall be wrought copper, with copper ground joint. ASTM B75, ANSI B16.22.
2. Di-electric, EPSO, 250 lb. WOG.

G. Solder:
   1. Solder Metal shall conform to ASTM B32-alloy grade 95TA: 95 percent tin, 5 percent antimony. Joints shall be made with approved solder containing not more than 0.2 percent lead.

H. Valves:
   1. Approved Domestic manufacturers: Hammond, Kitz, Nibco, Apollo, Milwaukee, or approved equal. See Drawings for specific callouts referring to Specification Section 40 23 43 – PROCESS VALVES.
   2. Valves should be installed according to manufacturer's recommendations.
   3. Valves 2-1/2" inches and smaller shall be equal to Nibco T-585-70, full port ball type with bronze body, chrome plated ball and bronze threaded ends, 600 psi WOG or Nibco S-585-70 in copper lines.

PART 3 - EXECUTION

3.1 GENERAL

A. All piping shall be routed to conserve building space, be coordinated with items installed by other trades and not interfere with access to or operation of the facility.

B. Provide roof flashings for pipe penetrations through roof, to be installed by roofing contractor. Install roof drains as recommended by manufacturer and such that piping does not carry weight of roof drain.

C. Water piping within building shall be size indicated on plans and risers. In the event no size is shown, pipe size or size required by the Plumbing Code. Piping shall be sloped toward a system drain and toward outlets, to provide for system drain-down. Install piping to prevent direct contact between ferrous and non-ferrous materials. Allow flexibility for expansion in piping.

D. All water piping within building shall be installed on the interior side of building envelope insulation, except where installed underslab. Where installed in attic locations piping shall be insulated and installed low to trusses/structure with the envelope insulation installed on top of the piping. A poly vapor barrier shall be secured over the piping and under the building insulation. Where it is not physically possible to install the piping within the building thermal envelope, the piping shall be fitted with electric heat tracing for freeze protection. Interior building piping shall be insulated.

E. Domestic water piping system shall be tested with potable water at a pressure of 125 psig or 25 psig above design working pressure, whichever is greater for 12 hours. Test shall be conducted with plumbing inspector unless approved otherwise in writing.

F. Water distribution piping shall be disinfected prior to occupancy or system start-up with a chlorine solution 50 ppm. Allow system to stand for six hours minimum; then exercise all valves to ensure treatment of all branches and components. System shall be flushed with potable water after disinfection and prior to placement into service.

G. Sanitary waste and vent piping shall be tested in accordance with water and air tests as specified in the International Plumbing Code, in addition to any tests required by the local plumbing official. (10 feet of head with no apparent leaks. Hold for 30 minutes minimum). Flush all gravity piping including floor drains and roof drains prior to turning over to the Owner.

3.2 PREPARATION

A. All pipe shall be cut square. Ream pipe and tube ends and remove burrs. Clean the ends of pipes to remove oil, grease and oxides.

B. Prepare piping connections to equipment with flanges or unions.

C. All soldered piping and equipment connections shall be properly prepared in accordance with good piping practice. Apply a thin layer of flux to only the male tubing. Rotate into the fitting with one or two revolutions.

D. Where PVC is connected to hubless cast iron the connection must be made with special coupling press to compensate for differences in outside diameters of the two materials.

3.3 INSTALLATION

A. Domestic Water Piping:
1. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
2. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
3. Provide clearance for installation of insulation and access to valves and fittings.
4. Provide access where valves and fittings are not exposed.
5. Install valves with stems upright or horizontal. Provide drain valves at low points in systems.
6. Test cold water piping before being insulated, or concealed in walls or ceiling.

B. Sanitary Waste and Vent Piping:
1. Horizontal soil, waste and drainage lines within building shall have a minimum uniform slope of 1/8 inch per foot on 4 inch and larger, and 1/4 inch per foot on lines 3 inch and smaller.
2. Turns in sanitary, soil, and drain piping shall be made using 45 degree elbows, wyes, quarter-, eighth-, or sixteenth bends, or other bends approved by the Plumbing Code.
3. Do not use sanitary tees or crosses except where discharging from horizontal to vertical.
4. Make changes in pipe sizes with reducing fittings and recessed reducers. Do not reduce line size in direction of flow.
5. Provide cleanouts in all horizontal turns in waste piping greater than 45 degrees.
6. Provide deep seal traps on all floor drains, and trap primers where required by code or as indicated on drawings.
7. Indirect waste lines dumping into floor or hub drains shall maintain a 2-inch air gap between the end of the waste line and the rim of the floor or hub drain.

3.4 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections. Install dielectric unions where joining dissimilar materials.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install brackets at cast iron no hub cleanouts to protect the integrity of the joint.

END OF SECTION

SECTION 22 11 19 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes the requirements for labor and materials required for the installation of plumbing specialties included as part of the building plumbing system.

1.2 SUBMITTALS

A. Manufacturers' literature indicating model numbers and options.
   1. Cleanouts
   2. Water Hammer Arresters
   3. Trap Primers
   4. Floor Sinks
   5. Hub Drains

B. Format shall include a schedule of the specialties submitted and include identification number of each item, such as "FD-1 Floor Drain", a list of each component, accessory, and option of the item being submitted. This schedule must be included in the front of the submittal page.

PART 2 - PRODUCTS

Refer to Basis of Design Schedule for more details.

2.1 CLEANOUTS

A. Cleanouts shall consist of a coated cast iron body with threaded top with spigot or no-hub connection and gasketed bronze closure plug with countersunk slot. Head shall be adjustable in height; provide non-skid covers for floor cleanouts. Provide thread shield to protect adjustment threads from concrete as required.

B. Cleanout Covers

Location	Adjacent Finish	Material	Features
Interior	Terrazzo	Nickel Bronze	Round Recessed Top
Interior	Tile	Nickel Bronze	Square Recessed Top
Interior	VCT	Nickel Bronze	Square Recessed Top
Interior	Carpet	Nickel Bronze	Round, Carpet Marker
Interior	Concrete	Nickel Bronze	Round
Exterior	Concrete	Cast Iron	Vandal Proof Secured Top
Wall	All	Chrome Plated	Covers

C. Cleanouts shall be Jay R. Smith, Wade, Josam, Zurn or MIFAB.

2.2 WATER HAMMER ARRESTERS

A. Water Hammer Arresters shall be constructed of a stainless steel or copper shell, stainless steel or elastomer bellows, with precharge of air, nitrogen, or argon. Arresters shall conform to ASSE Std. 1010, and shall be Zurn "Shoktrol", Josam "Absorbotron", Wade "Shokstop", or Precision Plumbing Products "Shock Arrestor". Sizing shall be according to PDI Standards.

2.3 TRAP PRIMERS

A. Trap Primer to prime multiple traps. Automatic brass trap primers activated by a drop in building water pressure, with trap primer distribution unit. P-1 or P-2 Primer with DU-2, 3, or 4 Distribution Unit by Precision Plumbing Products, Inc. or approved equal, Zurn, Smith, MIFAB, and Josam are acceptable manufacturers. ASSE Standard 1018.

B. Trap Primer to prime single trap. Automatic brass trap primer activated by a drop in building water pressure. P-2 Primer as manufactured by Precision Plumbing Products, Inc. or approved equal Manufacturers. ASSE Standard 1018.

C. Trap Primer Alternatives:
1. Flexible elastomer with permanent molding allowing liquid streams to pass through and scaling off gases. Meets ASSE 1072. Trapguard as manufactured by ProVent Systems, Sureseal, or approved equal.

2.4 FLOOR SINKS

A. Sanitary coated cast iron floor sink with nickel bronze rim and grate, aluminum dome bottom strainer and deep seal trap, trap primer connection. Jay R. Smith 3100-P or approved equal by Wade, Josam, Zurn, or MIFAB.

PART 3 - EXECUTION

3.1 CLEANOUTS

A. Cleanouts shall be installed in horizontal runs at spacing of no more than 75 feet. Install cleanouts at the base of every soil and waste stack, and at each 90 degree change in direction. Install cleanouts which are not easily accessible up through floor or wall and provide applicable covers. Install cleanouts to allow at least 18" for rodding.

3.2 WATER HAMMER ARRESTERS

A. Water hammer arrestors shall be sized to actual pipe size and installed as near the shock source as practical. Install to allow unobstructed path from shock source to arrestor.

3.3 TRAP PRIMERS

A. Trap primers shall be provided for all floor drains and floor sinks. Install trap primer valves and accessories per manufacturer's instructions. Trap primers shall be installed level and in accessible locations. Provide Distribution Units as required.

3.4 WALL HYDRANTS/HOSE BIBBS

A. Install hose bibbs and wall hydrants as indicated on drawings, minimum height 18" A.F.F. unless otherwise indicated.

3.5 FLOOR SINKS

A. Flush-floor drains shall be able to support traffic. Drains installed in building floor shall be sealed in such a manner as to prevent leakage of water around trap and body to ceiling below.

B. Provide 3 foot. Square, 6 mil butyl membrane, at each floor drain. Clamp membrane.

END OF SECTION

DIVISION 26

ELECTRICAL

SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical installations and includes requirements common to more than one section of Division 26. It expands and supplements the requirements specified in the General and Supplementary Conditions.

B. This project consists of construction of the new building structures, associated facilities, and all related electrical systems as defined in the plans and in these specifications.

C. The work includes the installation, connection and testing of new electrical equipment, including electrical services, power distribution equipment, lighting equipment, underground electrical work, grounding systems, control systems, conduit and wiring, coordination of traffic flow, temporary power systems, special electrical systems and all appurtenances to construct and demonstrate proper operation of the completed electrical systems.

D. The Contractor shall be responsible for the coordination of power, communication, and controls for the project.

E. The electrical plans do not give exact locations, etc., and do not show all the offsets, control lines, pilot lines, and other installation details. Each contractor shall carefully lay out the work at the sites to conform to the job conditions, to conform to details of installation supplied by the manufacturers of the equipment to be installed, and thereby to provide complete operating systems.

F. The electrical plans show diagrammatically the locations of the various electrical outlets and apparatus and the general method of circuiting and controlling. Exact locations of these outlets and apparatus shall be determined by reference to the general plans and to all detail drawings, etc., by measurements at the buildings, and in cooperation with other crafts, and in all cases shall be subject to the approval of the Owner and Engineer. The Engineer reserves the right to make any reasonable change in location of any outlet or apparatus before installation, without additional cost to the Owner.

G. These specifications and the accompanying drawings are intended to cover systems which will not interfere with the structure of the buildings, which will fit into the several available spaces, and which will ensure complete and satisfactory systems. Each bidder shall be responsible for the proper fitting of the material and apparatus into the buildings.

H. Should the particular equipment which any bidder proposes to install require other space conditions than those indicated on the Drawings, the Bidder shall arrange for such space with the Engineer before submitting the bid. Should changes become necessary on account of failure to comply with this clause, the Contractor shall make such changes at the Contractor's expense.

I. Where wire sizes, conduit and other items of construction are shown or required for a complete installation, but are not adequately identified as to size or material requirements, the materials furnished shall be in accordance with "Code" requirements as though shown in detail on the Drawings.

J. All equipment shall be leveled and made plumb. Metal junction boxes, equipment enclosures and metal raceways mounted on water or earth-bearing walls shall be separated from walls not less than 1/4 inch by corrosion-resistant spacers. All electrical conduits and items of equipment shall be run or set parallel to walls, floors and other items of construction.

1.2 STANDARDS

A. The Contractor shall perform work specified in Division 26 in accordance with standards listed below. Where these specifications are more stringent, the most stringent standard shall take precedence. In case of conflict, obtain a decision from the Engineer.
   1. Applicable National Fire Protection Association (NFPA) codes, including but not limited to:
      a. NFPA 70 – National Electrical Code.
      b. NFPA 70E – Standard for Electrical Safety in the Workplace.
      c. NFPA 72 - National Fire Alarm Code.
      d. NFPA 101 – Life Safety Code.
      e. NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
      f. Internet Website: http://www.nfpa.org
   2. Applicable Code of Federal Regulations (CFR) codes, including but not limited to:
      a. 29 CFR 1910 – Occupational Safety and Health Standards (OSHA).
      b. 29 CFR 1926 – Safety and Health Regulations for Construction.
      c. Internet Website: http://www.gpo.gov/fdsys
   3. ANSI/IEEE C2 – National Electrical Safety Code.
   4. Applicable Federal, State and Local Fire codes.
   5. Applicable Federal, State and Local Energy Codes.
   6. Applicable Federal, State and Local Building Codes.
   7. Applicable City Electrical Code.
   8. Applicable City Ordinances pertaining to electrical work.
   9. Applicable Federal, State and Local – Environmental, Health and Safety Laws and Regulations.

B. Contractor shall utilize the most current editions of standards, which are current at time of bid and as recognized by the Authority Having Jurisdiction for the respective standard.

1.3 SUBMITTALS

A. Submittals shall comply with Section 01 33 00 SUBMITTAL PROCEDURES and the General and Supplementary Conditions.

B. Submittals shall be furnished by the Contractor for the work involved in sufficient time so that no delay or changes will be caused.

C. Submittals shall consist of manufacturing information, schematics, wiring diagrams, ladder logic diagrams, instrument loop diagrams, outline drawings, clearances and related information. Shop Drawings shall be so marked as to indicate the EXACT items offered.

D. Submittals shall bear Contractor's certification that the item complies in all respects with the item originally specified. It is the Contractor's responsibility to procure the proper sizes, quantities, rearrangements, structural modifications or other modifications in order for the substituted item to comply with the established requirements.

E. The Contractor shall combine each submittal set into one electronic file (pdf format). Group materials submitted by their Specification numbers, but do not submit the entire electrical within one submittal. Provide electronic bookmarks in the pdf to indicate the included equipment types and a title sheet to separate each section.

F. The Contractor shall submit complete descriptions, illustrations, specification data, etc., of all materials, fittings, devices, fixtures, special systems, etc., as required by the individual sections of this Division.

G. Submittal of shop drawings, product data and samples will be accepted only when submitted by the Contractor. Data submitted from subcontractors and material suppliers directly to the Engineer will not be processed.

H. All submittals shall provide the following information:
   1. General Contractor.
   2. Sub-Contractor.
   3. Distributor and/or Supplier.
   4. Sales Agency.
   5. Submittals not supplying this information will be rejected.

I. Shop Drawings: In addition to the above, submit in reproducible form made by a process approved by the Engineer, shop drawings for major materials where called for and when requested by the Engineer.
   1. Lockout/Tagout Program.
   2. Switchboard, motor control centers, panelboards, surge arresters, and safety switches.
   3. Motor starters and contactors including custom wiring diagrams for all motors.
   4. Lighting fixtures and lamps including light pole foundation requirements.
   5. Wire, cable and conduit.
   6. Dry type transformers including weight and dimensions.
   7. Wiring devices and plates.
   8. Dimensioned layout of electrical room drawn to scale, with equipment location shown therein. Clearances shall be in accordance with NEC and local codes.
   9. Dimensioned layout of all below grade conduit installations.
   10. Grounding system and layout.
   11. Lightning protection system layout.
   12. Traffic control system layout and schematics.
   13. Seismic protection materials and methods for all electrical equipment.
   14. Mounting brackets, supports and assembly for walkway mounted equipment including instruments, lighting and control panels

1.4 QUALITY ASSURANCE

A. Any electrical equipment provided under this Division shall be turned over to the Owner in operating condition. Instruction on further operation and maintenance shall be included in the operating and maintenance instructions.

1.5 PRODUCT LISTING

A. Prepare listing of major electrical equipment and materials for the project.

B. Provide all information requested.

C. Submit this listing as a part of the submittal requirements.

D. When two or more items of same material or equipment are required they shall be of the same manufacturer when available. Product manufacturer uniformity does not apply to raw materials, bulk materials, wire, conduit, fittings, sheet metal, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment kits, and similar items used in Work, except as otherwise indicated.

E. Provide products that are compatible within systems and other connected items.

1.6 NAMEPLATE DATA

A. Provide permanent operational data nameplate on each item of power operated equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.7 WORK SUPERVISION

A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a master electrician as defined by the statutes of the State of the work being performed. The supervisor or his appointed alternate possessing at least a master electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.

B. All master and journeyman electricians shall be licensed in accordance with the statutes of the State of the work being performed. No unlicensed electrical workers shall perform work on this project. Apprentice electricians in a ratio of not more than one apprentice per journeyman electrician will be allowed if the apprentices are licensed and actively participating in an apprentice-ship program recognized and approved by the statutes of the State of the work being performed.

1.8 PRIMARY UTILITY SERVICE

A. The Contractor shall install all primary trenching, conduits, and backfilling for the primary service in accordance with utility requirements and utility specifications in conjunction with these plans and specifications. The Contractor shall construct concrete pads for all utility pad mount transformers in accordance with utility requirements and these plans and specifications.

B. The Contractor shall be responsible for coordinating all electrical work with the servicing utility prior to construction and providing all equipment, connectors, metering boxes and accessories to make all final connections.

1.9 SECONDARY SERVICE

A. New electrical work shall be as noted in the drawings. If required, services shall be 480Y/277 volt, three-phase, four-wire grounded as indicated. All secondary services are to be furnished and installed by the contractor.

B. The Contractor shall be responsible for coordinating all electrical work with the servicing utility prior to construction and providing all equipment, connectors, and accessories to make all final secondary connections.

C. The Contractor shall provide temporary service conductors and raceway system as may be required. The Contractor shall then provide and connect permanent service conductors and raceway system after the permanent installation. The Contractor shall coordinate temporary service, installation, metering and all other items as required with the servicing utility. The Contractor shall be responsible for paying all temporary electric monthly metering charges.

D. Service entrance electrical ducts shall be red blended concrete encased at a depth to provide 8 inches minimum cover over the top of the underground electrical duct, regardless of the soil conditions or substances encountered.

1.10 TELEPHONE WORK

A. The Contractor shall be responsible for coordinating all telephone work with the servicing utility, Owner and Engineer.

1.11 LOCKOUT / TAGOUT PROGRAM

A. The Contractor shall provide a complete copy of and electrical energy source Lockout/Tagout Program to the Owner, with copy to the Engineer. The document shall clearly identify the on-site master electricians and their contact information, including office and mobile telephone numbers.

B. The Lockout/Tagout Program shall comply with Part 1910 - Occupational Safety and Health Standards (OSHA) Subpart S – Electrical, and meet the requirements of 29 CFR 1910.147, The Control of Hazardous Energy (Lockout/Tagout), including requirements listed in 1910.331 through 1910.335.

C. Implementation of the Lockout/Tagout Program and all other related safety requirements are the sole responsibility of the Contractor.

1.12 SAFETY PROGRAM

A. The Contractor shall implement an electrical safety program that complies with NFPA 70E and 29 CFR 1926.

B. Implementation of the Electrical Safety Program, determining and providing proper Personal Protective Equipment (PPE), training and enforcing personnel to wear the prescribed PPE, conducting work area safety inspections (including correcting deficiencies), and all other related safety requirements are the sole responsibility of the Contractor.

1.13 EQUIPMENT CONNECTIONS

A. General: Provide connections for all equipment installed or modified by this contract, regardless of who furnished the equipment.

B. Provide all disconnect switches required by Code whether or not shown on the plans.

C. Contractor shall connect Owner-furnished equipment when specified.

1.14 GENERAL CONDITIONS

A. The work under this heading is subject to the General and Supplementary Conditions, special conditions for mechanical and electrical work, and the Contractor or subcontractor will be responsible for and be governed by all requirements thereunder as though specifically repeated herein.

1.15 COORDINATION

A. The Contractor shall coordinate arrangement, mounting and support of all electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   3. To allow right of way for piping and conduit installed at a required slope.
   4. So connecting raceways, cables and wireways will be clear of obstructions and of the working and access space of other equipment.

B. The Contractor shall coordinate electrical equipment to be mounted on vendor supplied walkways with supplier.

1.16 SPECIAL NOTE

A. The mechanical, structural and process plans and specifications, including the general conditions and all supplements issued thereto, information to bidders, and other pertinent documents issued by the Engineer, are a part of these specifications and the accompanying electrical plans, and shall be complied with in every respect. All the above is included herewith, and shall be examined by all bidders. Failure to comply shall not relieve the Contractor of responsibility or be used as a basis for additional compensation due to omission of mechanical, process and structural details from the electrical drawings.

1.17 CONTINUATION OF SERVICES

A. The Contractor shall install any temporary lines and connections required to maintain electric services and safely remove and dispose of them when complete. The Contractor shall supply emergency power whenever any existing electrical service is without power. In general, the existing facility shall remain operational during construction.

B. Planned outages shall be coordinated two weeks in advance with duration and time of start approved by the Owner. Changeover work which may be required after normal hours or weekends shall not constitute the basis for additional cost to the Owner. When an outage begins, the Contractor shall proceed directly to completion of the work without unscheduled interruptions or delays due to lack of manpower, equipment or tools.

C. The Contractor shall refer to the sequence of construction and shall provide temporary connections as may be required to complete each phase of construction as may be required. The Contractor shall submit proposed electrical service plans for each phase of construction to the Owner and Engineer for consideration.

1.18 LAYOUT

A. The Contractor shall coordinate and establish all bench marks and control lines. The Contractor shall lay out all work. The lay out shall be reviewed by the Engineer and Owner prior to starting any work.

1.19 RELATED WORK SPECIFIED ELSEWHERE

A. Mechanical Equipment: The Contractor shall rough-in for and make final electrical connections to all motor, panels, fixtures, and equipment furnished under other sections of the specifications, providing all material and equipment required for such final connections, except hereinbefore described. This includes, but is not limited to, control panels and other miscellaneous equipment.

B. The Contractor shall refer to other sections of these specifications for all information relating to the requirements of all electrical connections to the equipment and shall furnish and install electrical items required for a complete installation, ready for operation.

C. Roughing-in shall be accomplished from approved shop drawings.

D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

E. Refer to equipment specifications in other Divisions for rough-in requirements.

1.20 LOCAL CONDITIONS

A. Inspection of Sites: The bidder shall inspect the site, thoroughly acquaint himself with conditions to be met and work to be accomplished. Failure to comply with this shall not constitute grounds for any additional payments.

1.21 RECORD DOCUMENTS

A. Refer to the General and Supplementary Conditions for requirements. The following paragraphs supplement the requirements of the General and Supplementary Conditions:
   1. Mark Drawings to indicate revisions to conduit size and location both exterior and interior; actual equipment locations, dimensioned for column lines; concealed equipment, dimensioned to column lines; distribution and branch electrical circuitry; fuse and circuit breaker size and arrangements; support and hanger details; Change Orders; concealed control system devices.
   2. The Contractor shall locate all underground and concealed work, identifying all equipment, conduit, circuit numbers, motors, feeders, breakers, switches, and starters. The Contractor will certify accuracy by endorsement. Record drawings shall be correct in every detail, such that the Owner can properly operate, maintain, and repair exposed and concealed work.
   3. The Contractor shall store the Record drawings on the site. Drawings shall not be rolled. Make corrections, additions, etc., with pencil, with date and authorization of change.
   4. Mark specifications to indicate approved substitutions; Change Orders; actual equipment and materials used.

1.22 OPERATION AND MAINTENANCE DATA

A. Refer to Section 01 33 00 SUBMITTAL PROCEDURES and Section 01 78 23 OPERATION AND MAINTENANCE DATA for procedures and requirements for preparation and submittal of maintenance manuals.

B. In addition to the information required by Sections 01 33 00 and 01 78 23, include the following information:
   1. Installation manual: Description of function, installation and calibration manuals, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
   2. Operations manual: Manufacturer's printed operating instructions and procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; summer and winter operating instructions; and all programming and equipment settings.
   3. Maintenance manual: Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
   4. Service manual: Servicing instructions and lubrication charts and schedules, including the names and telephone numbers of personnel to contact for both routine periodic and warranty service for equipment and materials provided under this Division.
   5. Final approved equipment shop drawings, clearly labeled.
   6. Final test reports, clearly labeled, including motor certification tests.
   7. Final certified calibration sheets for all equipment and instruments.

C. After approval of the O&M Manuals, the Contractor shall provide three (3) complete electronic copies of all documentation in Adobe PDF file format using a storage media device of the Owner and Engineer's choosing along with 3 hard copies.

1.23 GUARANTEE

A. The Contractor shall guarantee the work and materials for a period of one (1) year from the date of completion. If there are failures due to faulty material or workmanship, the Contractor shall correct the failure at no cost to the Owner.

B. Refer to the General and Supplementary Conditions for procedures and submittal requirements for warranties. Refer to individual equipment specifications for warranty requirements.
   1. Compile and assemble the warranties specified in Division 26, into a separate set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

C. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

D. Upon completion of the installation, the Contractor shall adjust the systems to the satisfaction of the Engineer.

E. This guarantee shall include the capacity and integrated performance of the component parts of the various systems in accordance with the intent of the specifications. The Contractor shall conduct complete tests required by the Engineer to demonstrate the ability of the various systems.

1.24 CLEANING

A. Refer to Section 01 77 00 CLOSEOUT PROCEDURES for general requirements for final cleaning.

B. Clean all light fixtures, lamps and lenses prior to final acceptance. Replace all inoperative lamps.

C. The electrical system shall be thoroughly cleaned inside and outside, of all enclosures to remove all debris, dust, concrete splatter, plaster paint and lint.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All materials and equipment used in carrying out these specifications shall be new and have UL listing, or listing by other recognized testing laboratory when such listings are available. Specifications and drawings indicate name, type, or catalog numbers of materials and equipment to be used as standards.

2.2 HEAT TRACING

A. Heat trace and insulate all exposed piping, water lines, and valves less than 8" diameter and all equipment where water may collect. Where exact sizes, panels, boxes, conduit, circuitry and other items of construction are shown or required for a complete installation, but are not adequately identified as to size or material requirements, the materials furnished shall be as needed to provide freeze protection requirements as though shown in detail on the Drawings. The Contractor shall be responsible for supplying all items as required for complete heat tracing systems regardless of the level of detail shown on the Drawings.

B. Contractor shall meet all National Electrical code requirements for heat tracing and particularly to Resistance Heating Elements Article 427-21, 22 and 23.

PART 3 - EXECUTION

3.1 SALVAGE

A. All salvage and equipment removed by the work shall remain the property of the Owner unless directed otherwise by the Owner. Material removed from the project shall be stored on the project site where and as directed. Debris shall be removed from the job site and disposed of by the Contractor.

3.2 DEMOLITION AND DISPOSAL

A. All conduit, wire, and other electrical appurtenances associated with equipment removed in this project, and no longer in use, shall be removed and stored or disposed of as directed by the Owner. The Contractor shall patch and apply finish to walls, floors, and other structures from which such items are removed to match surrounding colors, textures, or other visual characteristics.

3.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

C. Equipment and materials shall be stored in accordance with the manufacturer's recommendations and instructions.

D. All equipment, including but not limited to equipment containing coils and/or electronics, shall be stored in a clean, dry, ventilated and heated building. The storage area shall be free from condensation or other injurious environmental conditions. Freedom from condensation shall be essential and shall be accomplished by the use of auxiliary heaters as required to raise the temperature to 5-degree C above the ambient temperature. The equipment shall be protected from excessive dust.

E. In addition, certain electronic equipment that requires cooling based upon its specific storage temperature range shall be stored in an air-conditioned building.

F. All motors shall be stored in a clean, dry, ventilated and heated building. The storage area shall be free from condensation or other injurious environmental conditions. Freedom from condensation shall be essential and shall be accomplished by the use of auxiliary heaters as required to raise the temperature to 5 degree C above the ambient temperature. The motors shall be protected from excessive dust.

G. Cables and wiring shall be kept in a dry location out of the sun.

H. Outdoor storage, even when protected by a tarpaulin, is unacceptable.

I. Equipment may be rejected if the storage criteria are not followed.

3.4 INSTALLATION

A. Coordinate electrical equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.

D. The Contractor shall keep ends of conduits, including those extending through roofs, equipment and fixtures covered or closed with caps or plugs to prevent foreign material from entering during construction.

E. Coordinate the installation of required supporting devices and sleeves to be set in concrete and other structural components as they are constructed.

F. Sequence, coordinate, and integrate installations of electrical materials and equipment for maintaining the required operation of the facility. Give particular attention to large equipment requiring positioning prior to closing-in the building.

G. Coordinate the cutting and patching of building components to accommodate the installation of electrical equipment and materials.

H. Where mounting heights are not detailed or dimensioned, install electrical services and overhead equipment to provide the maximum headroom possible.

I. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

J. Coordinate the installation of electrical materials and equipment above ceilings with suspension system, mechanical equipment and systems, and structural components.

K. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

L. Coordinate installation of electrical equipment on vendor supplied walkways with supplier.

3.5 MATERIALS AND WORKMANSHIP

A. All materials shall be new, and shall be of the latest standard design of a manufacturer regularly engaged in the manufacture of that type of equipment. Materials shall be in good condition and shall be free from dents, scratches or other damage incurred in shipment or installation.

B. All equipment shall comply with the National Electrical Code, Underwriters Laboratories or other appropriate agency.

C. Installation shall be made in a neat and workmanlike manner, and all materials shall be installed in accordance with the recommendations of the various manufacturers. The installation shall be subject to the approval of the Owner and Engineer.

D. Incidental materials required to complete the installation as intended by these Specifications shall be of the type and quality in keeping with specified equipment.

3.6 COORDINATION

A. Carefully examine specification and drawings to be thoroughly familiar with items which require electrical connections and coordination. (Electrical drawings are diagrammatic and shall not be scaled for exact sizes.)

B. Notify other tradesmen of any deviations or special conditions necessary for the installation of work. Interference between work of various contractors shall be resolved prior to installation. Work installed not in compliance with specifications and drawings and without properly checking and coordinating as specified above shall, if necessary, be removed and properly reinstalled without additional cost to the Owner. Engineer to be mediating authority in all disputes arising on project.

C. Equipment shall be installed in accordance with manufacturer's recommendation. Where conflicts occur between contract documents and these recommendations, a ruling shall be requested of the Engineer for decision before proceeding with such work.

3.7 CUTTING AND PATCHING

A. Repair or replace routine damage caused by cutting in performance of work under this Division.

B. Correct unnecessary damage caused due to installation of electrical work, brought about through carelessness or lack of coordination.

C. Holes cut through floor slabs to be sleeved or core drilled with drill designed for this purpose. All openings, sleeves, and holes in slabs to be properly sealed, fire proofed and water proofed.

D. Repairs to be performed with materials which match existing materials and to be installed in accordance with appropriate sections of these specifications.

E. All cutting and patching work shall be coordinated in advance with the Engineer and Owner prior to any work.

3.8 TRENCHING, EXCAVATION, BACKFILLING, AND REPAIRS

A. Provide trenching, excavation, and backfilling necessary for performance of work under this Division.

3.9 FOUNDATIONS AND PADS

A. Foundations and pads required for equipment shall be provided as indicated. Proper size and location of foundations, pads and anchor bolts shall be determined under this Division.

B. Provide anchors and bases for electrical equipment to withstand lateral forces and accommodate displacements.

3.10 NOISE AND VIBRATION CONTROL

A. The electrical system as installed shall be free of objectionable noise or vibration. The Contractor shall isolate motors, starters, transformers, equipment, ballasts, etc., as directed or required as to ensure acceptable noise level free from objectionable vibration in all systems.

3.11 TESTS

A. On completion of work, installation shall be completely operational and entirely free from ground, short circuits, and open circuits. Perform a thorough operational test in presence of the Owner and Engineer. Furnish all labor, materials and instruments for above tests.

B. Furnish the Engineer, as part of closing file, a copy of such tests including identification of each circuit and readings recorded. Test information to be furnished to the Engineer includes ampere readings of all panels and major circuit breakers, isolation resistance reading of motors and transformers.

C. Prior to final observation and acceptance test, all electrical systems and equipment shall be in satisfactory operating condition. Including, but not limited to the following:
1. Electrical power and distribution system.
2. Lighting systems.
3. Transformers.
4. Electric motors for all equipment.
5. Telecommunication system.
6. Emergency power system.
7. Special electrical control systems.

D. After installation of the electrical system and before operating equipment, functional checking shall be conducted in accordance with the manufacturer's recommendations, with the contract drawings and as follows:
1. Functional checking shall include inspection, testing and repair, replacement or adjustments as necessary to ensure compliance with the requirements of the specifications. Tests and inspections shall be recorded on appropriate yellow lined contract and shop drawings, standard test forms and checklists to indicate that wiring and controls are in place in accordance with requirements and to form the basis of record drawings.
2. The functional test procedures shall be signed and dated by the Contractor and presented to the Owner's construction observation personnel prior to operating any equipment.
   a. Visual Inspection – The electrical system shall be examined as outlined below:
      1). Parts of components missing
      2). Improper assembly
      3). Parts or components not functioning properly
      4). Finish not as specified
      5). Materials not as specified
      6). Connections not tight
      7). Mounting and supports loose or unsatisfactory
      8). Nameplates missing or inaccurate
   b. Grounding System Tests
      1). Measure the resistance of the counterpoise grounding system by the rate-of-fall of potential method. Record all measurements on an approved standard test form made specifically for the purpose. The resistance of the grounding system to ground shall not exceed NFPA 70 requirements.
   c. Continuity Tests
      1). Each wire and each wire in each cable rated 300 volts and below shall be tested for continuity. Record wire number and pass or fail on checklist for each wire.
   d. Dielectric Tests
      1). Each power conductor rated 600 volts and above shall be tested (meggered) for dielectric strength to ground.
      2). Prior to testing, all components that could be damaged should be disconnected. After testing, the circuit shall still register a resistance value of not

less than 1 megohm at 600 volts, dc. This test shall apply between all insulated circuits and external metal parts. Record equipment name, phase or wire number and all observed values for each wire.

3). Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning of all circuits. Record equipment or circuit number and pass or fail on function test checklist for each circuit.

4). The Contractor shall develop non-conforming material reports for each failure. Repair and report failures all failures to Owner and Engineer.

5). The Contractor shall replace defective parts, correct malfunctioning units, make all repairs and retest to demonstrate compliance. The Contractor shall document all actions taken on appropriate non-conforming material report.

3.12 INSPECTION FEES AND PERMITS

A. Obtain and pay for all necessary permits and inspection fees required for electrical installation.

3.13 IDENTIFICATION OF EQUIPMENT

A. Properly identify all electrical equipment, including but not limited to the following:
1. Switchgear, switchboards, motor control centers, and control panels.
2. Main distribution panel and individual devices within it.
3. Panelboards and individual devices within it.
4. Safety switches and disconnects.
5. Contactors and lighting control center, including all branch circuits.
6. Individually mounted circuit breakers.
7. Relays.
8. Transformers.
9. Generators and automatic transfer switches.
10. Any other type of enclosure that includes electrical equipment.

3.14 TEMPORARY LIGHTS AND POWER

A. Provide a temporary electrical lighting and power distribution system of adequate size to properly serve the following requirements, including adequate feeder sizes to prevent excessive voltage drop. Temporary work to be installed in a neat and safe manner in accordance with the National Electrical Code, Article 590, and as required by OSHA or applicable local safety codes.

B. Provide one pigtail socket with 150-watt lamp for every 1,000 square feet of floor area, evenly distributed throughout the building and with minimum of one pigtail socket per room.

C. Provide a minimum of one duplex power outlet for every 1,500 square feet of floor area, evenly distributed throughout the building. Power outlets shall be 20 amp, single phase located as directed by the General Contractor.

D. Coordinate prior to installation to determine if any lighting or power outlets over the minimum quantity noted above are required.

E. Provide service and panelboards required for above lighting and power outlets.

F. The Contractor will pay for power consumption.

G. Coordinate prior to installation to determine whether single phase or three-phase temporary service is desired.

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.

B. Related Sections include the following:
   1. Division 26 Sections

1.2 DEFINITIONS

A. EPDM: Ethylene-propylene-diene monomer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

A. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association (NETA) or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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.

1.5 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 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:

1. Alcan Products Corporation; Alcan Cable Division.
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70. No aluminum on project.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN, XHHW and RHH-RHW-USE.

2.2 CONNECTORS AND SPLICES

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:
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.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper, stranded.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type RHH-RHW-USE single conductors in raceway.

B. Exposed Feeders: Type RHH-RHW-USE, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type RHH-RHW-USE, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type RHH-RHW-USE single conductors in raceway.

E. Feeders in Cable Tray: Type RHH-RHW-USE, single conductors in raceway for larger than 4/0 AWG; Otherwise Type TC tray cable.

F. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW, single conductors in raceway.

I. Variable Frequency Drive Branch Circuits: Shielded cable, size adjusted for published ampacity of cable.

J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 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. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 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. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Cable splicing, in general, will not be allowed. Where applicable, all wiring connections to be made using terminal block type connections. Wire nut use will permitted only where allowed by the Owner and Engineer.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. Megger Test of individual conductors to ground after installation.
   2. Visual observation of conductor at accessible locations.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test the following for compliance with requirements.
   a. All panel feeders.
   b. All motor feeders.
   c. All control wires for continuity.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 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.

1.2 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. Test wells.
   2. Ground rods.
   3. Ground rings.
   4. Grounding arrangements and connections for separately derived systems.

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 test wells ground rings grounding connections for separately derived systems based on ANSI/NETA MTS.
      a. Test 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.

1.3 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

2.1 CONDUCTORS

A. Insulated Conductors: Copper or tinned-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 B3
   2. Stranded Conductors: ASTM B8.
   3. Tinned Conductors: ASTM B 33.
   4. Bonding Conductor: No. 4 AWG, stranded conductor or per NFPA 70.

2.2 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, 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.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.
   1. Bury at least 30 inches below grade.

C. 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: Bolted connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with ANSI/IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole and Handhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Equipment: Install four ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with utility transformers by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.3 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.

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 Antifrost 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. 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.

3.4 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. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. 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.

F. 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 entrance 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 bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. 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.

H. 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.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column and indicated item, extending around the perimeter of building.
   1. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inches from building foundation at a depth not less than 30 inches below finished grade.

J. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
   1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
   2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

3.5 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 at ground test wells. 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 10 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 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. RMC: Rigid metal conduit.

B. NECA: National Electrical Contractors Association.

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

B. Shop Drawings: 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. Equipment supports.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
   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:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of cooper Industries.
      c. ERICO International Corporation

d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101. NECA publications are available at www.NECAnet.org.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. 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.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes and bars.

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 304 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. 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:
      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. 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:
      1). Cooper B-Line, Inc.; a division of Cooper Industries
      2). Empire Tool and Manufacturing Co., Inc.
      3). Hilti Inc.
      4). ITW Ramset/Red head; a division of Illinois tool works, Inc.
      5). MKT Fastening, LLC.
3. Concrete Inserts: Stainless steel, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle bolts: All-steel springhead type.
7. Hanger Rods: Threaded 304 stainless steel.
8. Nuts: Match threaded rod or bolt; double nut vertical hanger rods.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES.

A. Description: bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 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. Outdoor locations: Supporting material shall be stainless steel or PVC-Coated galvanized steel or as described within the Drawings.

C. Indoor locations: Supporting materials shall be galvanized in dry areas and stainless steel or PVC-Coated galvanized steel in damp areas, or as described within the Drawings.

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for RMC as required by NFPA 70. Minimum rod size shall be ¼ inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support 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.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. 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 lbs.

D. 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 Wood: Fasten with lag screws or through bolts.
   2. To New Concrete: Bolt to concrete inserts.
   3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
   4. To Existing Concrete: Expansion anchor fasteners.
   5. 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.
   6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   7. To Light Steel: Stainless steel sheet metal screws.

8. 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.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor electrical materials and equipment.

3.4 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.

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.

END OF SECTION

SECTION - 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
2. Division 26 Section "PVC Coated Conduit."

1.2 DEFINITIONS

A. LFMC: Liquidtight flexible metal conduit.

B. LFNC: Liquidtight flexible nonmetallic conduit.

C. GRS: Galvanized Rigid Steel Conduit.

D. RNC: Rigid nonmetallic conduit.

E. EMT: Electrical Metallic Tubing.

1.3 SUBMITTALS

A. Product Data: for surface raceways, wireways and fittings, hinged-cover enclosures and cabinets.

B. Custom enclosures and cabinets.

C. Source quality-control test reports.

1.4 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.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

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:
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. Rigid Steel Conduit: ANSI C80.1.

C. PVC-Coated Steel Conduit: PVC-coated.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.
3. Comply with ETL Verified PVC-001.

D. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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:
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 TC2, Type EPC-40-PVC, unless otherwise indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.3 BOXES, ENCLOSURES, AND CABINETS

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:
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. Scott Fetzer Co.; Adalet Division.
9. Spring City Electrical Manufacturing Company.
10. Stahlin Non-Metallic Enclosures.
11. Thomas & Betts Corporation.
12. Walker Systems, Inc.; Wiremold Company (The)
13. Woodhead, Daniel Company; Woodhead Industries, Inc. subsidiary.

B. Sheet Metal Outlet and Device boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device boxes: NEMA FB 1, Type FD, with gasketed cover.

D. Small Sheet Metal Pull and Junction boxes: NEMA OS 1.

E. Cast-Metal Access, Pull and Junction boxes: NEMA FB 1.

F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch for conditioned spaces only, unless otherwise indicated.

G. Hinged-Cover Enclosures: NEMA 250, Type 4 Stainless steel, with continuous-hinge cover with latches for outdoor, process buildings, above and below grade structures and damp locations, unless otherwise indicated.

2.4 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A, 53M, Type E, Grade B, Schedule 40, galvanized 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 Engineer.

2.5 SLEEVE SEALS

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:
   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

3.1 RACEWAY APPLICATION

A. Outdoors: apply raceway products as specified below, unless otherwise indicated:
   1. Exposed: PVC-Coated Rigid Steel
   2. Concealed: PVC-Coated Rigid Steel.
   3. Underground, Single Run: RNC, Schedule 40 in concrete encasement.
   4. Underground, Grouped: RNC, Schedule 40 in concrete encasement.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): PVC-Coated LFMC.

B. Indoors:
   1. Exposed: Galvanized Rigid Steel or as noted in the Drawings.
   2. Concealed: Galvanized Rigid Steel or as noted in the Drawings.
   3. Connection to Vibrating Equipment (Including Transformers and Hydraulic. Pneumatic, Electric Solenoid or Motor-Driven Equipment): LFMC.
   4. Damp or Wet Locations: PVC-coated Rigid Steel or as noted in the Drawings.

C. Minimum Raceway Size: ¾-inch trade size; 1-inch trade size for below grade installation.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
   2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material.

3.2 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. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Raceways Embedded in Slabs:
   1. Run conduit larger than 1 inch trade size, 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. Do not install conduits in such a manner as to compromise the structural integrity of walls, roofs, ceilings or floor. Where necessary, provide additional supporting members to support conduit runs. Below grade conduits 1 1/2" and larger shall be routed 24" below the concrete floor slabs.
   4. Comply with Chapter 6 of ACI 318.
   5. Change from nonmetallic conduit to Galvanized Rigid Steel or PVC-Coated Rigid Steel Conduit 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. 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.

L. Expansion-Joint Fittings: 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 F temperature 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.

M. Flexible conduit connections: Use maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement, and for transformers and motors.
   1. Use LFMC in damp or wet locations subject to severe physical damage.
   2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

N. 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.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application Engineer.

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. 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.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Size pipe sleeves to provide ¼-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

H. 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.

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with fire-stop materials.

J. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

K. 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.

L. 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.

3.4 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 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.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 26 05 33.13 - PVC COATED CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes PVC-coated raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
1. Division 26 Section "Raceway and Boxes for Electrical Systems".

1.2 SUBMITTALS

A. Product Data: for surface raceways, wireways and fittings, hinged-cover enclosures and cabinets.

B. Custom enclosures and cabinets.

C. Source quality-control test reports.

1.3 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. All the conduit, fittings, and supporting products shall be provided by the same manufacturer to ensure that a five-year product warrantee is achieved.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include:
1. Perma-Cote
2. Plasti-Bond
3. KorKap

2.2 MATERIALS

A. PVC-coated, Galvanized Rigid Conduit (GRC) and fittings shall meet all the performance standards specified herein and such performance standards shall require verification by a nationally recognized testing agency including American Society for Testing and Materials (ASTM) and Underwriter Laboratories (UL).

B. The PVC coated galvanized rigid conduit shall be UL Listed. The PVC coating shall have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations shall be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating shall be UL listed. All conduits and fittings must be new, unused material. Applicable UL standards shall include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.

C. The PVC coated galvanized rigid conduit shall be Electrical Testing Laboratory (ETL) Verified to the Intertek ETL SEMKO High Temperature H_2O PVC Coating Adhesion Test Procedure for 200 hours. The PVC coated galvanized rigid conduit shall bear the ETL Verified PVC-001 label to signify compliance to the adhesion performance standard.

D. The conduit shall be hot dip galvanized inside and out with hot galvanized threads.

E. A PVC sleeve extending one pipe diameter or two inches, whichever is less, shall be formed at every female fitting opening except unions. The inside sleeve diameter shall be matched to the outside diameter of the conduit.

F. The PVC coating on the outside of conduit couplings shall have a series of longitudinal ribs 40 mils in thickness to protect the coating from tool damage during installation.

G. Form 8 Condulets, 1/2" through 2" diameters, shall have a v-seal tongue-in-groove gasket to effectively seal against the elements. The design shall be equipped with a positive placement feature to ease and assure proper installation. Certified results confirming seal performance at 15 psig (positive) and 25 in. of mercury (vacuum) for 72 hours shall be available. Form 8 Condulets shall be supplied with plastic encapsulated stainless steel cover screws.

H. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable.

I. The PVC exterior and urethane interior coatings applied to the conduit shall afford sufficient flexibility to permit field bending without cracking or flaking at temperatures above 30°F (-1°C).

J. All male threads on conduit, elbows and nipples shall be protected by application of a urethane coating.

K. All female threads on fittings or conduit couplings shall be protected by application of a urethane coating.

L. Independent certified test results shall be available to confirm coating adhesion under the following conditions:
   1. Conduit and condulet exposure to 150°F (65°C) and 95% relative humidity with a minimum mean time to failure of 30 days (ASTM D1151).
   2. The interior coating bond shall be confirmed using the Standard Method of Adhesion by Tape Test (ASTM D3359).
   3. No trace of the internal coating shall be visible on a white cloth following six wipes over the coating which has been wetted with acetone (ASTM D1308).
   4. The exterior coating bond shall be confirmed using the methods described in Section 3.8, NEMA RN1. After these tests the physical properties of the exterior coating shall exceed the minimum requirements specified in Table 3.1, NEMA RN1.

M. Right angle beam clamps and U bolts shall be specially formed and sized to snugly fit the outside diameter of the coated conduit. All U bolts will be supplied with plastic encapsulated nuts that cover the exposed portions of the threads.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide should be vigorously followed.

B. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's Installation Manual. To assure correct installation, the installer shall be certified by Manufacturer to install coated conduit.

C. Installer certification, before installation, is required.

D. Clamps, bolts, angles, pipe straps, struts, rods, nuts and other supporting products for PVC-coated conduits shall be PVC-coated or stainless steel.

E. The Contractor shall use equipment specifically designed for PVC-coated conduit when cutting, clamping, reaming, threading, bending, assembling or performing other installation procedures. PVC-coating shall be protected.

F. Touch-up compound for PVC-coated conduit shall not be allowed. All conduits with damaged coatings shall be removed and replaced at no cost to owner.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Conduit, ducts and duct accessories for concrete-encased duct banks.
   2. Handholes and boxes.

1.2 DEFINITIONS

A. RNC: Rigid nonmetallic conduit.

B. SCTE: Society of Cable Telecommunications Engineers.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Accessories for manholes, handholes, boxes.

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. Step details.
   4. Grounding details.
   5. Dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
   6. 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 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.

E. Product Certificates: for concrete and steel used in precast concrete handholes, as required by ASTM C858.

F. Source quality-control test reports.

G. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic 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.

1.6 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 arrangement of other utilities, site grading, and surface features as determined in the field.

C. 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 a required to suit field conditions and to ensure that duct runs drain to manholes and handholes and as approved by Engineer.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel conduit: Galvanized. Comply with ANSI C80.1.

B. PVC-Coated Steel Conduit: Comply with ANSI C80.

C. RNC: NEMA TC2, type EPPC-40-PVC, UL 651 , with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 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:
1. Oldcastle Precast Group.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosure 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.
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, "ELECTRIC."
7. Configuration: Units shall be designed for flush burial and have integral closed 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.

2.3 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 integral closed 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, "ELECTRIC" or as noted.
   6. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   7. 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:
      a. Amorcast Products Company.
      b. Quazite
      c. Carson Industries LLC.

d. CDR Systems Corporation.
e. NewBasis.

2.4 UTILITY STRUCTURE 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:
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 Divison.
15. Underground Devices, Inc.
16. Utility Concrete Products, LLC.
17. Utility Vault Co.
18. Wausau Tile, Inc.

B. Duct-Sealing Compound: Nonhardening, 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.

C. Cover Hooks: Heavy duty, designed for lifts 60 Lb and greater.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in red blended mix concrete-encased duct bank, unless otherwise indicated. Transition to above ground shall be PVC-coated steel conduit.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and boxes for 600 V and Less:
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, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3.3 EARTHWORK

A. Restore surface feathers at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

B. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, timing, seeding, sodding, sprigging and mulching.

C. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.4 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 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 36 inches, both horizontally and vertically unless otherwise indicated. All below grade elbows and bends to be galvanized.

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. Grout end bells into structure walls from both sides to provide watertight entrances.

E. Building Wall or Floor Penetrations: Make a transition from underground duct to PVC coated rigid steel conduit unless otherwise indicated, 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.

F. Sealing: Provide temporary closures 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.

G. Pulling cord: Install 100-lbf-test nylon cord in ducts, including spares.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES AND BOXES

A. 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 12" bed of crushed stone or gravel graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

B. Elevations:
   1. Install handholes with bottom below the frost line.
   2. Handhole covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
   3. Where indicated, cast handhole cover frame integrally with handhole structure.

C. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms as required for installation and support of cables and conductors and as indicated.

D. 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.

3.6 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.
   1. Concrete: 3000 psi, 28-day strength, with a troweled finish.
   2. Dimensions: 12 inches wide by 12 inches deep.

3.7 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 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.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.9 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.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Identification for conductors and communication and control cable.
   2. Warning labels and signs.
   3. Instruction signs.
   4. Equipment identification labels.
   5. Miscellaneous identification products.

B. Related sections:
   1. Section 26 05 70 – Power System Study.

1.2 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.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with NFPA 70E

D. Comply with 29 CFR 1910.145.

1.4 COORDINATION

A. Coordinate identification names, abbreviations, colors and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring 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.

PART 2 - PRODUCTS

2.1 CONDUCTOR, COMMUNICATION, AND CONTROL-CABLE IDENTIFICATION MATERIALS.

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.2 WARNING LABEL AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145 and NFPA 70E.

B. 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.

C. 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. ¼ inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

D. Sample warning label and sign shall include, but are not limited to the following legends:
   1. Multiple Power source Warning: "DANGER – ELECTRICAL SHOCK HAZARD – EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION – AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
   3. WARNING – ARC FLASH AND SHOCK HAZARD –APPROPRIATE PPE REQUIRED.

2.3 INSTRUCTION SIGNS

A. 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 sized.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark gray background. Minimum letter height shall be 3/8 inch.

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 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 degrees F.
   4. Color: Black, except where used for color-coding.

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 APPLICATION

A. Outlet Boxes for Receptacles: Identify branch circuit by panel name and circuit number.

B. Power-Circuit Conductor Identification: of secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

C. 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.

D. 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 type 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.

E. Warning Labels for Indoor Cabinets, Boxes and Enclosures for Power and Lighting: comply with 29 CFR 1910.145 and apply metal-backed, butyrate warning signs. 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.
   2. 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.

F. 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 approved legend where instructions are needed for system or equipment operation.
   2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.

G. 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 Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with ½-inch high letters on 1-1/2-inch high label; where 2 lines of text are required, use labels 2 inches high.
      b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
   2. Equipment to Be Labeled:
      a. Panelboards, electrical cabinets and enclosures.
      b. Access doors and panels for concealed electrical items.
      c. Electrical switchgear and switchboards.
      d. Transformers.
      e. Motor-control centers.
      f. Disconnect switches.

g. Enclosed circuit breakers.
h. Motor starters.
i. Push-bottom stations.
j. Power transfer equipment.
k. Contactors.
l. Remote-controlled switches and control devices.
m. Power-generating units.
n. Voice and data cable terminal equipment.
o. Terminals, racks and patch panels for voice and data communications and for signal and control functions.

3.2 INSTALLATION

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. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. 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 sized larger than No. 6 AWG if authorities having jurisdiction permit, field applied.
2. Colors for 480/277-V Circuits:
   a. Phase A: Brown
   b. Phase B: Orange
   c. Phase C: Yellow
3. 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.

END OF SECTION

SECTION 26 24 19 - MOTOR-CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes modifications to existing motor-control centers for use on ac circuits rated 600 V and less.

1.2 SUBMITTALS

A. Product Data: For each type of controller and each type of motor-control center. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings and finishes.

B. Shop Drawings: for each motor-control center.
   1. Include dimensioned plans, elevations, sections and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current ratings of buses and installed units.
      d. Vertical and horizontal bus capacities.
      e. UL listing for series rating of overcurrent protective devices in combination controller.
      f. Features, characteristics, ratings, and factory settings of each motor-control center unit.
   2. Wiring Diagrams: Power, signal and control wiring for class and type of motor-control center. Provide schematic wiring diagram for each type of controller.

C. Coordination Drawings: floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around motor-control centers where pipe and ducts are prohibited. Show motor-control center layout and relationships between electrical components and adjacent structural and mechanical elements. Show compliance with NFPA 70, Article 240.24 height limitation of overcurrent device operating handles. Show support locations, type of support and weight on each support. Indicate field measurements.

D. Qualification Data: for manufacturer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: for motor-control centers, all installed devices and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for motor-control centers and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 250 miles of Project site, a service center capable of providing training, parts and emergency maintenance and repairs.

B. Source Limitations: Obtain motor-control centers and controllers of a single type through one source from a single manufacturer.

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 NFPA 70.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver motor-control centers in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Handle motor-control centers according to the following:
   1. NEMA ICS 2.3, "Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers Rated Not More Than 600 Volts."
   2. NECA 402, "Recommended Practice for Installing and Maintaining Motor Control Centers."

1.5 COORDINATION

A. Coordinate layout and installation of motor-control centers with other construction including conduit, piping, equipment and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

C. Coordinate features of motor-control centers, installed units, and accessory devices with pilot devices and control circuits to which they connect.

D. Coordinate features, accessories, and functions of each motor-control center, each controller, and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.6 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. Spare fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
   2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Square D; Schneider Electric.

2.2 MOTOR-CONTROL CENTERS

A. Wiring: NEMA ICS 3, Class I, Type B.

B. Enclosures: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location. Standard, 20" depth.
   1. Compartments: Modular; individual doors with concealed hinges and quick-captive screw fasteners. Interlocks on combination controller units requiring disconnecting means in off position before door can be opened or closed, except by operating a permissive release device.
   2. Interchangeability: Compartments constructed to allow for removal of units without opening adjacent doors, disconnecting adjacent compartments, or disturbing operation of other units in motor-control center; same size compartments to permit interchangeability and ready rearrangement of units, such as replacing three single units with a unit requiring three spaces, without cutting or welding.
   3. Final installation height of disconnect devices, accounting for pad height under the motor control center, shall be in compliance with NFPA 70, Article 240.24.
   4. Wiring spaces: Wiring channel in each vertical section for vertical and horizontal wiring to each unit compartment; supports to hold wiring in place.

C. Short-Circuit Current Rating for Each Section: Equal to or greater than indicated available fault current in symmetrical amperes at motor-control center location.

2.3 FUNCTIONAL FEATURES

A. Description: Modular arrangement of controllers, control devices, overcurrent protective devices, transformers, panelboards, instruments, indicating panels, blank panels, and other items mounted in compartments of motor-control center.

B. Controller Units: Combination controller units of types and with features, ratings and circuit assignments indicated:
   1. Install units up to and including Size 3 on drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions.
   2. Provide units with short-circuit current ratings equal to or greater than short-circuit current rating of motor-control center sections.
   3. Equip units in Type B and Type C motor-control centers with pull-apart terminal strips or drawout terminal boards for external control connections.
   4. Controller Disconnecting Means: Factory-assembled combination disconnect and controller.
      a. Circuit-Breaker Disconnecting Means: NEMA AB1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

C. Overcurrent Protective Devices: Individual feeder-tap units through 400-A rating shall have drawout mountings with connectors that automatically line up and connect with vertical-section buses while being racked into their normal, energized positions. Installed height, including that of the concrete base, of operating handles of overcurrent protective devices shall not exceed the height limitation of NFPA 70, Article 240.24.

D. Surge Protective Devices: Connect to motor-control center bus.

E. Spaces and Blank Units: Compartments fully bused and equipped with guide rails or equivalent, ready for insertion of drawout units.

F. Spare Units: Type, sizes, and ratings indicated; installed in compartments indicated "spare."

2.4 FEEDER OVERCURRENT PROTECTION

A. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable electronic trip for circuit-breaker frame sizes 250 A and larger.
   1. Electronic Trip Unit circuit Breakers: RMS Sensing; field-replaceable rating plug; with the following field-adjustable settings:
      a. Instantaneous trip.
      b. Long-and short-time pickup levels.
      c. Long-and short-time time adjustments.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings and number of poles.
   1. Lugs: Mechanical Compression style, suitable for number, size, trip ratings and material of conductors.
   2. Application Listing: Appropriate for application: Type SWD for switching fluorescent lighting loads; type HACR for heating, air-conditioning, and refrigerating equipment.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Elapsed Time Meters: Heavy duty, LED type, with digital readout in hours.

2.6 FACTORY FINISHES

A. Finish: manufacturer's standard paint applied to factory-assembled and –tested, motor-control centers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive motor-control centers for compliance with requirements, installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 IDENTIFICATION

A. Identify motor-control center, motor-control center components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between motor-control devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.

3.5 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each motor-control center element, bus, component, connecting supply, feeder and control circuit.
   2. Test continuity of each circuit.

B. Perform the following:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components and equipment.
   2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
   3. Report results in writing.

C. Perform the following field test and inspections and prepare test reports:
   1. Perform each electrical test and visual and mechanical inspection tests, stated in NETA ATS "Motor Control Centers." 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.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION

SECTION 26 28 13 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches, controllers and motor-control centers.

1.2 SUBMITTALS

A. 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.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.

1.3 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.

1.4 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.5 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 two of each size and type.

PART 2 - PRODUCTS

2.1 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.
   5. Or equal.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 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.

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:
   1. Feeders: Class L, fast acting Class RK1 or fast acting Class RK5.
   2. Motor Branch Circuits: Class RK1, time delay.
   3. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket and holder.

END OF SECTION

DIVISION 31

EARTHWORK

SECTION 31 05 19 – GEOTEXTILE FILTER FABRIC

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: The installation of a non-woven geotextile fabric below the riprap.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
   a. Section 31 37 00 – Rip Rap.
   b. Section 01 33 00 – Submittal Procedures.

1.2 REFERENCE STANDARDS

A. ASTM D3786 – Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method

B. ASTM D4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus

C. ASTM D4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity

D. ASTM D4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

E. ASTM D4833 – Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products

F. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile

G. ASTM D4886 – Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding block Method)

H. ASTM D4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles

I. ASTM D6241 – Standard Test Method for Static Puncture Strength of Geotextiles and Related Products Using a 50mm Probe

1.3 QUALITY ASSURANCE

A. The installation shall be performed in accordance with the manufacturer's recommendations and as directed by Engineer.

1.4 SUBMITTALS

A. See Section 01 33 00, SUBMITTAL PROCEDURES.

B. Certificates: Certify that products meet or exceed specified requirements.

PART 2 - PRODUCTS

2.1 MATERIAL

A. The non-woven geotextile fabric shall be an 8-ounce fabric, US Fabrics US 205NW or equal. The fabric shall be of non-woven needle punched construction and consist of long-chain polymeric filaments or fibers composed of polypropylene, polyethylene or polyamide. The filaments and fibers shall be oriented whereby they retain their relative positions with each other and allow the passage of water as specified.

B. The fabric shall be mildew, insect and rodent resistant and shall be inert to chemicals commonly found in soil. The non-woven fabric shall conform to the physical property requirements below:

Physical Property	Test Method	Test Results
Weight	ASTM D 5261	8 oz/sy
Tensile Strength, wet, lbs	ASTM D 4632	205 lbs
Elongation, wet, %	ASTM D 4632	50%
Permittivity	ASTM D 4491	1.35 sec-1
Puncture Strength, lbs	ASTM D 4833	130 lbs
CBR Puncture	ASTM D 6241	535 lbs
Mullen Burst Strength, psi	ASTM D 3786	350 psi
Abrasion Resistance, % Strength Retained	ASTM D 4886	90
Apparent Opening Size (AOS)	ASTM D 4751	80 US Sieve
Ultraviolet Resistance, % Strength Retention	ASTM D 4355 (After 500 Xenon Weatherometer hrs.)	70%
Trapezoidal Tear	ASTM D 4533	85 lbs
Water Flow Rate	ASTM D 4491	90 gal/min/sf

C. The non-woven geotextile fabric shall be furnished in a protective wrapping which shall protect the fabric from ultraviolet radiation and from abrasion due to shipping and handling.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fabric Exposure Following Placement - Exposure of the geotextile filter fabric to the elements, particularly the sun, between lay down and cover shall be a maximum of 7 days.

B. The non-woven geotextile fabric shall be placed in the manner and at the locations shown on the drawings or as directed by the Engineer. The surface to receive the fabric shall be prepared to a smooth condition free of obstructions, depressions and debris. The fabric shall be placed loosely, not in a stretched condition.

C. The Contractor shall anchor the geotextile fabric at outer edges of the riprap courses by embedding the fabric down, across, and up a 1-foot deep by 1-feet wide trench. The fabric shall be centered on the pipe. The anchoring trench shall be backfilled with rock material approved by Engineer. There will be no separate payment for Geotextile Fabric; it shall be subsidiary to other items.

D. Where necessary, the fabric shall be placed so as to provide a minimum 24-inch overlap. The fabric shall be placed transverse to the direction of the flow with the upstream panel overlapping the downstream panel. All installations shall be subject to approval by Engineer.

E. Repairs - A geotextile patch, of the same material, shall be placed over any damaged area and shall extend 12-inches beyond the perimeter of the tear or damaged area. Patch shall be either glued or sewn to the mother fabric or as approved by Engineer.

END OF SECTION

SECTION 31 11 00 - SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Clearing, grubbing, scalping, stripping, and disposal of waste debris.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
a. Section 01 33 00 – Submittal Procedures.

1.2 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2 inches caliper to a depth of 12 inches below subgrade.

D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.3 SUBMITTALS

A. Shop Drawings: Drawings clearly showing clearing, grubbing, and stripping limits.

B. See Section 01 33 00, SUBMITTAL PROCEDURES.

1.4 QUALITY ASSURANCE

A. Obtain Engineer's approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.5 SCHEDULING AND SEQUENCING

A. Prepare site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls to maximum of 5 acres.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.2 LIMITS

A. As follows, but not to extend beyond Project limits.
   1. Excavation, including trenches, 5 feet beyond top of cut slopes or shored walls.
   2. Fill:
      a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
      b. Stripping and Scalping: 2 feet beyond toe of permanent fill.
   3. Structures: 15 feet outside of new structures.
   4. Roadways: Clearing, grubbing, scalping, and stripping 15 feet from centerline.
   5. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.3 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.

C. Cut stumps not designated for grubbing to within 6 inches of ground surface.

D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.4 GRUBBING

A. Grub areas within limits shown or specified.

3.5 SCALPING

A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.

B. Scalp areas within limits shown or specified.

3.6 STRIPPING

A. Do not remove topsoil until after scalping is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

C. Stockpile strippings, meeting requirements for topsoil, separately from other excavated material.

3.7 TOPSOIL

A. Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

3.8 DISPOSAL

A. Clearing and Grubbing Debris:
   1. Dispose of debris.
   2. Burning of debris will not be allowed.
   3. Woody debris may be chipped. Chips may be sold to CONTRACTOR'S benefit or used for landscaping as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Maximum dimensions of chipped material used shall be 1/4-inch by 2 inch. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
   4. Limit disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B. Scalpings: As specified for clearing and grubbing debris.

C. Strippings:
   1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil
   2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION

SECTION 31 22 13 - SUBGRADE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and testing required for preparing subgrade.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
   a. Section 02 41 00 – Demolition.
   b. Section 31 11 00 – Site Preparation.
   c. Section 31 23 16 – Excavation.
   d. Section 31 23 23.13 – Fill and Backfill.

1.2 REFERENCE STANDARDS

A. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)

1.3 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23.13, FILL AND BACKFILL.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23.13, FILL AND BACKFILL.

D. Relative Density: As defined in Section 31 23 23.13, FILL AND BACKFILL.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

F. Standard Specifications: The latest edition, including supplements of the Arkansas State Highway and Transportation Department Standard Specifications for Highway Construction.

1.4 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 02 41 00, DEMOLITION; 31 11 00, SITE PREPARATION; and 31 23 16, EXCAVATION, prior to preparation.

1.5 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for compaction or whenever compaction is resumed after a period of extended inactivity.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.2 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.3 TESTING

A. Test roll subgrade as specified in Standard Specifications to detect soft or loose subgrade or unsuitable material, as determined by Engineer.

3.4 CORRECTION

A. Soft or Loose Subgrade:
   1. Adjust moisture content and recompact, or
   2. Over excavate as specified in Section 31 23 16, EXCAVATION, and replace with suitable material from the excavation, as specified in Section 31 23 23.13, FILL AND BACKFILL.

END OF SECTION

SECTION 31 22 19 - GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Removal and storage of topsoil.
   2. Rough grading the site for site structures, building pads, and drive and parking isles.
   3. Finish grading for planting.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 31 23 16 – Excavation.
      b. Section 31 23 23.13 – Fill and Backfill.
      c. Section 31 23 16.13 – Trenching for Site Utilities.

1.2 SUBMITTALS

A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.3 QUALITY ASSURANCE

A. Perform Work in accordance with Arkansas State Highway and Transportation Department standards.
   1. Maintain one copy on site.

1.4 PROJECT CONDITIONS

A. Protect above – and below – grade utilities that remain.

B. Protect plants, lawns, rock outcroppings, and other features to remain as a portion of final landscaping.

C. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving and curbs from grading equipment and vehicular traffic.

PART 2 - PRODUCTS

2.1 MATERIALS.

A. Topsoil: Shall be soil suitable for sustaining grass and vegetation and shall not have any particles larger than ¾" in diameter and shall be free of any trash, debris, or deleterious material.

B. Other Fill Materials: See Section 31 23 23.13, FILL AND BACKFILL.

PART 3 - EXECUTIONS

3.1 EXAMINATION

A. Verify that survey bench mark and intended elevations for the Work are as indicated.

3.2 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Stake and flag locations of known utilities.

C. Locate, identify, and protect utilities that remain from damage.

D. Notify utility company to remove and relocate utilities.

3.3 ROUGH GRADING

A. Remove topsoil from areas to be further excavated, re-landscaped, or re-graded without mixing with foreign materials.

B. Do not remove topsoil when wet.

C. Remove subsoil from areas to be further excavated, re-landscaped, or re-graded.

D. Do not remove wet subsoil, unless it is subsequently processed to obtain optimum moisture content.

E. When excavating through roots, perform work by hand and cut roots with sharp axe.

F. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.

3.4 SOIL REMOVAL

A. Stockpile excavated topsoil on site.

B. Stockpile excavated subsoil on site.

C. Stockpiles: Use areas designated on site; pile depth not to exceed 8 feet; protect from erosion.

3.5 FINISH GRADING

A. Before Finish Grading:
   1. Verify building and trench backfilling have been inspected.
   2. Verify subgrade has been contoured and compacted.

B. Remove debris, roots, branches, stones, in excess of ½ inch in size. Remove soil contaminated with petroleum products.

C. In areas where vehicles or equipment have compacted soil, scarify surface to depth of 3 inches.

D. Place topsoil in areas where seeding are indicated.

E. Place topsoil to the following compacted thicknesses:
   1. Areas to be Seeded with Grass: 6 inches.

2. Areas to be Sodded: 4 inches.
3. Shrub Beds: 18 inches.
4. Flower Beds: 12 inches
5. Planter Boxes: To within 3 inches of box rim.

F. Place topsoil during dry weather.

G. Remove roots, weeds, rocks, and foreign material while spreading.

H. Near plants spread topsoil manually to prevent damage.

I. Fine grade topsoil to eliminate uneven areas and low spots. Maintain profiles and contour of subgrade.

J. Lightly compact placed topsoil.

3.6 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 foot from required elevation.

B. Top Surface of Finish Grade: Plus or minus ½ inch.

3.7 FIELD QUALITY CONTROL

A. See Section 31 23 23.13, FILL AND BACKFILL for compaction density testing.

3.8 CLEANING AND PROTECTION

A. Remove unused stockpiled topsoil and subsoil. Grade stockpile area to prevent standing water.

B. Leave site clean and raked, ready to receive landscaping.

END OF SECTION

SECTION 31 23 16 - EXCAVATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials associated with excavation.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
   a. Section 31 11 00 – Site Preparation.
   b. Section 31 23 19 – Dewatering.
   c. Section 31 50 00 – Excavation Support Systems.

1.2 SUBMITTALS

A. Shop Drawings:
1. Excavation Plan, Detailing:
   a. Methods and sequencing of excavation.
   b. Proposed locations of stockpiled excavated material.
   c. Proposed and spoil disposal sites.
   d. Numbers, types, and sizes of equipment proposed to perform excavations.

1.3 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.4 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.5 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02 41 00, DEMOLITION, prior to excavating.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 11 00, SITE PREPARATION, prior to excavating.

C. Dewatering: Conform to applicable requirements of Section 31 23 19, DEWATERING, prior to initiating excavation.

D. Excavation Support: Install and maintain, as specified in Section 31 50 00, EXCAVATION SUPPORT SYSTEMS, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1-foot except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not over excavate without written authorization of Engineer.

C. Remove or protect obstructions as shown and as specified in Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS, Article PROTECTION OF WORK AND PROPERTY.

3.2 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.3 TRENCH WIDTH

A. Minimum Width of Trenches:
   1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
      a. Less than 4-inch Outside Diameter or Width: 18 inches.
      b. Greater than 4-inch and up to 18-inch Outside Diameter or Width: 12 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
      c. Greater than 18-inch Diameter or Width: 24-inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
   2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
   3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.4 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES

A. Semicircular, trapezoidal, or 90-degree-V.

B. Excavated or plowed into trench bottom. Forming groove by compaction will not be acceptable.

3.5 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.6 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill,

B. Dispose of debris resulting from removal of underground facilities as specified in Section 02 41 00, DEMOLITION, for demolition debris.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 11 00, SITE PREPARATION, for clearing and grubbing debris.

3.7 EXCAVATION SAFETY

A. Conform to all applicable federal, state, and local regulations.

3.8 SUBGRADE PREPARATION

A. The excavation for all structures and facilities shall be in dewatered, firm, undisturbed earth. If, in the Engineer's opinion, the has been disturbed, corrective measures may include:
   1. Scarification and recompaction to 98 percent relative compaction or,
   2. Overexcavation and replacement with compacted granular fill.

B. If the source of disturbance is determined to be the result of the actions, or inactions of the Contractor, (for example, inadequate dewatering, disturbance by excavating or hauling equipment) the cost of additional subgrade preparation will be at the Contractor's expense.

END OF SECTION

SECTION 31 23 16.13 - TRENCHING FOR SITE UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Backfilling and compacting for utilities outside the building to utility main connections.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 31 05 19 – Geotextile Filter Fabric.
      b. Section 31 22 19 – Grading.
      c. Section 31 23 16 – Excavation.
      d. Section 31 23 23.13 – Fill and Backfill.
      e. Section 31 23 23.16 – Trench Backfill.

1.2 DEFINITIONS

A. Subgrade Elevations: 4 inches below finish grade elevations indicated on drawings, unless otherwise indicated.

B. Finish Grade Elevations: 4 inches above subgrade elevations indicated on drawings, unless otherwise indicated.

1.3 SUBMITTALS

A. See Section 01 33 00, SUBMITTAL PROCEDURES, for submittal procedures.

B. Compaction Density Test Reports.

1.4 PROJECT CONDITIONS

A. Provide sufficient quantities of fill to meet project schedule and requirements. When necessary, store materials on site in advance of need.

B. Verify that survey bench marks and intended elevations for the work are as indicated.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

A. As specified in Section 31 23 23.16, TRENCH BACKFILL.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Identify required lines, levels, contours, and datum locations.

B. Locate, identify, and protect utilities that remain and protect from damage.

C. Notify utility company to remove and relocate utilities.

D. See Section 31 22 19, GRADING, for additional requirements.

3.2 TRENCHING

A. Notify Owner's Representative of unexpected subsurface conditions and discontinue affected Work in areas until notified to resume work.

B. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.

C. Do not interfere with 45 degree bearing splay of foundations.

D. Cut trenches wide enough to allow inspection of installed utilities.

E. Hand trim excavations. Remove loose matter.

F. Remove excavated material that is unsuitable for re-use from site.

G. Remove excess excavated material from site.

3.3 PREPARATION FOR UTILITY PLACEMENT

A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.

B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.

C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.4 BACKFILLING

A. Backfill to contours and elevations indicated using unfrozen materials.

B. Employ a placement method that does not disturb or damage other work.

C. Systematically fill to allow maximum lime for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.

D. Maintain optimum moisture content of fill materials to attain required compaction density.

E. Store grade away from building minimum 2 inches in 10 ft. unless noted otherwise. Make gradual grade changes. Blend slope into level areas.

F. Correct areas that are over-excavated.
   1. Thrust bearing surfaces: Fill with concrete.
   2. Other areas: Use general fill, flush to required elevation, compacted to minimum 98 percent of maximum dry density.

G. Compaction Density Unless Otherwise Specified or Indicated.
   1. Under paving, slabs-on-grade, and similar construction: 98 percent of maximum dry density.
   2. All other locations: 95 percent of maximum dry density.

H. Reshape and re-compact fills subjected to vehicular traffic.

3.5 BEDDING AND FILL AT SPECIFIC LOCATIONS

A. Utility Piping, Conduits, and Duct Bank:
   1. Bedding: Use general fill.
   2. Cover with general fill.
   3. Fill up to subgrade elevation.
   4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

B. At Pipe Culverts:
   1. Bedding: use general fill.
   2. Place filter fabric specified in Section 31 05 19, GEOTEXTILE FILTER FABRIC, over compacted bedding.
   3. Cover with general fill.
   4. Fill up to subgrade elevation.
   5. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.

3.6 TOLERANCES

A. Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.

3.7 FIELD QUALITY CONTROL

A. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D6938, or ASTM D3017.

B. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 ("Modified Proctor").

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

D. Frequency of Tests; One test per every other lift per 200 lineal feet of trench.

3.8 CLEAN-UP

A. Leave unused materials in a neat compact stockpile.

B. Remove unused stockpiled material, leave area in a clean and neat condition. Grade stockpile areas to prevent standing surface water.

C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

END OF SECTION

SECTION 31 23 19 – DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work required to dewater excavations.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
   a. Section 01 50 00 – Temporary Facilities and Controls.

1.2 WATER CONTROL PLAN

A. As a minimum, include:
1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of dewatering system.

B. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Remove and control surface and subsurface water during periods when necessary to properly accomplish Work.

3.2 SURFACE WATER CONTROL

A. See Section 01 50 00, TEMPORARY FACILITIES AND CONTROLS.

B. Remove surface runoff controls when no longer needed.

3.3 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry conditions and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. Design and Operate Dewatering Systems:
   1. To prevent loss of ground as water is removed.
   2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
   3. To relieve artesian pressures and resultant uplift of excavation bottom.
   4. Prevent softening, loosening or otherwise disturbing the excavation subgrade.

C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

D. Provide supplemental ditches and sumps only as necessary to collect water from local seeps.

3.4 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in a manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. The discharge of ground water into treatment facilities will not be permitted unless specifically authorized by the Owner. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency, if Owner allows groundwater discharge into facilities.

3.5 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, sheeting bracing, underpinning, or compaction grouting.

3.6 REMEDIATION OF GROUNDWATER AFTER DEPLETION

A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to the well owner prior to beginning Work or as satisfactory to each well owner.

END OF SECTION

SECTION 31 23 23.13 - FILL AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required for fill and backfill for all excavations other than trench type excavations.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
   a. Section 03 30 00 – Cast-In-Place Concrete.
   b. Section 31 11 00 – Site Preparation.
   c. Section 31 22 13 – Subgrade Preparation.
   d. Section 31 23 16 – Excavation.
   e. Section 31 23 23.16 – Trench Backfill.
   f. Section 32 11 00 – Base Course.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American Society for Testing and Materials (ASTM):
   a. ASTM C117, Standard Test Method for Materials Finer Than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   b. ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. ASTM D75, Standard Practice for Sampling Aggregates.
   d. ASTM D698, Standard Test Methods for Laboratory Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
   e. ASTM D1556, Standard Test Method for Density of Soil in Place by the Sand Cone Method.
   f. ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)
   g. ASTM D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
   h. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   i. ASTM D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

1.3 DEFINITIONS

A. Relative Compaction:
1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:
   1. Determined in accordance with ASTM D1557 specified to maximum dry density for relative compaction.
   2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material.

G. Geosynthetics: Geotextiles, geogrids, or geomembranes.

H. Well-Graded:
   1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
   2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
   3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
   1. 1-foot outside outermost edge at base of foundations or slabs.
   2. 1-foot outside outermost edge at surface of roadways or shoulder.
   3. 0.5-foot outside exterior at spring line of pipes or culverts.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near site.

K. Selected Backfill Material/Earth fill: Materials available onsite that Engineer determines to be suitable for specific use.

L. Imported Material: Materials obtained from sources suitable for specified use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

O. Standard Specifications: When referenced in this section, shall mean the latest edition of the Arkansas State Highway and Transportation Department Standard Specifications for Highway Construction.

1.4 SUBMITTALS

A. Quality Control Submittals:
   1. Catalog and manufacturer's data sheets for compaction equipment.
   2. Certified test results from independent testing agency.

1.5 QUALITY ASSURANCE

A. Notify Engineer when:
   1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
   2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
   3. Fill material appears to be deviating from Specifications.

1.6 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 02 41 00, DEMOLITION; 31 11 00, SITE PREPARATION; 31 23 16, EXCAVATION; and 31 22 13, SUBGRADE PREPARATION, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, CAST-IN-PLACE CONCRETE. Obtain acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

D. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 22 13, SUBGRADE PREPARATION.

PART 2 - PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Gradation Tests: It will be the Contractor's responsibility to conduct testing as necessary to locate acceptable sources of imported material.

2.2 EARTH FILL

A. Excavated material from required excavations, free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Earth fill shall not be used beneath any slab-on-grade or equipment pad. Use granular fill, as defined below.

2.3 GRANULAR FILL

A. Type 57 aggregate as specified in ASTM D 448.

2.4 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.5 BASE COURSE ROCK

A. As specified in Section 32 11 00, BASE COURSE.

2.6 FOUNDATION STABILIZATION ROCK

A. Crushed rock or pit run rock.

B. Uniformly graded from coarse to fine.

C. Free from excessive dirt and other organic material.

D. Maximum 2-1/2 inches particle size.

PART 3 - EXECUTION

3.1 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.16, TRENCH BACKFILL.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.16, TRENCH BACKFILL, before resuming filling or backfilling specified in this section.

F. Tolerances:
1. Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

H. Fill and backfill materials shall be conditioned to a water content that is within 2 percentage points (plus or minus) of the optimum required for compaction as determined by ASTM D1557.

3.2 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with D1557.

B. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 6-inch maximum thickness and compact each lift to minimum of 98 percent relative density.

C. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D1557.

3.3 FILL

A. Outside Influence Areas Beneath Structures, Tanks, Pavements, Curbs, Slabs, and Other Facilities: Unless otherwise shown, place earthfill as follows:
1. Allow for 6-inch thickness of topsoil where required.
2. Maximum 9-inch thick lifts.
3. Place and compact fill across full width of embankment.
4. Compact to minimum 95 percent relative compaction as determined in accordance with ASTM D1557.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.4 SITE TESTING

A. Gradation:
1. One sample from each 400 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D1556, or ASTM D6938. During placement of materials, test as follows:
1. One test per every other lift per 200 lineal feet of roadway or trench.
2. A minimum of two tests on granular fill beneath structures.
3. A minimum of two test per 300 cubic yards during backfilling of walls.

C. Testing shall be the Contractor's responsibility and conducted by persons experienced in such work.

3.5 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 00, BASE COURSE.

3.6 REPLACING OVEREXCAVATED MATERIAL,

A. Replace excavation carried below grade lines shown or established by Engineer as follows:
1. Beneath Footings: Concrete of strength equal to that of respective footing.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.
4. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.16, TRENCH BACKFILL.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.16, TRENCH BACKFILL.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run:Vertical Rise or Flatter): Earthfill.
   b. Steep Slopes (Steeper than 3: 1):

1) Correct overexcavation by transitioning between areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
2) Backfilling overexcavated areas is prohibited unless, in opinion, backfill will remain stable, and overexcavated material is replaced as compacted earth fill.

END OF SECTION

SECTION 31 23 23.16 - TRENCH BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Bedding, backfill, and other related materials required to install a buried pipe or conduit.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
   a. Section 03 30 00 – Cast-In-Place Concrete.
   b. Section 31 23 19 – Dewatering.
   c. Section 31 23 23.13 – Fill and Backfill.
   d. Section 32 12 16 – Asphalt Concrete Pavement.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI): 253.1, Safety Color Code.
2. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.
3. American Society for Testing and Materials (ASTM):
   a. ASTM D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
   b. ASTM C94, Specification for Ready-Mixed Concrete.
   c. ASTM C117, Standard Test Method for Materials Finer than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. ASTM C150, Standard Specification for Portland Cement.
   f. ASTM C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.
   h. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft-lbf/cubic ft).
   i. ASTM D1140, Standard Test Methods for Amount of Material in Soils Finer than the No. 200 (75 micrometer) Sieve.
   j. ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf).
   k. ASTM D3776, Standard Test Methods for Mass per Unit Area (Weight) of Fabric.
   l. ASTM D3786, Standard Test Method for Bursting Strength of Textile Fabrics: Diaphragm Bursting Strength Tester Method.
   m. ASTM D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   n. ASTM D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

o. ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
p. ASTM D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
q. ASTM D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
r. ASTM D4991, Standard Test Method for Leakage Testing of Empty Rigid Containers by Vacuum Method.
s. ASTM D5034, Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).

1.3 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by the Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after stabilization and installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either the as-compacted field dry density or the maximum dry density, as determined by the Engineer.

H. Relative Density: As defined by ASTM D4253 and ASTM D4254.

I. Selected Backfill Material: Material available that the Engineer determines to be suitable for a specific use.

J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Well-Graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.4 SUBMITTALS

A. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

B. Samples:
1. Trench stabilization material.
2. Bedding and pipe zone material.
3. Granular drain.
4. Granular backfill.
5. Earth backfill.
6. Sand(s).

7. Geotextile.

C. Quality Control Submittals: Catalog and manufacturer's data sheets for compaction equipment.

D. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to site.

E. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 - PRODUCTS

2.1 MARKING TAPE

A. Plastic:
1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 4 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Allen; Markline.

B. Metallic:
1. Solid aluminum foil, visible on unprinted side, encased in a protective high visibility, inert polyethylene plastic jacket.
2. Thickness: Minimum 5 mils.
3. Width: 12 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
6. Manufacturers and Products:
   a. Reef Industries; Terra Tape Sentry Line.
   b. Allen; Detectatape.

C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color[a]	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Water, irrigation, and slurry lines
[a]As specified in ANSI Z53.1, Safety Color Code.	

2.2 TRENCH STABILIZATION MATERIAL

A. Clean, hard, durable 3-inch minus crushed rock gravel, or pit run, free from clay balls, other organic materials, or debris.

B. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

2.3 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.
   1. Duct Banks: 3/4-inch maximum particle size.
   2. PVC Irrigation System Piping, and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
   3. Pipe Under 18 Inches Diameter: 3/4-inch maximum particle size, except 1/4-inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3 inches diameter.
   4. Pipe Greater than 18 Inches Diameter: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe. 3/4-inch maximum particle size for PVC, FRP, or HDPE Pipe.
   5. Perforated Pipe: Granular drain material.
   6. Conduit and Direct-Buried Cable:
      a. Sand, clean or clean to silty, less than 12 percent passing the No. 200 sieve.
      b. Individual Particles: Free of sharp edges.
      c. Maximum Size Particle: Pass a No. 4 sieve.
      d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.4 EARTH FILL

A. As specified in Section 31 23 23.13, FILL AND BACKFILL.

2.5 CONTROLLED LOW STRENGTH FILL

A. Select and proportion ingredients to obtain compressive strength between 50 and 150 psi at 28 days in accordance with ASTM D4832.

B. Materials:

1. Cement: ASTM C150, Type I or II.
2. Aggregate: ASTM C33, Size 7.
3. Fly Ash (if used): ASTM C618, Class C.
4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.6 CONCRETE BACKFILL

A. Provide as specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.7 TOPSOIL

A. Topsoil removed and stockpiled from onsite excavation.

2.8 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:
1. Earth backfill, including specified class(es).
2. Trench stabilization material.
3. Bedding and pipe zone material.

B. Certify Laboratory Performance of Mix Designs:
1. Controlled low strength fill.
2. Concrete.

PART 3 - EXECUTION

3.1 TRENCH PREPARATION

A. Water Control: Conform to Section 31 23 19, DEWATERING.
1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.2 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If it is encountered that it may require removal to prevent pipe settlement, notify Engineer. Engineer will determine the depth of overexcavation, if any, required.

3.3 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.4 BEDDING

A. Furnish imported bedding material where, in the opinion of the Engineer, excavated material unsuitable for bedding or insufficient in quantity.

B. Place over the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness:
1. Pipe, 15-inch and Smaller: 4 inches.
2. Pipe, 18-inch to 36 inch: 6 inches.
3. Pipe, 42-inch and Larger: 12 inches.
4. Conduit: 3 inches.
5. Direct-Buried Cable: 3 inches.
6. Duct Banks: 3 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.5 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:
1. Pipe: 12 inches above top of pipe, unless shown otherwise.
2. Conduit: 3 inches above top of conduit, unless shown otherwise.
3. Direct-Buried Cable: 3 inches above top of cable, unless shown otherwise.
4. Duct Bank: 3 inches above top of duct bank, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
1. Pipes 10 Inches and Smaller Diameter: First lift less than or equal to pipe-diameter.
2. Pipes Over 10 Inches Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

F. Do not use power-driven impact compactors to compact pipe zone material.

3.6 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried piping, at depth of 2 feet. Coordinate with piping installation drawings.
   1. Metallic Marking Tape: Install with nonmetallic piping
   2. Plastic Marking Tape: Install with metallic piping.

3.7 BACKFILL ABOVE PIPE ZONE

A. General:
   1. Process excavated material to meet specified gradation requirements.
   2. Adjust moisture content as necessary to obtain specified compaction.
   3. Do not allow backfill to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over the top of pipe.
   4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
   5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
   6. Backfill around structures with same class backfill as specified for adjacent trench unless otherwise shown or specified.

B. Select Excavated Backfill:
   1. Place in lifts not exceeding 9-inch thickness.
   2. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

C. Excavated Backfill: Backfill trench above the pipe zone with granular backfill in lifts not exceeding 8 inches. Compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

D. Concrete Backfill:
   1. Place above bedding.
   2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
   3. Do not allow dirt or foreign material to become mixed with concrete during placement.
   4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
   5. Prevent flotation of pipe.
   6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
   7. Do not encase pipe joints except within the limits of the concrete backfill.

E. Controlled Low Strength Fill:
   1. Discharge from truck mounted drum type mixer into trench.
   2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3.8 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6 inches of backfilled trench.

B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.9 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain the surface of the backfilled trench level with the adjacent ground surface.

D. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, ASPHALT CONCRETE PAVEMENT.

E. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill or facilities constructed over trench backfill, will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 23 23.33 – FLOWABLE FILL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies controlled low strength concrete flowable fill.

B. Comply with all requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE except as specifically modified in this Section.

C. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 03 30 00 - Cast-In-Place Concrete.

1.2 DEFINITIONS

A. Flowable Fill: Controlled low strength concrete ready mix.

1.3 SUBMITTALS

A. Comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

1.4 QUALITY ASSURANCE

A. Comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE and as follows:
   1. Concrete Mixture for Flowable Fill only:
      a. Compressive strength 75 to 100 psi.
      b. Cement 80-100 lbs per CY.
      c. Fly Ash 200-300 lbs per CY.
      d. Sand variable to equal one CY.
      e. Water 65 to 199 gallons per CY.
      f. Unit weight approximately 110 lbs/CY.

PART 3 - EXECUTION

3.1 EXECUTION

A. Comply with the requirements of Section 03 30 00 CAST-IN-PLACE CONCRETE.

END OF SECTION

SECTION 31 32 00 - SOIL EROSION STABILIZATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to minimize erosion and comply with Storm Water Pollution Prevention Plan.

1.2 STABILIZATION

A. Soil Erosion Stabilization:
   1. Ground surfaces exposed during the wet weather conditions:
   2. Areas which will not be subjected to heavy wear by ongoing construction traffic.
   3. Temporary and long term stabilization of new or disturbed ditches, swales, detention ponds, or disturbed ground with intermittence construction traffic.

B. Permanent Stabilization:
   1. Permanently stabilize exposed soil surfaces at finished grades.
   2. Permanent stabilization methods include, but are not limited to, seeding (permanent), mulching, and landscaping.
   3. Immediately perform permanent stabilization at each completed excavation and areas except for areas that are scheduled to be redisturbed.
   4. Incorporate all permanent erosion control features into the project at the earliest practical time.

C. Buffer Zone: Undisturbed area or strip of natural vegetation or an established suitable planting adjacent to a disturbed area that reduces erosion and runoff.

D. Standard Specifications: The latest edition, including supplements, of the Arkansas State Highway and Transportation Department Standard Specifications for Highway Construction.

1.3 SUBMITTALS

A. Shop Drawings: Product Data for the following items:
   1. Erosion control rock.
   2. Fertilizer.
   3. Seed.
   4. Mulch.
   5. Erosion control rock.
   6. Soil tackifier
   7. Reinforced plastic covering.
   8. Silt fence.
   9. Straw bales.
   10. Posts for straw bales.
   11. Dust controller.
   12. Wire mesh.

B. See Section 01 33 00, SUBMITTAL PROCEDURES.

1.4 DELIVERY, STORAGE, AND PROTECTION

A. General: Prevent or reduce the discharge of pollutants to stormwater from all material delivery and storage by minimizing the storage of hazardous materials storing materials in a designated

area, installing Secondary containment, conducting regular inspection, and training employees and subcontractors.

B. Seed:
   1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
   2. Keep dry during storage.

C. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.5 SEQUENCING AND SCHEDULING

A. Install erosion and sediment control devices before starting earth disturbance activities and as drainage facilities get constructed.

B. Complete Soil Preparation: Seeding, fertilizing, mulching and matting on disturbed areas that will require stabilization either because the area has reached final grade (permanent landscaping) or because the area will remain unworked for over 14 days (temporary seeding) during the wet season.

C. Notify Engineer at least 3 days in advance of:
   1. Materials delivery.
   2. Start of stabilization activity.

D. Seeding: Perform between March 15 and September 15.

1.6 MAINTENANCE

A. Operations:
   1. Seeded Areas: Perform during maintenance period to include:
      a. Watering: Keep seeded surface moist.
      b. Washouts: Repair by filling with topsoil, fertilizing, seeding, and mulching.
      c. Mulch: Replace wherever and whenever washed or blown away.
      d. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
      e. Reseed during next planting season if scheduled end of maintenance period falls after September 15.
      f. Reseed entire area if satisfactory stand does not develop by July 1 of the following year.
      g. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
   2. Inspect, repair, and replace as necessary all erosion control measures during the time period from start of construction to completion of construction.
   3. Inspect a minimum of at least once every 7 days or after a 1/2-inch storm event in a 24-hour period.
   4. Furnish and install a rain gauge at the project site to monitor rainfall. At no time shall more than 1-foot depth of sediment be allowed to accumulate in any erosion control device.

B. Sediment Removal:
   1. Remove sediment from erosion control devices and work into the grading plan at least once a week as required to maintain proper operation of devices. The cleaning operation shall not dispose of sediment offsite

2. Sediment shall be removed and the controls upgraded or repaired as needed as soon as practicable, but not later than 2 days after the surrounding exposed ground has dried sufficiently to prevent further damage from equipment needed for repair operations.
3. In the event of continuous rainfall over a 24 hour period, or other circumstances that preclude equipment operation in the area, hand carry and install additional sediment controls as approved by the Engineer.

PART 2 - PRODUCTS

2.1 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.

B. Fertilizer shall have the following minimum percentage of plant food by weight:
1. Summer Hydroseed Mix:
   a. Nitrogen: 20 percent.
   b. Phosphoric Acid: 10 percent.
   c. Potash: 10 percent.
2. Winter Hydroseed Mix:
   a. Nitrogen: 16 percent.
   b. Phosphoric Acid: 8 percent.
   c. Potash: 0 percent.

2.2 SEED

A. Common bermudagrass meeting the requirements of Section 620 of the Arkansas State Highway and Transportation Department Standard Specifications for Highway Construction.

2.3 MULCH

A. Wood Cellulose Fiber Mulch:
1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed a suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, the material fibers will become uniformly suspended to form a homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

B. Straw:
1. Clean salt hay or threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds. Suitable for spreading with mulch blower equipment.
2. Average Stalk Length: 6 inches.
3. Seasoned before baling or loading.

2.4 EROSION CONTROL MATTING

A. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.

B. Manufacturers and Products:
1. American Excelsior Company, Dallas, TX; Curlex Mat.
2. North American Green, Evansville, IN; S150 blanket.

2.5 REINFORCED PLASTIC COVERING

A. Co-extruded, copolymer laminate reinforced with a nonwoven grid of high strength nylon cord submersed in a permanently flexible adhesive media allowing for equal tear resistance in all directions.

B. Black in color and ultraviolet stabilized.

C. Physical Requirement (Minimum Average Roll Values):
   1. Tear Strength: 130 pounds.
   2. Elongation: 620 percent.
   3. Minimum Thickness: 6 mil.

D. Manufacturers:
   1. Reef Industries, Inc., Houston, TX.
   2. Griffolyn Co., Houston, TX.

2.6 SILT FENCE

A. Support Posts: As recommended by manufacturer of geotextile.

B. Fasteners: Heavy-duty wire staples at least 1-inch long, tie wires, or hog rings, as recommended by manufacturer of geotextile.

C. Filter Fabric: Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.
   1. Filaments: Resistant to damage from exposure to ultraviolet rays and heat.
   2. Material Edges: Finish so that, filaments retain their relative positions under stress.

D. In accordance with requirements of Table No. 1:

Table No. 1 – Filter Fabric

Physical Property	Required Value	Test Method
Weight, pz/sq yd, min.	4	ASTM D3776
Equivalent Opening Size, max.	50-70	U.S. Standard Sieve
Grab Tensile Strength, lb, min. ARV	160	ASTM D4632
Elongation, % max.	25	ASTM D1682
Mullen Burst Strength, psi, min. ARV	200	ASTM D3786
Ultraviolet Radiation Resistance, % Strength Retention	70	ASTM D4355
Flow Rate, gpm/sf, min. ARV	30 to 50	ASTM D4491

E. Manufacturers:
   1. Polyfelt, Evergreen, AL.
   2. Dupont Co., Wilmington, DE.

3. Mirafi, Inc., Charlotte, NC.

2.7 STRAW BALES

A. Machine baled clean salt hay or straw of oats, wheat, barley, or rye, free from seed of noxious weeds, using standard baling wire or string.

2.8 POSTS FOR STRAW BALES

A. 2-inch by 2-inch untreated wood or commercially manufactured metal.

2.9 DUST CONTROLLER

A. Nontoxic materials that do not have an adverse effect on soil structure or establishment and growth of vegetation.

PART 3 - EXECUTION

3.1 GENERAL

A. Erosion control measures are required during all construction and site disturbance activity and shall remain until permanent site ground covers are in place.

B. The implementation of the erosion control plan and the construction maintenance, replacement and upgrading the erosion control devices are the responsibility of the Contractor until all construction is completed and landscaping established and approved. During the construction period, the erosion control devices shall be upgraded for unexpected storm events and to ensure that sediment and sediment laden water do not leave the site.

C. Maintain existing buffer zones adjacent to project limits. Keep all construction equipment, debris and soils out of the natural buffer zone.

3.2 GRAVEL CONSTRUCTION ENTRANCES

A. Provide a graveled construction access at each access point between the site and any public or private road or other paved surface.

B. Place subgrade geotextile, as specified, on the ground prior to erosion control rock placement.

C. Place erosion control rock over the geotextile to a minimum thickness of 8 inches.

D. Minimum dimensions for construction entrances are 50-foot in length by 16-foot width.

E. Contractor shall provide a minimum of 4 inches of erosion control rock for each entrance 3 times during the project at times directed by the Engineer to maintain proper function. More frequent applications of rock may be required, and if so, shall be considered as incidental work.

3.3 SOIL PREPARATION

A. Before start of hydroseeding, and after surface has been shaped and graded, and lightly compacted to uniform grade, scarify soil surface to minimum depth of 1 inch.

3.4 FERTILIZER

A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 1-inch of soil.

B. Application Rate: 5 pounds per 1,000 square foot over areas to be seeded. Use of approved hydraulic equipment to sow seed and distribute fertilizer at the same time will be acceptable.

3.5 SEEDING

A. Prepare 1-inch depth seed bed; obtain Engineer's acceptance prior to proceeding.

B. Apply by hydroseeding method on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.

C. Summer Application:
1. Prepare and apply slurry as follows:

Item	Rate
Seed Mix	200 pounds per acre
Fertilizer	750 pounds per acre
Wood Cellulose Fiber Mulch	As recommended by manufacturer
Water	As necessary

2. Irrigation: 1-inch per week to seeded areas.

3.6 MULCHING

A. Apply uniformly on disturbed areas that will remain undisturbed for 7 days or more, as requested by Engineer, and on all seeded areas.

B. Application: Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.
1. Straw: Apply by hand or mechanical means to minimum depth of 2 inches.
2. Wood Cellulose Fiber: 1,000 to 1,500 pounds per acre.

3.7 EROSION CONTROL MATTING

A. Place on seeded slopes 4H:1V and steeper.

B. Apply seed and fertilizer prior to matting.

C. At top of slope, entrench material in a 6-inch by 6-inch trench and staple at 1-foot intervals. At the bottom of the slope, extend the mat 2 feet beyond the toe of slope, turn material under 4 inches and staple at 1-foot intervals.

D. Mats shall be stapled in place as they are installed down the slope face. The mat shall have direct contact with the soil surface.

E. Overlap:
1. Lengthwise: 1-foot minimum.

2. Crosswise: 6-inches minimum.

3.8 REINFORCED PLASTIC COVERING

A. Place on areas where hydroseeding and erosion control matting have not controlled erosion and over all temporary stockpiles.

B. Install in single thickness, strips parallel to direction of drainage. Anchor plastic in 6-inch by 6-inch trench backfilled with compacted native material.

C. Maintain tightly in place by using sand bags on ropes with a maximum 10-foot grid spacing in all directions.

D. Tape or weight down full length, overlap seams at least 12 inches.

E. Remove at final acceptance unless notified otherwise by Engineer.

3.9 SILT FENCE

A. Install prior to starting earth disturbing activities upslope of fence.

B. One-piece filter fabric or continuously sewn to make one-piece filter fabric for full height of the fence, including portion buried in the toe trench.

C. When joints are necessary, splice filter fabric together only at a support post, with a minimum 6-inch overlap, and securely fasten both ends to support post.

D. Filter fabric shall not extend more than 24 inches above the ground surface. Securely fasten to upslope side of each support post using ties. Filter fabric shall not be stapled to existing trees.

E. Fasten wire mesh material support fence securely to upslope side of post fasteners. Extend wire into the trench a minimum of 4 inches, and not more than 36 inches above the ground surface.

F. Take precaution not to puncture filter fabric during installation. Repair or replace damaged area.

G. Remove silt fence after upslope area has been permanently stabilized. Immediately dress sediment deposits remaining after the silt fence has been removed to conform to existing grade. Prepare and seed graded area.

3.10 TEMPORARY SOIL STOCKPILES

A. Cover with reinforced plastic covering, as directed in Article REINFORCED PLASTIC COVERING.

B. Protect perimeter of stockpile from erosion with ditches.

3.11 STRAW BALES

A. Embed minimum of 4 inches in flat-bottomed trench. Place across swales or ditches to reduce velocities of concentrated flows. Space bales a minimum of 100-foot spacing.

B. Place with ends tightly abutting or overlapped. Corner abutment is not acceptable.

C. Install so that bale bindings are oriented around the sides and not over the top and bottom of the bale.

D. Use two posts for each bale. Drive posts through the bale until top of post is flush with top of bale.

E. Wedge loose straws in any gaps between bales.

3.12 DUST CONTROL

A. Apply appropriate dust control measures on a continuous basis until permanent stabilization measures are in place.

B. Apply on construction routes and other disturbed areas subject to surface dust movement and where off-site damage may occur if dust is not controlled.

C. Avoid creating erosion when using water as a dust controller.

3.13 CLEAN-UP

A. Sediment trapped in erosion control devices shall be regraded into the slopes on the site. Do not flush sediment-laden water into the drainage system.

B. After site restoration is complete and when approved by the Engineer, all temporary erosion control measures shall be completely removed. Immediately shape and permanently stabilize areas affected by the removal process.

C. Silt fence, straw bales, reinforced plastic covering, and any other erosion control devices shall be disposed off site to locations that are approved by federal, state, and local authorities.

END OF SECTION

SECTION 31 50 00 - EXCAVATION SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work required to install and remove excavation support systems.

1.2 SUBMITTALS

A. Shop Drawings:
   1. Excavation support plan.
   2. Movement monitoring plan.

B. Quality Control Submittals: Movement measurement and data and reduced results indicating movement trends.

1.3 QUALITY ASSURANCE

A. Provide surveys to monitor movements of critical facilities.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary and where shown to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

B. It will be the Contractor's responsibility to determine if areas will require excavation slope retention to protect existing structures and facilities from damage resulting from the Contractor's excavation or excavation methods.

C. The Contractor will also be responsible for providing shoring, sheeting and bracing of excavations as needed for worker safety and as may be required by federal, state, and local regulations.

3.2 EXCAVATION SUPPORT PLAN

A. Prepare excavation support plan addressing following topics:
   1. Details of shoring, bracing, sloping, or other provisions for worker protection of existing structures or facilities.
   2. Design assumptions and calculations.
   3. Methods and sequencing of installing excavation support.
   4. Proposed locations of stockpiled excavated material.
   5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.

3.3 MOVEMENT MONITORING PLAN

A. Prepare movement monitoring plan addressing following topics:
   1. Survey control.
   2. Locations of monitoring points (at least one every 50 feet).

3. Plots of data trends.
4. Interval between surveys (not to exceed 5 working days).

B. Movement monitoring shall be done on every existing structure that is adjacent to the Contractor's excavations.

C. Results of movement monitoring will be delivered for the Engineer at least once a week.

3.4 REMOVAL OF EXCAVATION SUPPORT

A. Do not begin to remove excavation support until it can be removed without damage to existing facilities, completed Work, or adjacent property.

B. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities. Maintain soil wall support as excavation is backfilled.

C. Fill voids immediately with approved backfill compacted to density specified in Section 31 23 23.13, FILL AND BACKFILL.

END OF SECTION

SECTION 31 70 19 - BORED EXCAVATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Boring under streams, highways, roads and railroads.

B. Casing pipe.

1.2 RELATED SECTIONS

A. Section 31 22 13, SUBGRADE PREPARATION

B. Section 31 23 23.16, TRENCH BACKFILL

1.3 SUPERVISION AND QUALITY

A. Contractor's work shall comply with all codes governing and all insurance requirements. Work shall be undertaken only when the construction superintendent is present and supervising the work.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

A. Crossings shall be completed in accordance with applicable federal, state and local regulations. In the case of railroad crossings, the project shall comply with regulations established by the railroad company.

PART 2 - PRODUCTS

2.1 CASING PIPE

A. Smooth wall casing pipe shall be of welded steel construction and shall be new material with a minimum yield point of 35,000 psi. The pipe shall have a wall thickness as noted on the plans. The casing pipe shall be cleaned and coated both inside and outside with two coats of coal tar paint, Koppers "Bitumastic Super Service Black," Tnemec "450 Heavy Tnemecol," or USS Chemicals "Pitt Chem 103."

1.	Carrier Pipe	4" 6" 8" 10" 12" 14" 16" 18" 20"
2.	Casing	10" 12" 14" 18" 18" 20" 24" 30" 30"

B. Casing wall thickness shall be 1/4 inch thick for casing pipe 10 inch thru 16 inches, 3/8 inch thick for casing pipe 18 inch thru 24 inches, 1/2 inch thick for 30 inches. Casing wall thickness for any railroad bores shall be specified by the railroad.

2.2 CARRIER PIPE

A. Carrier pipe shall be as shown on plans.

2.3 CASING SPACERS

A. Spacers shall be made of injection molded high density polyethylene. The spacers shall be of a projection type that has a minimum number of projections around the circumference totaling the number of diameter inches. Spacers shall be spaced a maximum of 10 feet apart. Spacers shall be fastened tightly to the barrel of the carrier pipe to prevent slippage. Spacers must provide

sufficient height to permit clearance between the pipe bell and the casing. Spacers shall be ISO 9002 certified for strength and quality.

2.4 CASING FILL MATERIAL

A. Sand fill shall be clean pea gravel with uniform gradation of 1/8" to 3/8" for blowing into casing pipe.

PART 3 - EXECUTION

3.1 GENERAL

A. Crossings under highways, roads and railroads shall be continuously encased under the through roadways, median, ramps and shoulder area to the limits called for or required by the federal, state and local regulations. Railroad crossings shall conform to the requirements of the regulations established by the railroad company.

B. Work shall be performed in a safe and proper manner, with suitable precautions being taken against hazards of every kind. All crossings shall be bored, unless rock formations or other obstructions are encountered that prevents boring or pushing operations. If such conditions are encountered, excavation shall be performed by standard tunneling methods.

C. Excavations shall provide adequate clearance for installation of and removal of equipment.

D. Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of the Engineer. No backfill, fill or embankment materials shall be installed on frozen surfaces nor shall frozen materials, snow or ice be placed in any backfill, fill or embankments.

E. When operating on pavements or walks all equipment shall be rubber tired, except for excavation equipment. Excavating equipment, in such cases, shall not have grousers, cleats or lugs on the tracks. The Contractor shall take all reasonable precautions to protect the existing pavements and walks.

F. No classification of excavated materials shall be made. Boring excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition or condition thereof.

G. Pipe lines and other existing underground installations and structures in the vicinity of the work to be done hereunder are indicated on the plans according to the best information available to the Owner. The Owner does not guarantee the accuracy of such information. The Contractor shall make every effort to locate all underground pipe lines, conduits and structures by contacting owners of underground utilities and by prospecting in advance of excavation and boring. Damage to any existing underground installation caused by the Contractor's operation shall be repaired at the Contractor's expense.

H. Any delays or extra cost to the Contractor caused by pipe lines or other underground structures or obstructions not shown by the plans, or found in locations different than those indicated, shall not constitute a claim for extra work, additional payment or damages.

I. Erosion control of disturbed areas shall be required during the construction period through the use of check dams, siltation pools, mulching, etc.

J. The Contractor shall meet the specific requirements of the Highway Department or Railroad. The Contractor shall obtain all necessary permits and insurance.

K. Operation:
1. Use all means necessary to control dust or mud that may interfere with operation.

L. Protection:
1. Use all means necessary to protect material and preserve specification requirements.
2. Replace all damaged material or material that has lost specification requirements.

3.2 EXCAVATION

A. The Contractor shall, during the entire period of construction, provide and maintain any necessary equipment as will, whenever practicable, keep his excavations reasonably free from water pending construction. When necessary to use pumps the Contractor must dispose of the water without detriment to adjacent properties.

3.3 SHEETING AND SHORING

A. General:
1. Except where banks may be cut back on a stable slope, excavation for trenches shall be properly and substantially sheeted, braced and shored, as necessary, to prevent caving or sliding, to provide protection for the workmen and the work, and to provide protection for existing structures and facilities. Sheeting, bracing and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure, and shall be rigid, maintaining its shape and position under all circumstances.

3.4 CASING AND CARRIER PIPE INSTALLATION

A. Casing pipe:
1. Before starting work on borings, complete details of the method of operation and casing to be used shall be submitted to the Engineer for review. All permits shall be obtained by the Contractor.
2. Casing pipes shall have a clear inside diameter not smaller than the size indicated on the schedule.
3. The casing pipe shall be installed by jacking into place. Earth displaced by the casing pipe shall be removed through the interior of the casing by hand, by auger, or by other acceptable means. Sections of the casing pipe shall be welded together to form a continuous casing capable of resisting all stresses, including jacking stresses. The casing pipe in its final position shall be straight and true in alignment and grade. There shall be no space between the earth and the outside of the casing.

B. Carrier pipe:
1. Polyethylene casing insulators shall be strapped to each end of each piece of pipe. The pipe shall then be pushed into the casing pipe with care being taken to ensure the joints are not displaced. The joints in the installed pipe within the casing shall be tested for leakage before the backfill is installed.

C. Casing backfill:
1. Following the installation of the carrier pipe in the casing pipe, the entire annular space between the pipe and the casing walls shall be filled. The ends of the casing shall then be closed with a concrete or masonry plug 8 inches thick.

D. Casing backfill:

1. Following the installation of the carrier pipe in the casing pipe, the ends of the casing pipe shall then be closed with wrap around or pull-on end seals.

3.5 FINAL GRADING AND DISPOSAL OF EXCESS EXCAVATED MATERIALS

A. General:
   1. Except as otherwise indicated, all excess excavated materials shall be disposed of by the Contractor away from the site of the work.
   2. Excavated rock, junk and debris encountered in excavation work, and other similar waste materials shall be disposed of away from the site of the work.
   3. The disposal of waste and excess excavated materials, including hauling, handling, leveling and surfacing, shall be at the Contractor's expense.

B. Restoration of disturbed earth:
   1. The Contractor shall restore all earth areas disturbed from the original condition by his operations. Restoration will be by seeding, fertilizing and mulching to obtain an established cover or by appropriate pavement and street repair.

3.6 RESPONSIBILITY OF CONTRACTOR FOR BACKFILL SETTLEMENT

A. The Contractor shall be responsible financially and otherwise, for:
   1. All settlement of trench and other backfill which may occur from time of original backfilling until the expiration of 1 year after the date of final payment for the entire contract under which the backfilling work was performed.
   2. The refilling and repair of all backfill settlement and the repair or replacement to the original or a better condition of all pavement, top surfacings, driveways, walks, surface structures, utilities, drainage facilities and sod which may have been damaged as a result of backfill settlement or which have been removed or destroyed in connection with backfill replacement operations.
   3. All damage claims or court actions against the Owner for any damage directly or indirectly caused by backfill settlement.

B. The Contractor shall make all necessary backfill replacements and repairs, or replacements appurtenant thereto, within 30 days after notification by the Owner or Engineer. Upon the Contractor's failure to do so, the Owner may do, or have done, the necessary work and charge the cost to the Contractor.

3.7 MAINTENANCE OF TRAFFIC

A. The Contractor shall conduct his work so as to interfere as little as possible with public travel, whether vehicular or pedestrian; whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, the Contractor shall at his own expense provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel, and shall give reasonable notice to owners of private drives before interfering with them; provided however, that such maintenance of traffic will not be required at any point where the Contractor has obtained permission from the owner and tenant of private property, or from the authority having jurisdiction over the public property involved, to obstruct traffic at any designated point thereon and for the duration of whatever period of time as may be agreed upon.

END OF SECTION

DIVISION 32

EXTERIOR IMPROVEMENTS

SECTION 32 10 00 - CONCRETE SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to install concrete sidewalk.

B. Related sections:
1. Section 03 30 00 – Cast-In-Place Concrete.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American Society for Testing and Materials (ASTM):
a. ASTM C94, Standard Specification for Ready Mixed Concrete.
b. ASTM C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
c. ASTM D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
2. American Association of State Highway and Transportation Officials (AASHTO): T99.
3. American Concrete Institute (ACI): ACI Guide for Measuring, Mixing, Transporting, and Placing Concrete.
4. Standard Specification: The latest edition, including supplements of the Arkansas Highway Transportation Department Standard Specifications for Highway Construction.

1.3 SUBMITTALS

A. Shop Drawings:
1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Quality Control Submittals:
1. Curing Compound: Manufacturer's Certificate of Compliance and application instructions.
2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

PART 2 - PRODUCTS

2.1 EXPANSION JOINT FILLER

A. 1/2-inch thick, preformed asphalt-impregnated, expansion joint material meeting ASTM D994.

2.2 CONCRETE

A. As specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

B. Maximum Aggregate Size: 1-1/2-inch.

C. Slump: 2 to 4 inches.

2.3 CURING COMPOUND

A. Liquid membrane-forming, clear or translucent, suitable for and meeting ASTM C309, Type 1.

PART 3 - EXECUTION

3.1 FORMWORK

A. Lumber Materials:
   1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed sidewalk.
   2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.

B. Metals: Steel in new undamaged condition.

C. Setting Forms:
   1. Construct forms to shape, lines, grades, and dimensions.
   2. Stake securely in place.

D. Bracing:
   1. Brace forms to prevent change of shape or movement resulting from placement.
   2. Construct short-radius curved forms to exact radius.

E. Tolerances:
   1. Do not vary tops of forms from gradeline more than 1/8-inch when checked with 10-foot straightedge.
   2. Do not vary alignment of straight sections more than 1/8-inch in 10 feet.

3.2 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.3 SIDEWALK CONSTRUCTION

A. Thickness:
   1. 4 inches in walk areas.
   2. 6 inches in driveway areas.

B. Connection to Existing Sidewalk:
   1. Remove old concrete back to an existing contraction joint.
   2. Clean the surface.
   3. Apply a neat cement paste immediately prior to placing new sidewalk.

C. Expansion Joints: Place at building corners and changes in sidewalk width around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

D. Contraction Joints:
   1. Provide transversely to walks at locations opposite contraction joints in curb.
   2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
   3. Construct straight and at right angles to surface of walk.

E. Finish:
   1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
   2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
   3. Apply curing compound to exposed surfaces upon completion of finishing.
   4. Protect sidewalk from damage and allow to cure for at least 7 days.

3.4 SLAB CONSTRUCTION ON GRADE

A. Thickness: Four inches or as shown.

B. Contraction Joints:
   1. As shown on Drawings.
   2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
   3. Construct straight and at right angles to surface of slab.

C. Finish:
   1. Broom surface with fine-hair broom and tool of edges, joints, and markings.
   2. Apply curing compound to exposed surfaces upon completion of finishing.
   3. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION

SECTION 32 11 00 - BASE COURSE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work and materials required to install base course.

B. Related sections:
1. Section 31 22 13 – Subgrade Preparation.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO):
a. T 89, Standard Method for Determining the Liquid Limit of Soils.
b. T 90, Determining the Plastic Limit and Plasticity Index of Soils.
c. T 96/ASTM C131, Standard Test Method for Resistance to Degradation of Small Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
d. T 99, Standard Methods of Test for the Moisture-Density Relations of Soils Using a 5.5 pound (2.5 kg) Rammer and a 12-inch (305 mm) Drop.
e. T 180, Standard Methods of Test for the Moisture-Density Relations of Soils Using a 10 pound (4.54 kg) Rammer and an 18-inch (457 mm) Drop.
f. T 191, Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method.
g. T 238, Standard Method of Test for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform surface reasonably true to cross- section.

C. Standard Specification: The latest edition, including supplements of the Arkansas State Highway and Transportation Department (AHTD) Standard Specifications for Highway Construction.

1.4 SUBMITTALS

A. Quality Control Submittals:
1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to project.
2. Certified Results of In-Place Density Tests from independent testing agency.

PART 2 - PRODUCTS

2.1 BASE COURSE ROCK

A. As specified for Class 7 in the Standard Specifications.

2.2 SOURCE QUALITY CONTROL

A. Contractor: tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on materials' test results on installed materials.

C. Should separation of course from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 - EXECUTION

3.1 PREPARATION

A. As specified in Section 31 22 13, SUBGRADE PREPARATION.

B. Obtain Engineer's acceptance of subgrade before placement of base course rock.

C. Do not place base materials in snow or on soft, muddy, or frozen subgrade.

3.2 EQUIPMENT

A. In accordance with the Standard Specifications.

B. Compaction Equipment: Adequate in design and number to provide compaction and obtain the specified density for each layer.

3.3 HAULING AND SPREADING

A. Hauling Materials:
1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Measure capacity of truck to determine vehicle load and quantity.
4. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:
1. Distribute material to provide required density, depth, grade and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.4 CONSTRUCTION OF COURSES

A. General: Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.

B. Base Course:
1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.

5. Add keystone to achieve compaction and as required when aggregate does not compact readily due to lack of fines or natural cementing properties, as follows:
   a. Use base 1/4-minus crushed aggregate material as keystone.
   b. Spread evenly on top of crushed base course, using spreader boxes or chip spreaders.
   c. Roll surface until keystone is worked into interstices of crushed base course without excessive displacement. ,
   d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

3.5 ROLLING AND COMPACTION

A. Blade or otherwise work existing surface as necessary to achieve a smooth and thoroughly compacted surface.

B. Commence compaction of each layer of base after spreading operations and continue until density of 100 percent of maximum density has been achieved as determined by AASHTO T 99.

C. Commence rolling at outer edges of surfacing and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain densities.

E. Place and compact each lift to required density before succeeding lift is placed.

F. Bind up preceding course before placing leveling course. Remove floating or loose stone from surface.

G. Blade or otherwise work surfacing as necessary to maintain grade and cross- section at all times, and to keep surface smooth and thoroughly compacted.

H. Surface Defects: Remedy surface defects by loosening and rerolling entire area, including surrounding surface, until thoroughly compacted.
   1. Finished Surface: True to grade and crown before proceeding with surfacing.

3.6 SURFACE TOLERANCES

A. Finished Surface of Base Course: Within plus or minus 0.04-foot of grade shown at any individual point.

B. Overall Average: Within plus or minus 0.01-foot from crown and grade specified.

3.7 FIELD QUALITY CONTROL

A. In-Place Density Tests:
   1. Construct base course so areas shall be ready for testing.
   2. Allow reasonable length of time for testing laboratory to perform tests and obtain results during normal working hours.
   3. Show proof that areas meet specified requirements before identifying density test locations.
   4. Perform a minimum of 2 tests on completed course per 200 cubic yards of material placed in accordance with T 191, or T 238 at locations acceptable to Engineer.

B. Cleaning
   1. Remove excess material; clean stockpile areas of aggregate.

END OF SECTION

SECTION 32 12 16 - ASPHALT CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Providing and placing Asphalt Concrete Hot Mix (ACHM).

B. Related sections:
1. Section 31 22 13 – Subgrade Preparation.

1.2 REFERENCE STANDARDS

A. The following is a list of standards which may be referenced in this section:
1. American Society for Testing and Materials (ASTM):
a. ASTM D2950 – Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
b. ASTM D2041 – Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
c. ASTM E699 – Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating Building Components.

1.3 DEFINITIONS

A. Combined Aggregate: All mineral constituents of an asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Standard Specifications: The latest edition, including supplements of the Arkansas Highway and Transportation Department Standard Specifications for Highway Construction.

1.4 SUBMITTALS

A. Shop Drawings: Job-mix formula for pavements.

B. Quality Control Submittals:

1. Manufacturer's Certificate of Compliance for the following materials:
a. Aggregate: Gradation.
b. Asphalt for Binder: Type and grade.
c. Tack Coat: Type and grade of asphalt.
d. Mixes: Job-mix formula approved by the Materials Engineer for the State of Arkansas dated no earlier than January, 2016.
2. Manufacturer's Certificate of Proper Installation.
3. Statement of qualification for independent testing laboratory.
4. Test Results:
a. For Each Trial Batch of the Mix Design:
1). Aggregate gradation.
2). Asphalt content.
3). Stability number.
4). Percent air voids.
5). Percent voids in mineral aggregate.
6). Density.
7). Retained strength.
b. Asphalt cement for binder.
c. Field density.

1.5 QUALIFICATIONS

A. Independent Testing Laboratory: In accordance with ASTM E699.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Temperature:
   1. Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F, air temperature is lower than 40 degrees F, or application surface is wet.
   2. Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

PART 2 - PRODUCTS

2.1 AGGREGATE

A. As specified in Section 708.02 of Standard Specification for hot plant mix bituminous pavement; however, reclaimed material will not be acceptable.

2.2 MINERAL FILLER

A. As specified in Section 708.02 of Standard Specifications.

2.3 TACK COAT

A. Emulsified asphalt, Type PMCRS-2s or PMCSS-1h conforming to Section 708.03 of Standard Specifications.

2.4 BLOTTER MATERIAL

A. As specified in Section 408 of Standard Specifications.

2.5 ASPHALT CONCRETE MIXTURE

A. Surface Course: Type S3, as specified in Section 708 of Standard Specifications.

B. Base Course: Type S2, as specified in Section 708 of Standard Specifications.

2.6 ASPHALT CEMENT

A. Surface Course: PG 70-28 OK, as specified in Section 708 of Standard Specifications.

B. Base Course: PG 64-22 OK, as specified in Section 708 of Standard Specifications.

2.7 SOURCE QUALITY CONTROL

A. Tests: Furnish services of independent testing laboratory to conduct tests.

   1. Job-Mix Formula for Pavements:
      a. Define gradation for each of the aggregate constituent used in mixture and establish exact proportion of each constituent to produce a gradation of aggregate within specified limits.
      b. Bulk specific gravity for each aggregate constituent.

c. Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
d. Properties as stated in Standard Specifications, Section 708.04, for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
e. Percent of asphalt lost due to absorption by aggregate.
f. After each job-mix formula is established, the combined aggregate grading of respective mixture furnished to the Project shall meet tolerances specified in Section 708.05 of Standard Specifications.

PART 3 - EXECUTION

3.1 GENERAL

A. Application Equipment: In accordance with Section 411 of Standard Specifications.

B. Roadways: Construct to lines, grades, and cross-sections shown.

C. Traffic Control: Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt. Maintain at least one-way traffic at all times.

D. Traffic Control: Contractor shall be solely responsible for traffic control and for meeting all federal, state, and local requirements for such.

3.2 CONTROL OF LINE AND GRADE

A. Provide and maintain intermediate control of the underlying base to meet finish surface grades and minimum thickness.

3.3 SURFACE PREPARATION FOR ASPHALT OVER EXISTING GRAVEL ROAD

A. Blade or otherwise work existing surface as necessary to achieve a smooth and thoroughly compacted surface.

B. Surface Depressions: Fill with base course, and thoroughly compact.

3.4 TACK COAT

A. Do not apply more tack coat than necessary for the day's paving operation.

B. Application: Apply tack coat uniformly to clean dry surfaces. Avoid overlapping of applications. Touch up missed or lightly coated surfaces and remove excess tack coat.

C. Application Rate: Minimum 0.05-gallon to maximum 0.15-gallon of asphalt (residual if diluted emulsified asphalt) per square yard of surface area. Apply at rate, within range specified, sufficient to assure good bonding, but not too heavy that surplus asphalt flushes into asphalt concrete being placed.

3.5 ASPHALT CONCRETE PAVEMENT PLACEMENT

A. Lay asphalt concrete over prepared base in a single lift to a total compacted thickness as shown on Plans.

B. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.

3.6 CONNECTIONS WITH EXISTING FACILITIES

A. Where asphalt concrete pavement connects to an existing roadway surface, bridge, railway crossing, or other facility, modify existing roadway profile to produce a smooth riding connection to existing facility.

B. Modifying Existing Surfaces: Sawcut existing paved surfaces to provide meet lines and surfaces. Allow for sufficient depth of removal to reinstall a minimum thickness of 1-inch of asphalt concrete.
   1. Meet Lines: Lines straight and edges vertical.
   2. Edges of Meet Line Cuts: Paint with tack coat prior to placing pavement.
   3. Sealing Meet Line: After placement of pavement, by painting with liquid asphalt or emulsified asphalt, cover immediately with clean, dry sand.

C. Paint edges of contact surfaces (curbs, manhole frames), before laying pavement, with tack coat or paving asphalt cement to provide watertight joints. Do not stain adjacent surfaces not intended to be coated.

3.7 JOINTS

A. Offset edge of each layer a minimum of 6 inches so joints shall not be directly over those in underlying layer.

B. Offset longitudinal joints in roadway pavements, so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.

C. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.

3.8 PATCHING

A. Patch Thickness: 3 inches or thickness of adjacent asphalt concrete, whichever is greater.

B. Preparation:
   1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
   2. Prepare patch as specified in Section 31 22 13, SUBGRADE PREPARATION.

C. Construction:
   1. Place asphalt concrete mix across full width of patch in layers of equal thickness.
   2. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.
   3. Finished surface of patch shall be flush with adjacent surface and match grade, slope, and crown of adjacent surface.

D. Compaction:
   1. Roll patches with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Use hand tampers where rolling is impractical.
   2. Begin rolling top course at edge of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 the width of roller. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

E. Surface Smoothness of Replaced Pavement: New pavement shall not deviate more than plus 1/4-inch or minus 0 inches when a straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.9 COMPACTION

A. Roll until roller marks are eliminated and a density of 92 percent of measured maximum density determined in accordance with ASTM D2041 and ASTM D2950 is obtained.

3.10 JOINT COMPACTION

A. Place top or wearing layer as continuously as possible.

B. Pass roller over unprotected end of freshly laid mixture only when laying of layer is discontinued long enough to permit mixture to become chilled.

C. Cut back previously compacted mixture when Work is resumed to produce a slightly beveled edge for full thickness of layer.

D. Cut away waste material and lay new mix against fresh cut.

3.11 TOLERANCES

A. Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.

B. Tolerance Measurements:
   1. Completed Surface of Top or Wearing Layer: Uniform texture, smooth, and uniform to crown and grade.
   2. Completed surface shall not vary more than 1/8-inch from lower edge of 10-foot straightedge placed on surface parallel to centerline.
   3. Transverse slope of completed surface shall not vary more than 1/4-inch in 10 feet from the rate of transverse slope shown.
   4. Finished grade shall not vary more than 0.02 feet.

C. Correct deviations in excess of specified tolerances by addition of asphalt concrete mixture to low places or removal of material from high places.

D. Wearing surface may be removed and replaced to achieve a satisfactory finish surface, if surface of completed pavement deviates by more than twice the specified tolerances.

3.12 FIELD QUALITY CONTROL

A. General: Provide services of independent testing laboratory to conduct tests.

END OF SECTION

SECTION 32 92 19 - SEEDING, FERTILIZING, AND MULCHING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
1. Fertilizer.
2. Mulch.
3. Seed.
4. Preparation.
5. Maintenance.

B. Related sections:
1. Section 31 22 19 – Grading.
2. Section 31 23 16 – Excavation.
3. Section 31 11 00 – Site Preparation.

1.2 ALTERNATE METHODS AND PRODUCTS

A. Alternate methods from those specified will be considered for use, provided that in the Engineer's opinion the end product will be equal to or exceed that which would result from the specified methods and products.

1.3 DEFINITIONS

A. Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wold Garlic, Perennial Sorrel, and Brome Grass.

1.4 REGULATORY REQUIREMENTS

A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.5 QUALITY ASSURANCE

A. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

1.6 MAINTENANCE DATA

A. Submit maintenance data for continuing Owner maintenance.

B. Include maintenance instruction, cutting method, maximum grass height, types, application frequency, and recommended coverage of fertilizer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.

B. Deliver fertilizer in water proof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 - PRODUCTS

2.1 AGRICULTURAL LIMESTONE

A. Shall be agricultural limestone with not less than 90 percent passing the No. 4 sieve and containing not less than 40 percent calcium carbonate equivalent. Lime shall be applied at the rate recommended by soil test.

2.2 FERTILIZER

A. Shall be a standard commercial product which when applied at the proper rate will supply the equivalent quantity of total nitrogen, available phosphoric acid and soluble potash specified. Fertilizer shall be delivered to the site in bags or other suitable containers, each fully labeled, conforming to applicable state fertilizer laws, and bearing the name, trade name or trademark, and warranty of the producer.

B. Requirements per acre:
1. Six hundred pounds of 17-17-17 grade fertilizer or equivalent.

2.3 MULCH

A. Shall be vegetative mulch consisting of cereal straw from stalks of oats, rye, wheat or barley. Straw shall be free of prohibited weed seeds as stated in State Seed Law and shall be relatively free of all other noxious and undesirable seeds. Straw shall be clean and bright, relatively free of foreign material and be dry enough to be spread properly.

2.4 SEED

A. Seed shall be a mixture with the specified minimum purity and germination requirements, as follows:

Seed Type	% Mix (By Wt.)	Purity %	Germination %
Kentucky K-31 Fescue	52	97	85
Creeping Red Fescue	18	85	80
Rye Grass	8	98	85
Rye Grain	22	-	-

Variation in the above mix to suit local conditions or time of year may be required.

B. Seed shall be labeled in accordance with USDA regulations. Care shall be taken during transportation to avoid segregation of seed mixtures.

C. Seed shall be sown at a rate of 217 pounds of seed mix per acre for drill seeding. Seed mixture shall be thoroughly mixed prior to application.

2.5 SOD

A. Sod may be required on slopes equal to or greater than 3:1 as directed by the engineer or as stated on the plans.

B. Sod shall be fresh, locally grown Bermuda.

PART 3 - EXECUTION

3.1 GENERAL

A. The application of fertilizer, seed, and mulch shall follow each other in successive sequence as closely as possible. Seeding shall be accomplished in the first of the following two periods after completion of earthwork.

February 15 to May 1st
September 1st to October 1st

B. Seeding outside the specified seeding periods may be permitted at the Engineer's option, provided the Contractor is willing to make appropriate modifications to his seeding operations, and will guarantee the crop.

3.2 INSPECTION

A. Contractor must request that Engineer inspect site grading, clean-up and surface preparation to determine if site is ready for the seeding, fertilizing and mulching operations.

B. Upon Engineer's approval operations may begin.

3.3 SURFACE PREPARATION

A. Immediately in advance of fertilizing, the surface to be seeded shall be repaired, if necessary, to eliminate all damage from erosion or construction operations. The surface shall then be loosened and thoroughly pulverized by discing, harrowing and raking or other approved methods, to such an extent that it is free from sod, stones, clods, or roots. All growth of vegetation that will seriously interfere with planting operations shall be removed and disposed of as directed. The final surface shall be smooth and uniform, and left in such a condition as to prevent formation of low places and pockets.

3.4 FERTILIZING

A. Fertilizer and lime shall be dressed evenly over the areas to be seeded using approved mechanical type spreading equipment.

B. Fertilizer and lime after spreading shall be immediately incorporated into the soil to a depth of approximately 2 inches, by chisel, spike tooth harrow, or other approved methods.

3.5 SEEDING METHODS

A. General methods: The Contractor shall employ a satisfactory method of sowing by use of either approved mechanical hand seeders or mechanical power-driven drills. When delays in operation carry the work beyond the specified planting seasons, or when conditions are such that by reason of drought, high winds, excessive moisture, or other factors, satisfactory results are not likely to be obtained, seeding shall stop. It will be resumed only where the desired results are probable or when approved alternate procedures have been adopted.

B. Broadcast seeding: When broadcast seeding is utilized, the seed shall be uniformly broadcast by mechanical hand seeder, in two directions at right-angles to each other and at 1/2 of the specified rate per acre in each direction. After the seed is broadcast it shall be covered by an approved method to a depth of 1/3 inch to 3/4 inch. Broadcast seeding shall not be done in windy weather.

C. Drill seeding: When drilling is utilized, it shall be done with approved equipment best suited to perform the work under prevailing conditions. The seed shall be uniformly drilled to a depth of one-third (1/3) inch to three-fourths (3/4) inch at the rate per acre specified. Drill seeding may be required in windy weather.

D. Prior to start of seeding, the Contractor shall demonstrate that the application of seed is being made at the specified rate. A final check of the total quantity of seed used shall be made against the area seeded. If the check shows that the Contractor has not applied seed at the specified rate, he shall uniformly distribute seed at a rate calculated to meet the shortage.

E. The Contractor shall maintain the seeded areas until all fertilizing, seeding and mulching is complete and the work accepted by the Engineer. Areas damaged from the Contractor's own operations shall be repaired at his expense. After acceptance of the work the Contractor will not be held responsible for erosion due to weather, or conditions not due to the Contractor's own operations or negligence. The Contractor is not required to guarantee a crop, if seeding is done during the specified seeding periods.

3.6 MULCHING

A. Immediately after seeding, the Contractor shall apply vegetative mulch at a rate between 1-1/2 and 2-1/2 tons per acre to all seeded areas. Quantity of mulch shall be adjusted within the above limits, as directed by the Engineer, to the particular area or slope being mulched. Total application of mulch for the project shall average approximately 2 tons per acre. Mulch shall be applied by mechanical mulch spreaders equipped to eject by means of a constant air stream controlled quantities of the vegetative mulch.

B. Mulch shall be embedded by a disc type roller having flat serrated discs spaced not more than 10 inches apart, with cleaning scrapers for each disc.

C. Where indicated, or in areas of the project where soil conditions are not suitable for satisfactory crimping, asphalt emulsion shall be applied with the mulching operation. The normal rate of application shall be 100 gallons per ton of straw; however, this rate may be varied as directed by the Engineer to suit the particular area or slope conditions.

D. All mulch shall be distributed evenly over the areas to be mulched within 24 hours after the seeding operation. Following the mulching operation, suitable precautions shall be taken to prohibit traffic over mulched areas. Displaced mulch shall be replaced immediately, including repair of the underlying seed bed, if damaged as well.

3.7 MAINTENANCE

A. The Contractor shall maintain all seeded areas until the grass is properly established (not less than 90 days) until satisfactory development. Maintenance shall be continued until final acceptance of the work.

B. Maintenance of seeded areas shall include protecting, watering, mowing, fertilizing, and such other work as may be necessary to establish a permanent lawn. The Contractor shall reseed those seeded areas in which a satisfactory growth is not obtained, and shall refill any areas which become eroded prior to final acceptance of the work.

C. Paved areas shall be kept clean while maintenance operations are in progress.

3.8 REPLACEMENT

A. The Contractor shall replace all trees, shrubs, and flowers damaged by construction activities in the areas designated on the construction plans. The replacement trees and shrubs shall be equal in size to the damaged or removed specimen.

END OF SECTION

DIVISION 33

UTILITIES

SECTION 33 05 16 - UNDERGROUND ELECTRICAL DUCTS AND MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: metal conduit.

B. Related sections:
1. Section 03 11 00 – Concrete forms and Accessories.
2. Section 03 30 00 – Cast-in-Place Concrete.
3. Section 31 23 16 – Excavation.
4. Section 31 23 23.13 – Fill and Backfill.

1.2 REFERENCES

A. ANSI C80.1 - American National Standard for Electrical rigid Steel Conduit (ERSC) 2005.

B. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; National Electrical manufacturers Association; 2003.

C. NFPA 70 – National Electrical Code; National Fire Protection Association, 2005.

1.3 SUBMITTALS

A. See Section 01 33 00 – Submittal Procedures.

B. Product Data: Provide for metallic conduit and nonmetallic conduit.

C. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes.

D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.4 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with service facilities available.

C. Products: Listed and classified by underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 CONDUIT AND DUCT

A. Rigid Steel Conduit: ANSI C80.1.
1. Fittings: NEMA FB 1, steel.

2.2 ACCESSORIES

A. Underground Warning Tape: 4 inch wide plastic tape, detectable type colored with suitable warning legend describing buried electrical lines.

PART 3 - EXECUTIONS

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify routing and termination locations of duct bank prior to excavation for rough-in.

3.2 DUCT BANK INSTALLATION

A. Install duct to locate top of ductbank at depths as indicated on drawings.

B. Install duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope duct away from building entrances.

C. Cut duct square using saw or pipe cutter; de-burr cut ends.

D. Insert duct to shoulder of fittings; fasten securely.

E. Install no more than equivalent of three 90-degree bends between pull points.

F. Provide suitable fittings to accommodate expansion and deflection where required.

G. Stagger duct joints vertically in concrete encasement 6 inches minimum.

H. Use suitable separators and chairs installed not greater than 4 feet on centers.

I. Band ducts together before backfilling.

J. Securely anchor duct to prevent movement during concrete placement.

K. Place concrete under provisions of Section 03 30 00, CAST-IN-PLACE CONCRETE. Use mineral pigment to color concrete red.

L. Provide minimum 3 inch concrete cover at bottom, top, and sides of ductbank.

M. Provide two No. 4 steel reinforcing bars in top of bank under paved areas.

N. Provide suitable pull string in each empty duct except sleeves and nipples.

O. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.

P. Interface installation of underground warning tape with backfilling. Install tape 6 inches below finished surface.

END OF SECTION

SECTION 33 11 11 – PIPING LEAKAGE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work, materials, and procedures required to test installed piping other than gravity sewer piping.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
   a. Section 01 33 00 – Submittal Procedures.
   b. Section 40 23 39 – Process Piping General.

C. See Section 40 23 39, PROCESS PIPING GENERAL, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

1.2 SUBMITTALS

A. Submittals shall be made as required in Section 01 33 00, SUBMITTAL PROCEDURES. The following specific information shall be provided:
1. Quality Control Submittals:
   a. Testing Plan: Submit at least 30 days prior to testing and include at least the information that follows.
      1) Testing dates.
      2) Piping systems and sections(s) to be tested.
      3) Test type.
      4) Method of isolation.
      5) Calculation of maximum allowable leakage for piping sections(s) to be tested.
   b. Certifications of Calibration: Testing equipment.
   c. Certified Test Report.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:
1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

4. New Piping connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
   b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
5. Items that do not require testing include: Equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.
6. Test Pressure: As indicated on the Piping Schedule.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:
1. Perform test as specified hereinafter.
2. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
3. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.2 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Test piping as indicated in pipe schedule.

B. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

C. Exposed Piping:
1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 feet per second, applied over full area of pipe.
3. Vent piping during filling: Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning.

D. Buried Piping:
1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

$$L = \frac{S D \sqrt{P}}{133{,}200}$$

Where:
L = Allowable leakage, in gallons per hour.
S = Length of pipe tested, in feet.
D = Nominal diameter of pipe, in inches.
P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.3 PNEUMATIC TEST FOR PRESSURE PIPING

A. Test piping as indicated in pipe schedule.

B. Do not perform on:
   1. PVC or CPVC pipe.
   2. Piping larger than 18 inches.
   3. Buried and other non-exposed piping.

C. Fluid: Oil-free, dry air.

D. Procedure:
   1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections, examine for leakage.
   2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
   3. Gradually increase pressure in system to half of specified test pressure. Thereafter increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
   4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
   5. Correct visible leakage and retest as specified.

E. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

F. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.4 HYDROSTATIC TEST FOR 18-INCH THROUGH 30-INCH GRAVITY PIPING.

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon of water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Exfiltration Test:
   1. Hydrostatic Head:
      a. At least 6 feet above maximum estimated groundwater level in section being tested.
      b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
   2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

D. Infiltration Test:
   1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

E. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered *defective* even if pipe previously passed a leakage test.

F. *Defective* Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.5 PNEUMATIC TEST FOR GRAVITY PIPING 12-INCH AND SMALLER

A. Equipment:
1. Calibrate gauges with standardized test gauge at start of each testing day.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:
1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reached 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered *defective* when time required for pressure to decrease from 3.5 to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed utilizing values from following table:

TABLE 1*

A	B	C	D	E	F
Pipe Diameter (Inches)	**Time per Foot up to Length in Col C (Seconds)**	**Test Length (Feet)**	**Test Time for any Length Between Col C & E**	**Length at Which time in Col F Applies (Feet)**	**Time per Foot for Total Length (Seconds)**
4	0.18	636	1:54	1.114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67

EXAMPLE: 15-inch diameter pipe:
For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec – 6:15
For 250 feet, T = 7:05 (Col D)
For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50

* Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered *defective* even if pipe previously passed a leakage test.

E. *Defective* Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.6 JOINT TESTING FOR 36-INCH AND LARGER GRAVITY PIPING

A. The Contractor shall develop a numbering system for the pipeline joints so that the test logs can be tied to the tested joint.

B. The Contractor shall develop a test system that allows the Engineer reasonable access for witnessing the joint testing. The contractor shall submit his proposed testing plan to the Engineer for approval prior to the start of testing.

C. Pressurize the void at the joint with air to 3.5 psi greater than the pressure exerted by groundwater above the pipe. Allow the air pressure and temperature to stabilize before shutting off the air supply, and start of test timing. If pressure holds, or drops less than 1 psi in 5 seconds, the joint is acceptable.

D. If there is any visible leakage within the pipeline after the joint testing, repairs will be required before the pipeline is accepted.

3.7 FIELD QUALITY CONTROL

A. Test Report Documentation:
   1. Test date.
   2. Description and identification of piping tested.
   3. Test fluid.
   4. Test pressure.
   5. Remarks, including:
      a. Leaks (type, location).
      b. Repair/replacement performed to remedy excessive leakage.
   6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 33 13 00 - DISINFECTION OF WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Work, material, and procedures for disinfection of installed potable water lines.

B. Related sections:
1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American Water Works Association (AWWA):
a. AWWA B300, Hypochlorites.
b. AWWA B301, Liquid Chlorine.
c. AWWA B303, Sodium Chlorite.
d. AWWA C651, Disinfecting Water Mains.
e. AWWA C652, Disinfection of Water-Storage Facilities.
f. AWWA C653, Disinfection of Water Treatment Plants.
g. AWWA C654, Disinfection of Wells.

1.3 QUALITY CONTROL SUBMITTALS

A. Submittals shall be made as required in Section 01 33 00, SUBMITTAL PROCEDURES. The following specific information shall be provided:
1. Procedures and plans for disinfection and testing.
2. Type of disinfecting solution and method of preparation.

1.4 SEQUENCING AND SCHEDULING

A. Commence disinfection after completion of following:
1. Completion and acceptance of internal painting of system(s).
2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.

PART 2 - PRODUCTS

2.1 WATER FOR DISINFECTION AND TESTING

A. Clean, uncontaminated, and potable.

B. Owner will supply potable quality water, Contractor shall convey in disinfected pipelines or containers.

2.2 CONTRACTOR'S EQUIPMENT

A. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.

2.3 MIXING DISINFECTANT

A. Prepare solution by mixing any of following as described below. The purpose of the stock solution is to facilitate mixing and dilution to ensure a uniform disinfecting solution. The Contractor will not be required to mix a stock solution if a liquid chlorine gas feed system that can accurately feed a desired amount of chlorine to mix a final (dilute) disinfecting solution is used.
   1. Liquid chlorine gas conforming to AWWA B301 and water mixture.
   2. Dry chlorine gas conforming to AWWA B301.
   3. Calcium hypochlorite conforming to AWWA B300 or sodium hypochlorite conforming to AWWA B303 powder or liquid and water mixture.

B. Feed dry chlorine gas through devices to regulate the rate of flow and ensure uniform diffusion of gas into water within the pipe or vessel being treated. Chlorinating devices for feeding chlorine gas solution or the gas itself shall prevent of water into chlorine cylinder.

C. Use following proportions of hypochlorite or chlorine to water:
   1. Chlorine Gas or Liquid (100 Percent Cl):1 pound per 1 1.75 gallons water.
      a. Apply liquid chlorine gas-water solution by means of a solution feed chlorinating device.
   2. Calcium Hypochlorite (65 to 70 Percent Cl): 1 pound per 7.5 gallons water.
      a. If calcium hypochlorite is used, first mix dry powder with water to make a thick paste, then thin to a 1 percent solution (10,000 ppm chlorine).
   3. Sodium Hypochlorite (5.25 Percent Cl): 1 gallon per 4.25 gallons water.
      a. If sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution.

PART 3 - EXECUTION

3.1 GENERAL

A. Disinfect pumps and pipelines, installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:
   1. Disinfect new pipelines that connect to existing pipelines up to the point of connection.
   2. Disinfect surfaces of materials that will contact finished water, both during and following construction using spray method described below.
   3. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

B. Prior to application of disinfectants, clean equipment and pipelines of loose and suspended material. Flush pipelines until clear of suspended solids and color. Use water suitable for flushing and disinfecting.

C. Conform to AWWA C651 for pipes and pipelines, C652 for tanks and reservoirs, and AWWA C654 for wells, except as modified in these Specifications.

D. Allow freshwater and stock disinfectant solution to flow into the pipe or vessel at a measured rate so that the chlorine-water solution is at the specified strength. Do not place concentrated commercial disinfectant in the pipeline or vessel before it is filled with water.

3.2 PIPING AND PIPELINES

A. Flushing:
   1. Before disinfecting, flush all foreign matter from pipeline. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to

adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe, where it is impractical or impossible to flush the pipe at specified velocity, clean the pipeline in-place from the inside by brushing and sweeping, then flush the line.

2. Flush pipelines through flushing branches and remove branches after flushing is completed. Operate valves during flushing process at least twice during each flush.
3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections.

B. Disinfecting Solution: Chlorine-water solution having a free chlorine concentration of not less than 50 ppm.

C. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

D. Point of Application:
1. Inject chlorine mixture into pipeline to be treated at beginning of line through corporation stop or suitable tap in top of pipeline.
2. Control water from existing system to flow slowly into pipeline during application of chlorine.
3. Control rate of chlorine solution flow in proportion to rate of water entering pipe so that combined mixture shall contain not less than 50 ppm of free available chlorine.
4. Prevent of chlorine solution into line supplying water.

E. Retention Period:
1. Retain treated water in pipeline for at least 24 hours to destroy all nonspore-forming bacteria. At end of 24 hour period, disinfecting solution shall contain at least 10 ppm of free chlorine or the pipeline shall be recleaned, disinfecting solution shall be reapplied, and specified procedure repeated.
2. Operate valves, hydrants, and appurtenances during disinfection to ensure that disinfecting solution is dispersed into all parts of pipeline, including dead-ends and areas that otherwise may not be treated.
3. After disinfection, flush water from the permanent source until water through the pipeline is equal chemically and bacteriologically to permanent source of supply.

3.3 PUMPS

A. Disinfecting Solutions: Minimum free chlorine concentration of 200 ppm.

B. Disinfecting Procedure: In accordance with AWWA unless herein modified.

C. Application:
1. Inject the disinfecting solution into the pump and associated piping and circulate for a minimum 2 hour period of time. At the end of the 2 hour period, the solution shall have a strength of at least 100 ppm free chlorine.
2. Operate valves and/or pump appurtenances during disinfection to ensure that the disinfecting solution is dispersed into all parts of the pumps and lines.
3. If the disinfecting solution contained in the pumps has a residual free chlorine concentration less than 100 ppm after the 2 hour retention period, reclean the pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
4. After chlorination, flush the water from the pumps until the water through the units is chemically and bacteriologically equal to the permanent source of supply.

3.4 DISPOSAL OF DISINFECTING WASTEWATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.
1. See AWWA C652 for acceptable neutralization methods.

3.5 TESTING

A. Test Equipment:
   1. Clean containers and equipment used in sampling and assure they are free of contamination.
   2. Obtain sampling bottles with instructions for handling from laboratory.

B. Chlorine Concentration Sampling and Analysis:
   1. Sampling Frequency for Disinfecting Solution: Two samples per disinfecting procedure.
   2. Residual Free Chlorine Samples: Two samples per disinfecting procedure.
   3. Dechlorinated Disinfecting Wastewater Residual Samples: Two samples per disinfecting procedure.
   4. Sampling Locations: Each 1,000 feet of pipeline or each building.
   5. Analysis to be performed by the Owner's laboratory.

C. After pipelines have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies. Samples shall be analyzed for coliform concentrations in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater.
   1. A minimum of two Samples on each of 2 consecutive days from each separable structure every 1,000 feet of pipeline will be obtained and analyzed by standard procedures outlined by state and local regulatory agencies.

D. If the minimum Samples required above are not bacterially negative, the disinfecting procedures and bacteriological testing shall be repeated on the respective facilities until bacterial limits are met.

END OF SECTION

SECTION 33 71 19 – PRECAST CONCRETE PULL BOXES AND ELECTRICAL MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Precast concrete electrical pullboxes, manholes, and vaults.
   2. Precast Concrete Electrical Manhole/Vault Accessories:
      a. Pulling eyes/irons
      b. Cable racks
      c. Covers
      d. Manhole sump pumps

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
   1. American Association of State Highway Transportation Officials (AASHTO):
      a. Standard Specifications.
   2. American National Standards Institute (ANSI):
      a. C2 - National Electrical Safety Code (NESC
   3. American Society for Testing and Materials (ASTM):
      a. C857 – Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
      b. C858 – Standard Specification for Underground Precast Concrete Utility Structures.
      c. C891 – Standard Practice for Installation of Underground Precast Concrete.
      d. C1037 – Standard Practice for Inspection of Underground Precast Concrete Utility Structures.
   4. National Precast Concrete Association (NPCA).

1.3 SYSTEM DESCRIPTION

A. Design, fabricate, and install precast concrete pull boxes and electrical manholes. Provide boxes and manholes of size and shape and with interior details as indicated on the Drawings and as specified herein.

B. Performance Requirements:
   1. Provide electrical manholes with watertight joints between sections, and with details to minimize water infiltration at duct bank and conduit penetrations.
   2. Provide electrical manholes that are watertight and free of water infiltration.

1.4 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00, SUBMTITAL PROCEDURES.

B. Precast manufacturer's qualifications.

C. Product Data: Manufacturer's catalog data, details, and warranties for the following items:
   1. Precast Concrete Structures:
      a. Describe proposed inspection program during construction and provide names of qualified inspectors.
   2. Access Covers.
   3. Interior Appurtenances:
      a. Conduit and cable supports and racks.
      b. Pulling irons.
      c. Ladders and ladder accessories.
      d. Sump covers and cover supports.
   4. Sump Pumps.

D. Shop Drawings:
   1. Dimensioned plans and sections. Indicate size, location, and vertical elevation of duct bank windows and conduit penetrations. Include location and details of access openings, cable and conduit supports and racks, ladders, access openings, and sumps.
   2. Structure reinforcement. Indicate reinforcing steel sizes and spacing.

E. Design Data:
   1. Structural Calculations: A complete set of detailed structural design calculations:
      a. Stamped by a Professional Engineer licensed in the state where the project is being constructed.
   2. Concrete mix designs documenting that the mixes to be used conform to the requirements of this Section.

F. Record Data:
   1. Tests for compressive strength of concrete used in structures, in accordance with ASTM C858.
   2. Manufacturer's inspection reports required by ASTM C1037.

G. Certificates:
   1. Manufacturer's certification that precast electrical boxes and manholes conform to the requirements of ASTM C858.

H. Warranties.

1.5 QUALITY ASSURANCE

A. Precast concrete boxes and electrical manholes shall comply with ASTM C858 and ANSI C2, except as modified herein:
   1. In the event of a conflict between referenced standards or between standards and Specification requirements, the more stringent requirements shall govern.

B. Precast Manufacturer Qualifications:
   1. Holding current Plant Certification by NPCA.
   2. Able to demonstrate at least 5 years experience in production and installation of products for the type required for this Work.
   3. Capable of providing structural designs prepared by a Professional Engineer licensed in the State where the project is being constructed.
   4. Capable of providing inspection during construction in accordance with the requirements of ASTM C1037.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:

1. Furnish crane or forklift for unloading of pull boxes and manholes.
2. Manholes and pull boxes shall be adequately packaged and braced to avoid damage to sumps and ventilators.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. One of the following:
1. Dalworth
2. Amcor
3. Oldcastle

2.2 MANUFACTURED UNITS

A. Precast Concrete Pull Boxes and Electrical Manholes:
1. General:
   a. Precast concrete structures shall comply with ASTM C858, except as modified herein.
   b. Do not use panel-type vaults unless prior written acceptance is obtained from the Engineer.
2. Each member or element shall be marked to indicate location in the structure, exterior face, manufacturer, and date of fabrication.

B. Design Criteria:
1. Design loads shall be in accordance with ASTM C857, except as modified herein.
2. Vehicle and pedestrian loads: Designation A-16, per Table 1 of ASTM C857. Increase loads for impact and distribute wheel loads based on soil cover over the structure as specified in ASTM C857.
3. Live Loads on Covers and Roof Slabs:
   a. Vehicle and pedestrian loads: Minimum 1,000 pound concentrated load, located so as to produce maximum stress.
   b. Minimum 300 pounds per square foot loading over entire slab.
4. Seismic Loads: Design shall meet seismic requirements specified in Section 01 81 02.
5. Soil bearing pressure: Maximum 1,500 pounds per square foot net increase on prepared subgrade soils.
   a. Lateral soil loads: Determine in accordance with ASTM C857.
6. Groundwater: Design based on maximum site groundwater level at elevation 5.00 ft. Include effects of groundwater on lateral loads.
   a. Flooding: Design based on flood elevation of 14 ft.
   b. Buoyancy: For groundwater and flood conditions, provide minimum 1.20 factor of safety against flotation. If the weight of soil surrounding the structure is used to resist flotation, calculations shall consider the buoyant weight of the soil using a unit weight of not more than 30 pounds per cubic foot.
7. Lifting and Handling: Make provisions in the design to accommodate additional stresses or loads that may be imposed during factory pre-casting, transporting, or erecting.
8. Load Combinations: Design structure to sustain loads individually or in combination.

C. Materials:
1. Concrete:
   a. Minimum specified 28-day compressive strength, f'c: 4500 pounds per square inch.
   b. Maximum ratio of water to cementitious materials: 0.40.
   c. Air entrainment: 5.5 percent + 1.5 percent.
   d. Cement: Low-alkali.
   e. Aggregates: ¾ inch.

D. Manufactured Units:
1. Size: As indicated on the Drawings, and to suit duct banks, conduit, and cable installation requirements identified on the plans:
a. Minimum Interior Dimensions:
1) As required to provide a clear working space with minimum horizontal dimensions of not less than 3 feet in any direction.
2) Not less than the following, unless otherwise indicated on the Drawings:
a) Electrical Manhole – Medium voltage system: 6 feet wide by 6 feet long by 6 feet deep.
2. Details of Construction:
a. Manhole Floor: Construct as monolith. Where sump is included, slope floor to sump pit.
b. Minimum Wall and Slab Thickness: 5 inches.
c. Minimum Concrete Cover Over Reinforcement: 2 inches of clear concrete cover between any face of the concrete and embedded steel reinforcement:
1) Where cable racks are embedded on interior walls, provide minimum 1 inch clear concrete cover between back face of rack and steel reinforcement.
d. Access: Locate access openings so that they are not directly over cables, equipment, or obstructions.
e. Joints: Include details and sealing compounds as required to provide a watertight installation.
3. Source Quality Control:
a. Submit concrete mix designs and compressive strength test reports for record.
b. Manufacturer shall provide inspection during construction of precast concrete structures in accordance with ASTM C1037. Confirm that products conform to the requirements of ASTM C858 and this Section. Submit inspector's reports.

E. Manufacturers:
1. One of the following:
a. Oldcastle Precast (including Utility Vault Company)
b. Anchor
c. W.R. White
d. Brooks Products
e. Dalworth Quickset

2.3 ACCESSORIES

A. Pulling Eyes/Irons:
1. Design Criteria:
a. Designed and installed to withstand twice the load expected to be applied to the pulling iron.
b. Secured to wall reinforcement. Isolate dissimilar metals using dielectric materials.

B. Cable Racks:
1. Preformed channels 1-5/8 inch section
2. Materials: 316 stainless steel
3. Spacing: spaced to support each conductor at 2-foot intervals.
4. Cable supports: porcelain insulators

C. Manhole Covers:
1. Cast iron; frame and inner pan for traffic loading and or electrical installations; inner pan with caulking joint; radial block tread, lifting ring, and machined to fit; word, "ELECTRICAL", engraved on top side: 30-inch clear opening.
2. Design criteria.
3. Manufacturers: One of the following or equal:
a. Neenah

b. Alhambra

D. Conduit/Duct Bank Penetration Sealing System:
1. Provide keyed, reinforced duct bank windows at locations in manholes as required. See plan drawings for duct bank locations and details.

E. Manhole Sump Pumps:
1. Portable.
2. Submersible.
3. Non-corrosive.
4. Epoxy coated inside and out.
5. Screened bottom inlet.
6. Capable of pumping 15 gallons per minute at a head of 10 feet.
7. Continuous service rated.
8. Sealed-in-oil.
9. 120 volt, single phase motor.
10. Integral water level sensing.
11. Manufacturers: One of the following or equal:
a. Flygt Pumps
b. Gelber Pumps.
c. Peerless Pumps.

F. Grounding Conductor: Furnish a #2/0 AWG bare copper grounding electrode conductor in the floor slab of each manhole or pull box. Allow an 8 foot exposed length of this conductor for ground connection to duct bank ground conductor.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install pull boxes and manholes as indicated on the Drawings, in accordance with ASTM C891, and as specified. Install additional pull boxes and manholes as required to meet cable manufacturer's pulling tension requirements.

B. Set boxes and electrical manholes plumb and true to site construction lines.

C. Place base sections over minimum 12 inches of compacted aggregate base course. Level subgrade so that base will be plumb and duct banks and conduits will be on proper grade and alignment. Wedging or blocking of base sections for leveling will not be permitted.

D. Clean and prime joints between precast sections. Install sealing compound between adjacent sections and provide watertight joints.

E. Set vault wall sections plumb, using sections of required heights to bring top of manhole to required elevation.

F. Set covers and hatches at elevations indicated on the Drawings. Securely attach frames to top of precast structure, or on grade adjustment rings:
1. Where no paving surrounds structure, set top of pull box or manhole cover minimum 6 inches above surrounding grades.
2. In paved areas, set pull box or manhole cover flush with paving.

G. Backfill structures in accordance with the provisions of ASTM C891 (except that jetting is not permitted).

3.2 REPAIR/RESTORATION

A. Repair cracks and blemishes in concrete by methods acceptable to the Engineer. Repair to damaged or broken concrete will not be permitted.

3.3 CLEANING

A. Before installation of cables in any duct bank/manhole systems, remove all concrete spoilage, forms, debris, etc.

3.4 DEMONSTRATION AND TRAINING

A. Demonstrate proper operation of sump pump.

END OF SECTION

DIVISION 40

PROCESS INTEGRATION

SECTION 40 05 00 – PIPING SYSTEMS TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Test requirements for piping systems.

B. Related Sections:
1. Section 01 41 00 – Regulatory Requirements.
2. Section 01 50 00 – Temporary Facilities and Controls.
3. Section 40 23 39 – Process Piping, General.

1.2 REFERENCES

A. National Fuel Gas Code (NFGC):
1. ANSI Z 223.1 or NFPA 54.

B. American Society of Mechanical Engineers (ASME):
1. B31.8 – Gas Transmission and Distribution Piping Systems.
2. B31.1 – Power Piping.
3. B31.3 – Process Piping.

1.3 TESTING REQUIREMENTS

A. General Requirements:
1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 40 23 39; are specified in the specifications covering the various types of piping; and are specified herein.
2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01 41 00, and UL requirements.
4. Test Natural Gas or Digester Gas Piping:
   a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01 41 00, or the National Fuel Gas Code, whichever is more stringent.
   b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
5. When testing with water, the specified test pressure is considered to be the pressure at the highest point of the piping section under test. Lower test pressure as necessary to prevent testing the lowest point above a safe test pressure.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for Testing, Cleaning, and Disinfecting:
1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01 50 00.

D. Pipes to be Tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and

install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful Tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test Completion: Drain and leave piping clean after successful testing.

G. Test Water Disposal: Dispose of testing water at the Siloam Springs WWTP in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00.

B. Schedule and Notification of Tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of Readiness to Test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.5 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TESTING, ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and Grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection Test:
   1. Pull a mandrel through the clean piping section under test.

2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
3. Use a 9 rod mandrel with a contact length of not less than the nominal diameter of the pipe within one percent plus or minus.
4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.2 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 40 23 39:
1. Provide temporary pressure relief valve for piping under test. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1. AS<E B31.3, ASE B31.8, or the pipe manufacturer's stated maximum working pressure.
3. Gradually increase test pressure to an initial test pressure equal to the lesser of one-half the test pressure or 25 pounds per square inch gauge.
4. Perform initial check of joints and fittings for leakage.
5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage at each step increase until test pressure reached.
6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.3 TESTING GRAVITY FLOW PIPING

A. Test Gravity Flow Piping indicated with "G" in the Piping Schedule, as follows:
1. Unless specified otherwise, subject gravity flow piping to the following tests:
   a. Alignment and grade.
   b. For plastic piping test for deflection.
   c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
2. Inspect piping for visible leaks before backfilling. Provide temporary restraints when needed to prevent movement of piping. Pressure test piping with maximum leakage allowance after backfilling.
3. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours.
   a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
   b. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
   c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of four hours while accurately measuring the volume of water added to maintain the test pressure.
      1). Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:

a). For Concrete Piping with Rubber Gasket Joints: 80 gallons per day per inch of diameter per mile of piping under test.
   (1) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
   (2) For Vitrified Clay and Other Piping: 500 gallons per day per inch of diameter per mile of piping under test.

3.4 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping Schedule.

B. General:
1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
3. Do not include valves, equipment or piping specialties in test sections if test pressure exceeds the valve, equipment or piping specialty safe test pressure allowed by the item's manufacturer.
4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
6. When test results indicate failure of selected sections, limit tests to piping:
   a. Between valves.
   b. Between a valve and the end of the piping.
   c. Less than 500 feet long.
7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing Procedures:
1. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule.
2. Before pressurizing for the test, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
3. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure Test with Maximum Leakage Allowance:
1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
2. Pressure test piping after completion of visible leaks test.
3. For piping systems using joint designs other than flanged threaded or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piing and appurtenances has occurred.
   b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
   c. Successful completion of the pressure test with maximum leakage allowance shall have been achieved with the observed leakage during the test period is equal or

less than the allowable leakage and no damage to piping and appurtenances has occurred.

d. When leakage is allowed, calculate the allowable leakage by the following formula:

L = S x D x P 1/2 x 133,200-1

wherein the terms shall mean:

L = Allowable leakage in gallons per hour.

S = Length of the test section in feet.

D = Nominal diameter of the piping in inches.

P = Average observed test pressure in pounds per square inches, gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

X = The multiplication symbol.

3.5 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

B. General:
1. Test pressures shall be as scheduled in Section 40 23 39.
2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
4. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible Leaks Test:
1. Subject piping under test to the specified pressure measured at the lowest end.
2. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule.
3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure Test with Maximum Leakage Allowance:
1. Pressure test piping after completion of visible leaks test.
2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours and no damage to piping and appurtenances has occurred.
   b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

E. Optional Joint Test:
   1. When Joint Testing Is Allowed by Note in the Piping Schedule, the Procedure Shall Be as Follows:
      a. Joint testing will be allowed only for low head pressure piping.
   2. Joint testing may be performed with water or air.
   3. Joint test piping after completion of backfill and compaction to the top of the trench.
   4. Joint Testing with Water:
      a. Measure test pressure at the invert of the pipe. Apply pressure of 4 feet plus the inside diameter of the pipe in water column within 0.20 feet in water column.
      b. Maintain test pressure for one minute.
      c. Base the allowable leakage per joint on 80 gallons per inch nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
      d. Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
      e. Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.
   5. Joint Testing with Air:
      a. Apply test pressure of 3 pounds per square inch gauge with a maximum variation of plus 0.20 and minus 0.00 pounds per square inch.
      b. Maintain test pressure for 2 minutes.
      c. Consider the pressure test to be complete when the test pressure does not drop below 2.7 pounds per square inch for the duration of the test.

END OF SECTION

SECTION 40 05 13 - COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one section of Division 40 and includes joining materials, piping specialties, and basic piping installation instructions.

B. Related Sections:
1. Piping materials and installation methods peculiar to individual systems are specified within their respective system specification sections of Division 40.
2. Valves are specified in a separate section and in individual piping system sections of Division 40.
3. Supports and Anchors are specified in a separate section of Division 40.
4. Mechanical Identification is specified in a separate section of Division 40.
5. Fire Barrier Penetration Seals are specified in Division 07.

1.2 SUBMITTALS

A. Refer to Division 01 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:
1. Escutcheons
2. Dielectric Unions and Fittings
3. Mechanical Sleeve Seals

C. Quality Control Submittals:
1. Submit welders' certificates specified in Quality Assurance below.

1.3 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.1.0 - Standard Code for Pressure Piping, Power Piping, and The American Welding Society, Welding Handbook.

C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering piping materials and specialties which may be incorporated in the work include, but are not limited to, the following:

B. Pipe Escutcheons:
1. Chicago Specialty Mfg. Co.
2. Sanitary-Dash Mfg. Co.
3. Grinnell

C. Dielectric Waterway Fittings:
1. Epco Sales, Inc.
2. Victaulic Company of America

D. Dielectric Unions:
1. Eclipse, Inc.
2. Perfection Corp.
3. Watts Regulator Co.

E. Mechanical Sleeve Seals:
1. Thunderline Corp.

2.2 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 15 for specifications on piping and fittings relative to that particular system.

2.3 JOINING MATERIALS

A. Welding Materials: Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

B. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

C. Soldering Materials: Refer to individual piping system specifications for solder appropriate for each respective system.

D. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions: Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Dielectric Waterway Fittings: electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.

E. Sleeves:
   1. Sheet-Metal Sleeves: 10 gauge, galvanized sheet metal, round tube closed with welded longitudinal joint.
   2. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A53, Grade A.
   3. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream ends of pipes and tubes, and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
   1. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.
   2. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.
   3. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
   4. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.
   5. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.
   6. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

B. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.

C. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 07 for special sealers and materials.

3.3 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.

D. Install unions adjacent to each valve and at the final connection to each piece of equipment and plumbing fixture having 2" and smaller connections, and elsewhere as indicated.

E. Install Flanges in piping 2-1/2" and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

F. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum).

G. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water, steam).

3.4 JOINTS

A. Steel Pipe Joints:
1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.
2. Pipe Larger Than 2": Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.
3. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.
4. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.1.0 Code for Pressure Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints
1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0 - Standard Code for Pressure Piping, Power Piping and ANSI B9.1 - Standard Safety Code for Mechanical Refrigeration.
2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine Emory cloth prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Mechanical Joints: Flared compression fittings may be used for refrigerant lines 3/4" and smaller.

D. Joints for other piping materials are specified within the respective piping system sections.

3.5 FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION

SECTION 40 23 39 - PROCESS PIPING-GENERAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Basic Process Piping Materials, Methods, and Appurtenances.

B. Related sections:
1. Section 01 60 00 – Product Requirements.
2. Section 03 30 00 – Cast-In-Place Concrete.
3. Section 09 90 00 – Painting and Protective Coatings.
4. Section 22 05 29 – Process Supports and Anchors.
5. Section 22 05 53 – Mechanical Identification.
6. Section 31 23 23.16 – Trench Backfill.
7. Section 33 11 11 – Piping Leakage Testing.
8. Section 33 13 00 – Disinfection of Water Systems.
9. Section 40 41 13 – Heat Tracing.
10. Section 40 24 00 – Process Piping Specialties.
11. Section 40 42 00 – Process Mechanical Insulation.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section and any supplemental Data Sheets:
1. American Association of State Highway and Transportation Officials (AASHTO): Standard Specifications for Highway Bridges.
2. American National Standards Institute (ANSI):
a. A21.52, Ductile Iron Pipe, Centrifugally Cast, for Gas.
b. B1.20.1, Pipe Threads, General Purpose (Inch).
c. B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
d. B16.3, Malleable Iron Threaded Fittings.
e. B16.5, Pipe Flanges and Flanged Fittings.
f. B16.9, Factory-Made Wrought Steel Butt welding Fittings.
g. B16.11, Forged Fittings, Socket-Welding and Threaded.
h. B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150,300,400,600,900, 1500 and 2500.
l. B16.25, Butt Welding Ends.
m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300.
3. American Petroleum Institute (API): 5L, Specification for Line Pipe.
4. American Society of Mechanical Engineers (ASME):
a. Boiler and Pressure Vessel Code, Section VITI, Division 1, Pressure Vessels.
b. Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
c. B31.1, Power Piping.
d. B31.3, Chemical Plant and Petroleum Refinery Piping.
e. B31.9, Building Services Piping.
f. B36.10M, Welded and Seamless Wrought Steel Pipe.
5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Nondestructive Testing Personnel Qualifications.
6. American Society for Testing and Materials (ASTM):
a. A47, Standard Specification for Ferritic Malleable Iron Castings.
b. A53 Rev A, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

c. A105/ A105M, Standard Specification for Forgings, Carbon Steel, for Piping Components.
d. A106, Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
f. A135, Standard Specification for Electric-Resistance-Welded Steel Pipe.
g. A139 Rev A, Standard Specification for Electric-Fusion (Arc) -Welded Steel Pipe (NPS 4 and Over).
h. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
i. A181/A181M Rev A, Standard Specification for Forgings, Carbon Steel, for General-Purpose Piping.
j. A182/A182M Rev C, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
l. A193/A193M Rev A, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
n. A197, Standard Specification for Cupola Malleable Iron.
o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
q. A240, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.
r. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
s. A283/A283M Rev A, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
t. A285/ A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate Tensile Strength.
u. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
v. A312/A312M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
w. A320/A320M, Standard Specification for Alloy Steel Bolting Materials for Low-Temperature Service.
x. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
y. A403/ A403M Rev A, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
z. A409/ A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
aa. A536, Standard Specification for Ductile Iron Castings.
bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
cc. 587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
dd. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
ee. A778 Rev A, Standard Specification for Welded, Un-annealed Austenitic Stainless Steel Tubular Products.
ff. B32, Standard Specification for Solder Metal.
gg. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
hh. B61, Standard Specification for Steam or Valve Bronzed Casting.
ii. B62, Standard Specification for Composition Bronzed or Ounce Metal Castings.

jj. B75, Standard Specification for Seamless Copper Tube.
kk. B88 Rev A, Standard Specification for Seamless Copper Water Tube.
ll. B98, Standard Specification for Copper-Silicone Alloy Rod, Bar, and Shapes.
mm. 582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment.
nn. D412, Standard Testing Method for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension.
oo. D413, Standard Testing Methods for Rubber Property-Adhesion to Flexible Substrate.
pp. D1248, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
qq. D1784, Standard Specifications for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
rr. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
ss. D2000, Standard Classification System for Rubber Products in Automotive Applications.
tt. D2310, Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
uu. D2464, Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
vv. 2466, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
ww. D2467, Standard Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
xx. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
yy. D2665, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe for Drain, Waste, and Vent Pipe and Fittings, Schedule 40.
zz. D2996, Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
aaa. D3222 Rev A, Standard Specification for Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
bbb. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
ccc. D4101 Rev B, Standard Specification for Propylene Plastic Injection and Extrusion Materials.
ddd. F437, Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
eee. F439 Rev A, Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
fff. F441, Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
ggg. F491 Rev A, Standard Specification for Poly (Vinylidene Fluoride) (PVDF) Plastic-Lined, Ferrous Metal Pipes, and Fittings.
hhh. F493 Rev A, Standard Specification for Solvent Cements for Chlorinated Poly Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
iii. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) based on outside diameter.

7. American Welding Society (AWS):
   a. A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   b. QC 1, Standard for AWS Certification of Welding Inspectors.
8. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3" through 48"for Water and Other Liquids.
   c. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

d. C115/A21.15, Flanged Ductile-Iron Pipe with Threaded Flanges.
e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
f. C153/A21.53, Ductile-Iron Compact Fittings 3" through 16", for Water and Other Liquids.
g. C200, Steel Water Pipe – 6" and Larger.
h. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4" and Larger-Shop Applied.
i. C207, Steel Pipe Flanges for Water Works Service, Sizes 4" through 144".
j. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
k. C214, Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
l. C606, Grooved and Shouldered Type Joints.
m. M11, Steel Pipe - A Guide for Design and Installation.

9. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP 43, Wrought Stainless Steel Butt-Welding Fittings Including Reference to Other Corrosion Resistant Materials.
10. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 DEFINITIONS

A. Submerged or Wetted:
1. Zone below elevation of:
a. Top face of channel walls and cover slabs.
b. Top face of basin walkways.
c. Top face of clarifier walkways.
d. Top face of digester walls, including structure piping penetrations.
e. Liquid surface or within 2 feet above top of liquid surface.
f. Top of tank wall or under tank cover.

1.4 SUBMITTALS

A. Shop Drawings:
1. Shop Fabricated Piping:
a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
6. Gasket material, temperature rating, and pressure rating for each type of pipe and each type of service.

B. Quality Control Submittals:
1. Manufacturer's Certification of Compliance.
2. Qualifications:
a. Weld Inspection and Testing Agency: Certification and qualifications.
b. Welding Inspector: Certification and qualifications.
c. Welders:
1). List of qualified welders and welding operators.

2). Current test records for qualified welder(s) and weld type(s) for factory and field welding.

3. Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
4. Nondestructive inspection and testing procedures.
5. Manufacturer's Certification of Compliance:
   a. Pipe and fittings.
   b. Factory applied resins and coatings.
6. Certified weld inspection and test reports.
7. Test logs.

1.5 QUALITY ASSURANCE

A. Weld Inspection and Testing Laboratory Qualifications:
   1. Retain approved independent testing laboratory that will provide the services of an AWS certified welding inspector qualified in accordance with AWS QC1 with prior inspection experience of welds specified herein.
   2. Perform weld examinations with qualified testing personnel who will carry out radiography, ultrasonic, magnetic particle, and other nondestructive testing methods as specified herein.
   3. Welding Inspector:
      a. Be present when shop or field welding is performed to certify that welding is in accordance with specified standards and requirements.
      b. Duties include, but are not limited to, the following:
         1). Job material verification and storage.
         2). Qualification of welders.
         3). Certify conformance with approved welding procedure specifications.
         4). Maintain records and prepare reports in a timely manner.
         5). Notify Engineer within 1 hour of discovery of unsatisfactory weld performance and within 24 hours of weld test failure.
         6). Supervision of testing personnel.

B. Welder and Welding Operator Performance:
   1. Qualify welders and welding operators by approved testing laboratory before performing any welding under this section.
   2. Perform welder qualification tests in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code.
   3. Qualification tests may be waived if evidence of prior qualification is deemed suitable by the Engineer.
   4. Qualify welders and operators in the performance of making groove welds in each different pipe material, including carbon steel pipe, in Positions 2G and 5G for each welding process to be used.
   5. Qualify welders and welding operators for stainless steel as stated herein on the type of stainless steel being welded with the welding process used.

C. Certifications:
   1. Coal-Tar Epoxy Applicator: Certified by Piping Manufacturer to be qualified to apply coal-tar epoxy coating to submerged or embedded ductile iron or cast iron soil piping.
   2. Weld Testing Agency: Certified in accordance with current American Society for Nondestructive Testing (4153 Arlingate Plaza, Columbus, OH 43228) recommended practice SNT-TC-1A, NDT Level II.

D. Quality Control Submittals:
   1. Manufacturer's Certification of Compliance.
   2. Laboratory Testing Equipment: Certified calibrations, Manufacturer's product data, and test procedures.
   3. Certified welding inspection and test results.

4. Qualifications:
   a. Weld Inspection and Testing Agency: Certification and qualifications.
   b. Welding Inspector: Certification and qualifications.
   c. Welders:
      1). List of qualified welders and welding operators.
      2). Current test records for qualified welder(s) and weld type(s) for factory and field welding.
5. Weld Procedures: Records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
6. Nondestructive inspection and testing procedures.
7. Manufacturer's Certification of Compliance:
   a. Pipe and fittings.
   b. Welding electrodes and filler materials.
   c. Factory applied resins and coatings.
8. Certified weld inspection and test reports.
9. Pipe coating applicator certification.

1.6 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 60 00, PRODUCT REQUIREMENTS, and:
   1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
   2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
   3. Linings and Coatings: Prevent excessive drying.
   4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
   5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 - PRODUCTS

2.1 PIPING

A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.

B. Diameters Shown:
   1. Standardized Products: Nominal size.
   2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME 836.l0M.
   3. Cement-Lined Steel Pipe: Lining inside diameter.

2.2 JOINTS

A. Grooved End System:
   1. Rigid, except where joints are used to correct misalignment, to provide flexibility, or where shown, furnish flexible type.
   2. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. Flanged Joints:
   1. Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.
   2. Higher pressure rated flanges as required, to mate with equipment when equipment flange is of higher pressure rating than required for piping.

C. Threaded Joints: NPT taper pipe threads in accordance with ANSI B 1.20. 1.

D. Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

E. Mechanical Joint Anchor Gland Follower:
1. Ductile iron anchor type, wedge action, with break off tightening bolts.
2. Manufacturer and Product: EBAA Iron Inc.; Megalug.

F. Flexible Mechanical Compression Joint Coupling:
1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
   a. Pipeline Products Corp.
   b. Ferno Joint Sealer Co.

G. Mechanical connections of the high density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of the following:
1. A polyethylene stub end thermally butt-fused to the end of the pipe.
2. ASTM A240, Type 304 stainless steel backing flange, 125-pound, ANSI B16.1 Standard. Insulating flanges shall be used where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when the joint is made and tightened to the Manufacturer's standard. Re-torque the nuts after 4 hours.
4. Gaskets as specified on Data Sheet.

2.3 COUPLINGS

A. Steel Middle Rings and Followers:
1. Fusion bonded, epoxy-lined, and coated in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

B. Flexible Couplings:
1. Manufacturers and Products:
   a. Steel Pipe:
      1). Dresser; Style 38.
      2). Smith-Blair; Style 411.
   b. Ductile Iron Pipe:
      1). Dresser; Style 153.
      2). Smith-Blair; Style 411.

C. Transition Couplings:
1. Manufacturers and Products:
   a. Dresser; Style 162.
   b. Smith-Blair; Style 413.

D. Flanged Coupling Adapters:
1. Manufacturers and Products:
   a. Steel Pipe:
      1). Smith-Blair; Series 913.
      2). Dresser Industries, Inc.; Style 128.
   b. Ductile Iron Pipe:
      1). Smith-Blair; Series 912.
      2). Dresser Industries, Inc.; Style 127.

2.4 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe Manufacturer and no substitute or "or-equal" will be allowed.

2.5 DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. All system components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.6 THRUST BLOCKS

A. Concrete: As specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.7 VENT AND DRAIN VALVES

A. Pipeline 2-1/2" Diameter and Larger: Vent connections shall be 3/4-inch with V300 ball valve. Drain connection shall be 1-inch with V300 ball valve, unless shown otherwise.

B. Pipeline 2" Diameter and Smaller: Vent connections shall be 1/2-inch with V300 ball valve. Drain connection shall be 1-inch with V300 ball valve, unless shown otherwise.

C. Provide galvanized steel pipe plug in each ball valve.

2.8 FABRICATION

A. Mark each pipe length on outside:
1. Size or diameter and class.
2. Manufacturer's identification and pipe serial number.
3. Location number on laying drawing.
4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the Manufacturer.

2.9 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s), Piping Schedule, and Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

B. Galvanizing:
1. Hot-dip applied, meeting requirements of ASTM A153.
2. Electroplated zinc or cadmium plating is unacceptable.
3. Stainless steel components may be substituted where galvanizing is specified.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Welding Electrodes: Verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.2 PREPARATION

A. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

C. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with Manufacturer's instructions, except for damaged glass-lined pipe or PVDF-lined pipe that is to be promptly removed from the site.

3.3 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting Manufacturer.

B. Weld Identification: Mark each weld with symbol identifying welder.

C. Pipe End Preparation:
1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
3. Beveled Ends for Butt Welding: ANSI B16.25.

D. Surfaces:
1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:
1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
2. Root Opening of Joint: As stated in qualified welding procedure.
3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1", whichever is greater.

F. Climatic Conditions:
1. Do not perform welding if there is impingement of any rain, snow, sleet or high wind on the weld area, or if the ambient temperature is below 32 °F.
2. Stainless Steel and Alloy Piping: f the ambient is less than 32 °F, local preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Passes: As required in welding procedure.

J. Weld Quality: Free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.

3.4 INSTALLATION - GENERAL

A. Join pipe and fittings in accordance with Manufacturer's instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:
1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.

D. Threaded and Coupled Joints:
1. Conform to ANSI B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Soldered Joints:
1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply non-corrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

F. Couplings:
1. General:
   a. Install in accordance with Manufacturer's written instructions.
   b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
   c. Remove pipe coating if necessary to present smooth surface.
2. Application:
   a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.
   b. Nonmetallic Piping Systems: Teflon bellows connector.
   c. Concrete Encased Couplings: Sleeve type coupling.
   d. Corrosive Service Piping: Elastomer bellows connector.
   e. Grit Slurry Piping: Elastomer bellows connector.

G. Service Saddle Applications:
1. Ferrous Metal Piping (except stainless steel): Double-strap iron.
2. Plastic Piping: Nylon-coated iron.
3. Buried Plastic Piping (Odor Control): PVC solvent weld saddle with retaining clamps.

H. Pipe Connections at Concrete Structures: As specified in article PIPING FLEXIBILITY PROVISIONS in Section 40 24 00, PROCESS PIPING SPECIALTIES.

I. Penetrations:
   1. Watertight Penetrations:
      a. Provide wall pipes with thrust collars, as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
      b. Provide taps for stud bolts in flanges to be set flush with wall face.
   2. Non-watertight Penetrations:
      a. Pipe sleeves with seep ring as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
      b. Pipe sleeves with modular mechanical seal may be provided where fabrication of seep ring on pipe sleeve is impractical.
   3. Existing Walls:
      a. Pipe sleeve with modular mechanical seal as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.
      b. Rotary drilled holes may be provided in lieu of sleeves in concrete walls.
   4. Fire-Rated or Smoke-Rated Walls, Floor, or Ceilings: Insulated and encased pipe sleeves as specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.

J. PVC and CPVC Piping:
   1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
   2. Use strap wrench for tightening threaded plastic joints. Do not over tighten fittings.
   3. Do not thread Schedule 40 pipe.

K. Ductile Iron, Cement-Lined Ductile Iron, and Glass-Lined Ductile Iron Piping:
   1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.
   2. Dressing Cut Ends:
      a. General: As required for the type of joint to be made.
      b. Rubber Gasketed Joints: Remove sharp edges or projections.
      c. Push-On Joints: Bevel, as recommended by pipe Manufacturer.
      d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter Manufacturer.

3.5 INSTALLATION-EXPOSED PIPING

A. Piping Runs:
   1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
   2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 22 05 29, PROCESS SUPPORTS AND ANCHORS.

C. Group piping wherever practical at common elevations; installing to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment Manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:
   1. Over Walkway and Stairs: Minimum of 7' 6", measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3' 0", measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   3. From Adjacent Work: Minimum 1" from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
   4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
   5. Head room in front of openings, doors, and windows shall not be less than the top of the opening.
   6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
   7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.6 INSTALLATION-BURIED PIPE

A. Joints:
   1. Dissimilar Buried Pipes:
      a. Provide flexible mechanical compression joints for pressure pipe.
      b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown.
   2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete unless specifically shown.

B. Placement:
   1. Keep trench dry until pipe laying and joining are completed.
   2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.16, TRENCH BACKFILL.
   3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
   4. Measure for grade at pipe invert, not at top of pipe.
   5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
   6. Prevent foreign material from entering pipe during placement.
   7. Close and block open end of last pipe section laid when placement operations are not in progress and at close of day's work.
   8. Lay pipe upgrade with bell ends pointing in the direction the pipe is laying.
   9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
   10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
      a. Shorter pipe lengths.
      b. Special mitered joints.
      c. Standard or special fabricated bends.
   11. After joint has been made, check pipe alignment and grade.
   12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
   13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC and CPVC Pipe Placement:
   1. Lay pipe snaking from one side of trench to other.
   2. Offset: As recommended by Manufacturer for maximum temperature variation between time of solvent welding and during operation.

3. Do not lay pipe when temperature is below 40 °F, or above 90 °F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:
1. Deflection from Horizontal Line, Except PVC, CPVC, or HDPE: Maximum 2".
2. Deflection from Vertical Grade: Maximum 1/4".
3. Joint Deflection: Maximum of 75% of Manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75' from position shown.
5. Pipe Cover: Minimum 5', unless otherwise shown.

3.7 THRUST RESTRAINT

A. Location:
1. Buried Piping: At pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist.
2. Exposed Piping: At all joints in pressure piping.

B. Thrust Ties:
1. Install as detailed.
2. Anchoring retainer glands or thrust ties with setscrews is unacceptable.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint Manufacturer's adapter gland follower and pipe end retainer, or thrust tie-rods and socket clamps.

D. Thrust Blocking:
1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
3. Place blocking so that pipe and fitting joints will be accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, CAST-IN-PLACE CONCRETE.

3.8 WALL PIPES

A. Applications: As specified in Section 40 24 00, PROCESS PIPING SPECIALTIES.

B. Wall Pipe Installation:
1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie wires.

3.9 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:
1. Ductile Iron Piping: Connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.

2. Welded Steel or Alloy Piping: Connect only with welded thread-o-let or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.10 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install the vents on high points, and drains on low points of pipelines, whether shown or not.

3.11 CLEANING

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris plant process air, natural gas, and instrument air-lines with compressed air at 4,000 fpm; do not flush with water.

C. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2" and larger or by removing spools and valves from piping.

3.12 DISINFECTION

A. Disinfect pipelines intended to carry potable water (W1).

B. See Section 33 13 00, DISINFECTION OF WATER SYSTEMS

3.13 FIELD FINISHING

A. Notify Engineer at least 3 days prior to start of any surface preparation or coating application work.

B. As specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS.

3.14 PIPE IDENTIFICATION

A. See Section 22 05 53, MECHANICAL IDENTIFICATION and 09 90 00 PAINTING AND PROTECTIVE COATINGS.

3.15 INSULATION

A. See Section 40 42 00, MECHANICAL INSULATION.

3.16 HEAT TRACING

A. See Section 40 41 13, HEAT TRACING.

3.17 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified. See Section 33 11 11, PIPING LEAKAGE TESTING.

B. Minimum Duties of Welding Inspector
   1. Job material verification and storage
   2. Qualifications of welders.
   3. Certify conformance with approved welding procedures.
   4. Maintenance of records and preparation of reports in a timely manner
   5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:
   1. Perform Examinations in accordance with Piping Code ASME B31.1.
   2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this section.
   3. Examine at least one of each type and position of weld made by each welder or welder operator.
   4. For each weld found to be defective under the acceptable standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above 3. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.18 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.
   1. Piping Schedule.
   2. Data Sheets.

Number	Title
40 23 39.13	Cement Mortar Lined Ductile Iron Pipe and Fittings
40 23 39.14	Centrifugally Cast, Fiberglass Reinforced, Polymer Mortar (CCFRPM) Pipe and Fittings
40 23 39.16	Welded Steel Pipe and Fittings
40 23 39.32	Steel Pipe
40 23 39.36	Stainless Steel Pipe and Fittings
40 23 39.40	C900 and C905 PVC Pipe and Fittings
40 23 39.42	Polyvinyl Chloride (PVC) Pipe and Fittings
40 23 39.43	Polyvinyl Chloride (PVC) Pipe and Fittings
40 23 39.46	Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings
40 23 39.53	Copper and Copper Alloy Pipe, Tubing, and Fittings
40 23 39.56	High Density Polyethylene (HDPE) Pipe and Fittings

END OF SECTION

PROCESS PIPING SCHEDULE

Service	Flow Stream Identifier	Installation (Note 1)	Nominal Diameter (Note 2)	Material (Note 3)	Coating (Note 8)	Spec / Data Sheet No.	Max Operating Temp (°F)	Max Operating Pressure (psig)	Test Pressure (psig) & Method (Note 4)	Pipe Color (Note 5)	Remarks
Water, Non-Potable	NPW	Buried	≥4" <4"	CLDI HDPE		40 23 39.13 40 23 39.56	Ambient	125	200, H	Purple	3
Water, Non-Potable	NPW	Exposed - Inside	≤ 3"	PVC		40 23 39.43	Ambient	125	200, H	Purple	4, 5
Water, Non-Potable	NPW	Exposed-Outside	ALL	CLDI	EPP	40 23 39.13	Ambient	125	200,H	Purple	3

Notes:

1. Encased – All buried piping under concrete slabs and/or structures shall be concrete encased per standard detail D40/2400-009 unless indicated otherwise on the Drawings.
2. > Greater Than
   < Less Than
   ≤ Less Than or Equal To
   ≥ Greater Than or Equal To
3. CLDI - Cement Lined Ductile Iron
   CELDI – Ceramic Epoxy Lined Ductile Iron
   HDPE – High Density Polyethylene
   FS – Flanged Steel
   GLDI – Glass Lined Ductile Iron
   SST – Stainless Steel
   WS – Welded Steel
   FL PVC – Flanged Polyvinyl Chloride Pipe
   PO PVC – Push on Joint Polyvinyl Chloride Pipe
   SW PVC – Solvent Weld Polyvinyl Chloride Pipe
   FRP – Fiberglass Reinforced Plastic Pipe
   CU – Copper Pipe
4. H - Hydrostatic Test
   P - Pneumatic Test
   G - Gravity Piping
   AM – Air Method
   HH – High Head
   LH – Low Head
   LP – Low-Pressure Pneumatic Test
   See Section 33 11 11 for Piping Leakage Testing requirements, for systems specified in Division 33.
   See Section 40 05 00 for Piping Leaking Testing requirements for systems specified in Division 40.
   Pipe testing required as specified above.
5. See Section 09 90 00 for required painting.
   For exposed piping not coated, provide colored banding and identification.
6. General - Deviations from this schedule are indicated directly by note on Drawings where deviation is required.
7. General - The piping material shall conform to the requirements for the service listed being drained or vented.
8. EPP – Epoxy and Polyurethane Coating System
   HSE – High Solids Epoxy
   CTP – Coal Tar Pitch
   HT – High Temperature
   Where no coating is listed, refer to Section 09 90 00 – Painting and Protective Coatings.

Remarks:

1. Welded or flanged, flanged where shown.
2. Insulate all exposed post aeration blower piping, interior and exterior, on the discharge side of blowers as specified in Section 40 42 00. Piping on inlet side of blowers does not require insulation. All insulated piping shall still receive a high solids epoxy coating at a minimum. Aeration basin air piping, aerobic digester air piping, and piping within the post-aeration basin and aerobic digester do not require insulation.
3. Heat trace and insulate all outside exposed piping as noted on plans. For exposed Hydrant piping, drain boxes shall be installed at tie in to main lines.
4. SW PVC or FL PVC, FL PVC where shown.
5. Where buried piping transitions to exposed PVC piping, the buried piping shall be extended at least six (6) inches above the finished floor before transitioning to exposed PVC piping.

SECTION 40 23 39.13 DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Pipe	**Buried Liquid Service**: Push-On, Mechanical, or Proprietary Restrained Joints: AWWA C110/A21.10-93, AWWA C115/A21.15-88, and AWWA C151/A21.51-91, pressure class conforming to Tables 51.1 and 51.3 for Type 4 trench, 250 psi minimum working pressure. **Exposed Pipe**: Grooved End or Flange Joints: AWWA C115/A21.15-88, and AWWA C151/A21.51-91, thickness Class 53 minimum conforming to Table 51.7, 250 psi minimum working pressure.
Encasement	Polyethylene encasement shall be used on all underground ductile iron pipe, fittings, valves, and appurtenances. See Specification Section 40 42 13.16 – POLYETHEYLENE ENCASEMENT FOR DUCTILE IRON AND CAST IRON PIPE.
Lining	Lining shall be Cement-Mortar AWWA C104/A21.4-90 unless noted otherwise. Ceramic Epoxy Protecto 401 or equal shall be used where indicated in the pipe schedule. Linings for fittings shall be as indicated below.
Fittings	**Push-On**: AWWA C110/A21.10-93 and C111/A21.11-90, gray or ductile iron, 250 psi minimum working pressure. American Cast Iron Pipe Co., Fastite Joints; U.S. Pipe and Foundry, Tyton Joint. **Mechanical Joint**: For Buried Service. AWWA C110/A21.10-93, C111/A21.11-90, and C153/A21.53-88 gray or ductile iron, 250 psi minimum working pressure. Coating/lining shall be Fusion-Bonded Epoxy meeting AWWA C116. American Cast Iron Pipe Co., Mechanical Joint; U.S. Pipe and Foundry, Mechanical Joint. **Proprietary Restrained Joint**: AWWA C111/A21.11-90 and C153/A21.53-88, ductile iron, 250 psi minimum working pressure. Coating/lining shall be Fusion-Bonded Epoxy meeting AWWA C116. Clow Corp., Super-Lock Joint; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring Joint; U.S. Pipe, TR Flex. **Proprietary Restrained River Crossing**: Clow Ball and Socket; U.S. Pipe Usiflex. Coating/lining shall be Fusion-Bonded Epoxy meeting AWWA C116. **Grooved End**: AWWA C606-87 and C110/A21.10-93, ductile iron, 250 psi minimum working pressure. Lining and coating shall match connecting pipe. Victaulic; Gustin-Bacon. **Flange**: AWWA C110/A21.10-93 and ANSI B16.1-89, ductile or gray cast iron, faced and drilled, 125-pound flat face or 250-pound raised face. Gray cast iron will not be allowed. Lining and coating shall match connecting pipe.

SECTION 40 23 39.13 DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Joints	**Push-On**: 250 psi minimum working pressure, AWWA C110/A21.10-93 and C111/A21.11-90. American Cast Iron Pipe Co., Fastite Joints; U.S. Pipe and Foundry, Tyton Joint. **Mechanical**: 250 psi minimum working pressure, AWWA C111. American Cast Iron Pipe Co., Mechanical Joint; U.S. Pipe and Foundry, Mechanical Joint. **Proprietary Restrained**: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. **Grooved End**: Rigid type radius cut conforming to AWWA C606-87, 250 psi minimum working pressure. Victaulic; Gustin-Bacon. **Flange**: 125-pound flat face, 250-pound raised face, ductile iron, threaded conforming to AWWA C115/A21-15.88. Gray cast iron will not be allowed.
Couplings	Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47-90 or ductile iron per ASTM A536-84. Victaulic; Gustin-Bacon. Grooved End Adapter Flanges: 250-pound malleable iron per ASTM A47-90 or ductile iron per ASTM A536-84. Victaulic; Gustin-Bacon.
Bolting	**Mechanical, Proprietary Restrained, and Grooved End Joints**: 316 Stainless Steel Hardware. **125-pound Flat-Faced Flange**: Exposed piping - ASTM A307-94, Grade A carbon steel hex head bolts and ASTM A563-93, Grade A steel hex head nuts. **250-pound Raised-Face Flange**: Exposed piping - ASTM A307-94, Grade B carbon steel hex head bolts and ASTM A563-93, Grade A carbon steel heavy hex head nuts. All hardware on submerged piping or piping below the top elevation of tanks and directly exposed to water, wastewater and/or wastewater solids , including but not limited to bolts, nuts, washers, and threaded rod shall be stainless steel.

SECTION 40 23 39.13 DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Gaskets	**Mechanical, and Proprietary Restrained Joints, Water and Sewage**: Rubber conforming to ANSI/AWWA C111/A21.11-90 Locking gaskets produced in accordance with AWWA C111 are acceptable for use as a joint restraint mechanism for buried push-on type joints. Locking gaskets shall be rated for the same working pressure as the pipe. American Cast Iron Pipe Co., Fast-Grip Gasket; US Pipe, Field LOK Gaskets. **Mechanical and Proprietary Restrained Joints, Air**: Viton, Fluorel, or Manufacturer's standard for high temperature air service, rated to 300 degrees F minimum, conforming to ANSI/AWWA C111/A21.11-90 **Grooved End Joints**: Halogenated butyl conforming to ASTM D2000-90 and AWWA C606-87. Gaskets for air service shall be pressure-responsive synthetic rubber, rated to 300 degrees F minimum, conforming to ASTM D2000. **Flanged, Water and Sewage Services**: 1/8-inch thick, unless otherwise specified, homogenous black rubber (EPDM), hardness 60 (Shore A), rated to 212 degrees F., conforming to ANSI B16.21 and ASTM D1330 Steam Grade. **Flanged, Air Service**: 1/8-inch thick, unless otherwise specified, Teflon, PTFE, or compressed inorganic fiber with nitrile binder, rated to 300 degrees F. minimum, conforming to ANSI B16.21 and ASTM D1330. Ring gaskets shall not be permitted. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange. Gasket pressure rating equal to the pressure rating as the pipe or fitting.
Joint Lubricant	Manufacturer's Standard.

END OF SECTION

SECTION 40 23 39.40 C900 & C905 PVC Pipe and Fittings		
Item	**Size/Installation**	**Description**
Pipe	4 IN. – 12 IN. 14 IN – 48 IN.	C900 DR 18: Conforming to ASTM D1784 with a cell classification of 12454. Conforming to AWWA C900 C905 DR 18: Conforming to AWWA C905
Fittings	Buried	Ductile Iron Mechanical Joint Fittings as specified in 40 23 39.13 CM LINED DUCTILE IRON PIPE AND FITTINGS with restraint gland
Joints	All	Push-on: Meeting ASTM D3139 with gasket meeting ASTM F477 Restrained Joints: • C900: Proprietary Locking Gaskets • C905: Joint Restraint Harness; EBAA Iron Series 2800 or equal
Flanges	None	Not allowed
Couplings	Dissimilar Pipe Materials Similar Pipe Materials	Transition Coupling: Smith-Blair Style 413 or equal Ductile Iron Mechanical Joint Solid Sleeve

END OF SECTION

SECTION 40 23 39.42 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS (DWV)		
Item	**Size**	**Description**
Pipe	All	Schedule 40 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D2665 or F1866. Threaded Nipples: Schedule 40 PVC.
Fittings	All	Schedule 40 PVC as specified above: Conforming to the requirements of ASTM D2665.
Joints	All	Solvent socket-weld except where connection to valves and equipment may require future disassembly. Threaded joints shall not be used unless specifically approved by ENGINEER.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1-89 drilling.
Bolting	All	Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A-94 Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M-94 Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307-94 Grade B square head bolts and ASTM A563-93 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8" thick. Raised Face Mating Flange: Flat ring 1/8" thick, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Gasket material shall be suitable for each service. Submit recommended gasket material for each service to ENGINEER.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM F493 Rev A. Solvent cement shall be rated for use with each service. Provide manufacturer's certification that the solvent is appropriate for respective service.
Thread Lubricant	All	Teflon Tape

END OF SECTION

SECTION 40 23 39.43 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	All	Schedule 80 PVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1785-05. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule 80 PVC as specified above: Conforming to the requirements of ASTM D2467.
Joints	All	Solvent socket-weld except where connection to valves and equipment may require future disassembly. Threaded joints shall not be used unless specifically approved by ENGINEER
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, 125-pound ANSI B16.1-89 drilling.
Bolting	All	Flat Face Mating Flange or In Corrosive Areas: ASTM A193/A193M Rev A-94 Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M-94 Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307-94 Grade B square head bolts and ASTM A563-93 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8" thick. Raised Face Mating Flange: Flat ring 1/8" thick, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Gasket material shall be suitable for each service. Submit recommended gasket material for each service to ENGINEER.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM F493 Rev A. Solvent cement shall be rated for use with each service. Provide manufacturer's certification that the solvent is appropriate for respective service.
Thread Lubricant	All	Teflon Tape

END OF SECTION

SECTION 40 23 39.53 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
Tubing	Seamless, conforming to ASTM B88 Rev A as follows: Buried.....Type K, soft or hard temper Exposed..... Type L, hard drawn P-trap priming service..... Type L, soft temper
Fittings	Commercially pure wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ANSI B16.22.
Flanges	Commercially pure wrought copper, socket joint, conforming to ASTM B75, faced and drilled 150-pound ANSI B16.24 standard.
Bolting	ASTM A307, carbon steel, Grade A hex head bolts and ASTM A563 Grade A hex head nuts.
Gaskets	Flanged, Water and Air Services: 1/16-inch thick, compressed inorganic fiber with nitrile binder, rated to 700 degrees F and 1,000 psi. Ring gaskets shall not be permitted. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange.
Solder	95-5 wire solder (95 percent tin, 5 percent antimony), conforming to ASTM B32 Grade 95TA. Do not use cored solder.

END OF SECTION

SECTION 40 23 39.56 HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS		
Item	**Size**	**Description**
Pipe	4" and Smaller	DR 11 (IPS): conforming to ASTM 3035 / AWWA C901, or ASTM F714 / AWWAC906. With pressure rating of 160 psi
Fittings	All	DR 11 HDPE as specified above, meeting FMRC standards. Or Muller 110 Compression Fittings or Equal
Joints	All	Thermo-weld joints with butt fusion technique, according to ASTM F2620 and Plastic Pipe Institute TR-33. Or Muller 110 Compression Fittings or Equal.
Thread Lubricant	All	Teflon Tape

END OF SECTION

SECTION 40 23 43 - PROCESS VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Basic requirements for Process Valves.

B. Related sections:
1. Section 01 33 00 – Submittal Procedures.
2. Section 01 60 00 – Product Requirements.
3. Section 01 78 23 – Operation and Maintenance Data.
4. Section 01 79 00 – Demonstration and Training.
5. Section 09 90 00 – Painting and Protective Coatings.
6. Section 22 05 53 – Mechanical Identification.
7. Section 40 23 39 – Process Piping - General.
8. Section 40 92 13 – Motorized Operators.
9. Section 40 92 16 – Manual Valve and Gate Operators.
10. Section 40 92 19 – Pneumatic Valve Actuators

1.2 GENERAL

A. See Section 40 23 39, PROCESS PIPING - GENERAL, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

B. Certain valves are specified in Division 44 to be furnished by equipment manufacturer as part of their equipment package and/or system. These valves are to be installed by the Contractor as specified herein. In addition to installation, the Contractor shall be responsible for test, inspection, and assisting the equipment suppliers in start-up services as required to the place the valves into continuous, reliable operation.

1.3 SUBMITTALS

A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS. The following specific information shall be provided:
1. Shop Drawings:
a. Product data sheets for make and model.
b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
c. Refer to specific valve type for additional submittal requirements.
2. Quality Control Submittals:
a. Tests and inspection data.
b. Manufacturer's Certificate of Proper Installation.
c. Manufacturer's printed installation instructions.
d. Special shipping, storage and protection, and handling instructions.
e. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
f. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

1.4 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

PART 2 - PRODUCTS

2.1 GENERAL

A. Valve to include operator, actuator, hand wheel, chain wheel, extension stern, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation. For operator specifications, see sections 40 92 13 MOTORIZED OPERATORS, and 40 92 16 VALVE AND GATE OPERATORS.

B. Valve shall be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve shall be the same size as adjoining pipe.

D. Valve ends to suit adjacent piping.

E. Valve shall open by turning counterclockwise unless otherwise specified.

F. Operator, actuator, and accessories shall be factory mounted.

G. EFFECTIVE JANUARY 4, 2014 ANY VALVE, PIPE, FITTING, SOLDER OR FLUX MUST USED OR IN CONTACT WITH POTABLE WATER MUST COMPLY WITH REDUCTION OF LEAD IN DRINKING WATER ACT AN AMMENDMENT TO SECTION 1417 OF THE SAFE DRINKING WATER ACT (SDWA). VALVES SPECIFIED IN THIS SECTION MAY NOT MEET TO REQUIRMENTS OF THIS ACT, HOWEVER THIS DOES RELIEVE THE CONTRACTOR FROM PROVIDING A VALVE TO MEET REQUIREMENTS OF THE (SDWA) OR THE SAME FUNCTIONAL REQUIREMENTS OF THIS SPECIFICATION.

2.2 SCHEDULE

A. Requirements relative to this section for certain type of actuated or process valves are shown on the Valve Schedules attached as Supplements to the related Sections.

2.3 MATERIALS

A. Brass and bronze valve components and accessories that have surfaces in contact with water shall be alloys containing less than 16% zinc and 2% aluminum.

B. Approved alloys are of the following ASTM designations:
1. B61, B62, B98 (Alloy UNS No.C65100, C65500, or C66100), B139 (Alloy UNS No.C51000), B584 (Alloy UNS No.C90300 or C94700), B164, B194, and B127.
2. Stainless steel, AISI Type 316 may be substituted for bronze.

2.4 FACTORY FINISHING

A. Epoxy Lining and Coating:
1. In accordance with AWWA C550 unless otherwise specified. Coating shall be either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion bonded" epoxy.
2. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

B. Exposed Valves Field Finish:

1. Final paint coating shall be in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS. System and color shall match adjacent piping system.
2. Safety isolation valves and lockout valves with handles, hand wheels, or chain wheels "safety yellow."

2.5 VALVES

A. Gate Valves:
1. Type V140: Gate Valve, Less Than 3 Inches
   a. General:
      1) Service: Aboveground, clean water and air.
      2) 150 psi Class
      3) Rising Stem type
      4) Threaded ends
      5) Conform to MSS-SP-80, Type 2
   b. Materials:
      1) Body & bonnet: Bronze, ASTM B62 alloy C83600
      2) Disc: Bronze, ASTM B62 alloy C83600
      3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400
   c. Manufacturers and Products:
      1). Crane – Figure 431.
      2). Jenkins – Figure 2810J
      3). Nibco – T-131

2. Type V141: Buried Gate Valve, 3 Inches and Larger
   a. Valve shall be resilient wedge type, of non-rising stem design and rated for 250 psig cold water working pressure.
   b. Valve shall meet or exceed all requirements of the latest revision of AWWA C515.
   c. Valve shall have mechanical joint ends, except tapping valves may be flanged by mechanical joint.
   d. Stem shall be sealed by three O-Rings. O-Rings set in a cartridge shall not be allowed.
   e. Each valve shall have maker's name, pressure rating, and year in which it was manufactured cast in the body. Country of origin to be clearly cast into body & cover castings.
   f. Valves 14" and larger shall be equipped with geared actuators. Valves to be installed in the standard vertical position shall have spur gear actuators. Valve to be installed in the horizontal position shall have bevel gear actuators. Valves shall only be installed in the horizontal position if noted on the plans or if instructed by the Engineer.
   g. Materials:
      1). All cast ferrous components shall be ductile iron, ASTM A536.
      2). The body, bonnet and O-ring plate shall be fusion-bonded epoxy coated, both interior and exterior on body and bonnet. Epoxy shall be applied in accordance with AWWA C550 and be NSF 61 Certified.
      3). Wedge shall be ductile iron fully encapsulated in EPDM rubber.
      4). Hardware shall be 304 stainless steel
      5). Stems shall be cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem
      6). Provide standard AWWA 2-inch operating nut, matching valve key, and valve box for operating stem.
   h. Manufacturers and Products:
      1). M&H/Kennedy Valve Company.
      2). Mueller.
      3). American.

3. Type V142: Exposed Gate Valve, 3 Inches and Larger
   a. Valve shall be resilient wedge type, of non-rising stem design and rated for 250 psig cold water working pressure.
   b. Valve shall meet or exceed all requirements of the latest revision of AWWA C515.
   c. Valve shall have flanged ends.
   d. Stem shall be sealed by three O-Rings. O-Rings set in a cartridge shall not be allowed.
   e. Each valve shall have maker's name, pressure rating, and year in which it was manufactured cast in the body. Country of origin to be clearly cast into body & cover castings.
   f. Valves 14" and larger shall be equipped with geared actuators. Valves to be installed in the standard vertical position shall have spur gear actuators. Valve to be installed in the horizontal position shall have bevel gear actuators. Valves shall only be installed in the horizontal position if noted on the plans or if instructed by the Engineer.
   g. Materials:
      1). All cast ferrous components shall be ductile iron, ASTM A536.
      2). The body, bonnet and O-ring plate shall be fusion-bonded epoxy coated, both interior and exterior on body and bonnet. Epoxy shall be applied in accordance with AWWA C550 and be NSF 61 Certified.
      3). Wedge shall be ductile iron fully encapsulated in EPDM rubber.
      4). Hardware shall be 304 stainless steel
      5). Stems shall be cast copper alloy with integral collars in full compliance with AWWA. All stems shall operate with copper alloy stem nuts independent of wedge and of stem
      6). Provide handwheel, chainwheel, 2" nut, or actuator as noted on the drawings or specified in the valve schedule.
   h. Manufacturers and Products:
      7). M&H/Kennedy Valve Company.
      8). Mueller.
      9). American.

4. Type V145: Knife Gate Valve, 2 Inches to 36 Inches
   a. Suitable for service under pressures equal to and less than 150 pounds per square inch.
   b. Full round port, metal seated, raised face design.
   c. Flanged wafer design, drilled and tapped to ANSI Class 125/150 standard.
   d. Founded gate with beveled edge, finish-ground to 32 RMS, maximum, on both sides.
   e. Body to incorporate guides and jams to assist in seating.
   f. Materials:
      1). Body: Cast or ductile iron or cast steel, with Type 316 stainless steel lining or cast Type 316 stainless steel.
      2). Wetted Components (including gate): Type 316 stainless steel.
      3). Yoke Sleeve: Acid resisting bronze or aluminum bronze.
      4). Packing: PTFE.
   g. Outside screw and yoke (OS&Y) with handwheel operator.
   h. Manufacturers and Products:
      1). DeZurik.
      2). Red Valve.

B. Globe Valves:
   1. Type V200: Globe Valve, 3 Inches and Smaller
      a. General:
         1) Service: Aboveground, clean water.
         2) 150 psi Class

3) Rising Stem type
4) Union Bonnet
5) Threaded ends
6) Conform to MSS-SP-80, Type 2

b. Materials:
1) Body & bonnet: Bronze, ASTM B62 alloy C83600
2) Disc: PTFE
3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400

c. Manufacturers and Products:
1). Stockham; B-22T, threaded end.
2). Crane. Co.; 7TF, threaded end.
3). Nibco: T-235-Y

2. Type V201: Angle Pattern Valve, 2 Inches and Smaller
a. General:
1) Service: Aboveground, clean water.
2) 150 psi Class
3) Rising Stem type
4) Union Bonnet
5) Threaded ends
6) Conform to MSS-SP-80, Type 2

b. Materials:
1) Body & bonnet: Bronze, ASTM B62 alloy C83600
2) Disc: PTFE
3) Stem: ASTM B505 alloy C83600 or ASTM B371 alloy C69400

c. Manufacturers and Products:
1). Stockham; Figure B-222T.
2). Crane Co.; Cat. No. 17TF.
3). Nibco: T-335-Y

3. Type V235: Angle Type Hose Bibb Valve
a. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE Standard 1011 and IAPMO code.

b. Manufacturers and Products:
1). Acorn; 8126, surface pipe mount valve, bent nose without flange:
2). Acorn; 8121, surface mount through wall valve, bent nose with flange.
3). Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.
4). Acorn; 8136, pedestal mounted valve located lower than 6 inches inverted nose.

4. Type V236: Angle Pattern Hose Valve, 1 Inch Through 3 Inches
a. All-bronze, screwed ends, inside screw, rising stem, 'I'F±. disc, outlet of cast brass NST by NPT, male by male, nipple adapter with hexagonal wrench feature, rated 300 WOG.

b. Manufacturers and Products:
1). Stockham; Figure B-222T.
2). Crane Co.; Cat. No. 17TF.
3). James Jones Co.: J-300 Series, angle fire hydrant valve with NPT inlet and National Hose thread outlet.
4). ITT Kennedy; Figure 936, angle fire hydrant valve with NPT inlet and National Hose thread outlet.

C. Ball Valves:
1. Type V300: Metal Body Ball Valve, Less than 6 Inches

a. General
   1). Type: Non-lubricated and capable of sealing in either flow direction.
   2). End Connections:
      a) Threaded or solder ends for sizes 3-inch and smaller.
      b) Class 150 flanged for sizes larger than 3 inch. Flanges shall conform to ANSI/ASME B16.1 standards.
   3). Stem Packing: Manually adjustable while valve is under pressure.
   4). Shafts: Rigidly connected to the ball by a positive means. The connection shall be designed to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
   5). Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
   6). Temperature Limits: Suitable for operation between minus 20 and 350 degrees Fahrenheit.

b. Materials:
   1). Valves in Copper Lines: Bronze body
   2). Valves in Steel and Ductile Iron Piping: Ductile iron or cast steel bodies.
   3). Ball: Type 304 or 316 stainless steel.
   4). Seats: PTFE.
   5). Stem Seals: TFE or Viton
   6). Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.

c. Manufacturers and Products:
   1). Apollo.
   2). Nibco.
   3). Milwaukee Valve.

2. Type V302: Metal Body Ball Valve, 6 Inches and Larger
   a. General
      1). Type: Non-lubricated and capable of sealing in either flow direction.
      2). Conform to AWWA C 507.
      3). Stem Packing: Manually adjustable while valve is under pressure.
      4). ANSI B16.1, Class 125 flanged ends.
   b. Materials
      1). Body: ASTM A48 cast iron and integrally cast bronze bushed trunnions.
      2). Ball: Type 304 or Type 316 stainless steel.
      3). Seats: TFE.
      4). Stem Seals: TFE or Viton.
   c. Manually operated ball valves shall have self-locking worm gear type actuator with position indicator. Gearing shall be permanently lubricated. Provide adjustable screws to stop travel at both Open and Closed positions.
   d. Manufacturers and Products:
      1). Henry Pratt.
      2). McANNA/MARPAC

3. Type V303 Instrumentation Ball Valves
   a. Brass or stainless steel body ball valve, nylon handle.
   b. Manufacturers and Products:
      1). Swagelok, 40G Series.
      2). Imperial Eastman; Series 200.

4. Type V330 PVC Body Ball Valve
   a. General:
      1). Type: Non-lubricated and capable of sealing in either flow direction.
      2). End Connections: True union; solvent or heat welded to piping.
      3). Operator Handle: Lever.

4). All ball valves on sodium hypochlorite lines and/or chlorine dioxide lines shall be venting type valves.

b. Materials
1). Body: Polyvinyl chloride (PVC).
2). Ball: Polyvinyl chloride (PVC).
3). Seats: Teflon (TFE).
4). O-rings: Viton (FPM).

c. Manufacturers and Products:
1). Asahi/America, Inc.
2). Nibco.

D. Plug Valves:

1. Type V404: Eccentric Plug Valve, 1/2 Inch through 3 Inches
a. Non-lubricating type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body, or stainless steel body where indicated, with threaded NPT full size inlets. Connection shall be hexagonal for a wrench connection. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.
b. Provide valves with wrench lever manual operator.
c. Manufacturers and Products:
1). DeZurik.
2). Henry Pratt.
3). Val-Matic.

2. Type V405: Eccentric Plug Valve, 4 Inches through 12 Inches
a. Non-lubricating type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body, or stainless steel body where indicated, with flanged ends or grooved ends in accordance with AWWA C606 for rigid joints, mechanical joint ends for buried valve. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.
b. 4" valve with wrench lever manual operator and 6 through 12" valve with totally enclosed, geared, manual operator with hand wheel, 2" nut, or chain wheel.
c. Manufacturers and Products:
1). DeZurik.
2). Henry Pratt.
3). Val-Matic.

3. Type V406: Eccentric Plug Valve, 14 Inches and Larger
a. Non-lubricating type rated 150 psig CWP, drip-tight shutoff with pressure from either direction, cast iron body with flanged ends or grooved ends in accordance with AWWA C606 for rigid joints, mechanical joint ends for buried valve. Plug cast iron with round or rectangular port of no less than 80% of connecting pipe area and coated with Buna-N or Hycar, seats nickel, stem bearing self-lubricating stainless steel, stem seal multiple V -rings or V-cups of nitrile rubber, grit seals on stem.
b. Provide with totally enclosed, geared, manual operator with hand wheel, 2" nut, or chain wheel.
c. Manufacturers and Products:
1). DeZurik.
2). Henry Pratt.
3). Val-Matic.

E. Butterfly Valves:

1. General: Provide valves designed and manufactured in accordance with AWWA C504, Class 150B or Class 250B, AWWA C516, and the following requirements:
   a. Valve class shall meet the requirements of the connecting line or as indicated in valve schedule or as indicated on the drawings.
   b. Suitable for throttling operations and infrequent operation after periods of inactivity.
   c. Elastomer seats bonded to body shall have adhesive integrity of bond between seat and body assured by testing with minimum 75-pound pull in accordance with ASTM D429, Method B. Seat may be retained by mechanical means on valves 24-inches and larger.
   d. Bubble-tight with rated pressure, or any pressure lower than rated, applied from either side with the valve mounted in any orientation.
   e. No travel stops for the disc on interior of the body.
   f. Shaft seal shall include V-type packing for self-adjusting and wear compensation.
   g. Isolate metal-to-metal thrust bearing surfaces from flow stream.
   h. Valves intended for air service shall meet ANSI B16.104 and ANSI B16.5.

2. Type V500: Butterfly Valve, 4 Inches and Larger
   a. Valve Style: Flanged end, short body type.
   b. Flanged end connections shall fully conform with ANSI B16.1 Class 125 or Class 250, or AWWA C207 Class D.
   c. Materials:
      1). Body: Class 150B valve bodies shall be ASTM A126, Class B gray iron or ASTM A536 Grade 65-45-12 ductile iron. Class 250B valve bodies shall be ASTM A536 Grade 65-45-12 ductile iron.
      2). Disc: Valve disc shall be made from cast iron ASTM A-126 Class B or stainless steel ASTM A351 in sizes 20" and smaller. Sizes 24" and larger shall be built from ductile iron in conformance to ASTM A-536. Disc shall be furnished with Type 316 stainless steel seating edge to mate with the rubber seat on the body.
      3). Shafts: Shafts shall be Stainless Steel. ASTM A276 Type 304, or Type 316, or ASTM A564, grade 630.
      4). Seat: Valve seat shall be Buna-N rubber located on the valve body. In sizes 20" and smaller, valves shall have bonded seats that meet test procedures outlined in ASTM D-429 Method B. Sizes 24" and larger shall be retained in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream.
      5). Bearings: Shall be sleeve type that is corrosion resistant and self-lubricating.
      6). Manual Actuators: Shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 ft. lbs. against the stop. The traveling nut shall engage alignment grooves in the housing. The actuators shall have a built in packing leak bypass to eliminate possible packing leakage into the actuator housing.
      7). Hardware: All seat retaining hardware shall be Type 316 stainless steel.
   d. Manufacturers and Products:
      1). Henry Pratt – Class 150B - 2FII, 4"-20" or Triton 24" and larger
                Class 250B - HP-250II
      2). Mueller Co. – Class 150 B - Lineseal III
                Class 250 B – Lineseal XP
      3). DeZurik - AWWA Butterfly Valves (BAW) 150B or 250B
      4). Val-Matic – American BFV 150B or 250B

3. Type V504: Buried Butterfly Valve, 4 Inches and Larger
   a. Valve Style: Mechanical joint end type
   b. Mechanical joint end connections shall fully conform to ANSI/AWWA C111/A21.11.

c. Valve position indicator at valve box locations. Indicator to be hermetically sealed and show valve disc position, direction of rotation, and number of turns from FULLY OPENED to FULLY CLOSED.

d. Materials:
   1). Body: Class 150B valve bodies shall be ASTM A126, Class B gray iron or ASTM A536 Grade 65-45-12 ductile iron. Class 250B valve bodies shall be ASTM A536 Grade 65-45-12 ductile iron.
   2). Disc: Valve disc shall also be made from cast iron ASTM A-126 Class B in sizes 20" and smaller. Sizes 24" and larger shall be built from ductile iron in conformance to ASTM A-536. Disc shall be furnished with Type 316 stainless steel seating edge to mate with the rubber seat on the body.
   3). Shafts: Shafts shall be Stainless Steel. ASTM A276 Type 304, or Type 316, or ASTM A564, grade 630.
   4). Seat: Valve seat shall be Buna-N rubber located on the valve body. In sizes 20" and smaller, valves shall have bonded seats that meet test procedures outlined in ASTM D-429 Method B. Sizes 24" and larger shall be retained in the valve body by mechanical means without use of metal retainers or other devices located in the flow stream.
   5). Bearings: Shall be sleeve type that is corrosion resistant and self-lubricating.
   6). Manual Actuators: Shall be suitable for buried service. Shall be fully grease packed and have stops in the open/close position. The actuator shall have a mechanical stop which will withstand an input torque of 450 ft. lbs. against the stop. The traveling nut shall engage alignment grooves in the housing. The actuators shall have a built in packing leak bypass to eliminate possible packing leakage into the actuator housing.
   7). Hardware: All seat retaining hardware shall be Type 316 stainless steel.

e. Manufacturers and Products:
   1). Henry Pratt - Class 150B - Groundhog
   Class 250B - HP-250II
   2). Mueller Co. - Class 150 B - Lineseal III
   Class 250 B – Lineseal XP
   3). DeZurik - AWWA Butterfly Valves (BAW) 150B or 250B
   4). Val-Matic - American BFV 150B or 250B

4. Type V510: Lug Style Butterfly Valve, 2 Inches and Larger
   a. Cast iron ASTM A126 body, ASTM A351-CF8M discs, Type 18-8 stainless steel or Type 416 stainless steel one-piece stem/shaft, self-lubricating sleeve-type Teflon or bronze bearing, EPDM replaceable resilient seat, self-adjusting multi-ring V-type packing, suitable for temperatures up to 250°F, bubble-tight at 150 psi differential pressure. Flanges and/or mounting design shall be for ANSI B16.1 125- or 150-pound flanges.
   b. Manufacturers:
      1). Henry Pratt – Series 397
      2). DeZurik – BOS-CL

5. Type V511: Wafer-Style Butterfly Valve, 2 Inches and Larger
   a. Cast iron body, cast iron or ductile iron discs, Type 18-8 stainless steel one-piece stem, self-lubricating sleeve type bearing, EPDM replaceable resilient seat, self-adjusting packing, suitable for temperatures up to 250 degrees F, bubble-tight at 50 psi differential pressure, valve body to fit between ANSI B16.1 flanges.
   b. Manufacturers:
      3). Henry Pratt.
      4). DeZurik

6. Type V512: Plastic Body Butterfly Valve, 8 Inches and Smaller

a. PVC or CPVC body, CPVC discs, 316 SS stem/shaft, Viton (FKM) seats and seals, suitable for pressures of up to 150 psi at 70°F. The liner seal shall be full seat design such that the disc and seat are the only wetted parts. Flanges and/or mounting design shall be for ANSI B16.5 or ANSI B16.10 bolt patterns

b. Manufacturers
   1). Asahi/America, Inc.

F. Check and Flap Valve:

1. Type V600: Check Valve, 2 Inches and Smaller
   a. All-bronze, screwed ends and cap, swing type replaceable Buna-N disc, rated 125-pound SWP, 200-pound WOG.
   b. Manufacturers:
      1). Stockham.
      2). Milwaukee Valve.

2. Type V605: Resilient Seated Swing Check Valve, 3 Inches and Larger
   a. Valve Connections: Flanged in accordance with ANSI B16.1, Class 125
   b. The valve shall be in conformance with AWWA C508
   c. The valves used in potable water service shall be certified to NSF/ANSI 61 Drinking Water System Components – Health Effects, and certified to be Lead-Free in accordance with NSF/ANSI 372.
   d. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The 4 in. (100mm) valve shall be capable of passing a 3 in. (75mm) solid. The seating surface shall be a minimum of 35 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator or oil cushion device without special tools or removing the valve from the line.
   e. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.
   f. The disc shall be of one-piece construction, precision molded with an integral O-ring type sealing surface and reinforced with alloy steel. The flex portion of the disc contains nylon reinforcement and shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a disc accelerator to provide a cracking pressure of 0.3 psig.
   g. The disc accelerator shall be of one piece construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place captured between the cover and disc. It shall be formed with a large radius to allow smooth movement over the disc surface
   h. Materials:
      1). Body: The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron or ASTM A126 class B gray iron for 30 in. (800mm) and larger. The exterior and interior of the valve shall be coated with an NSF/ANSI 61 approved fusion bonded epoxy coating.
      2). Disc: The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG.
      3). Hardware: All retaining hardware shall be Type 316 stainless steel.
   i. Manufacturers and Products:
      1). Val-Matic - Surgebuster
      2). Henry Pratt – RD-Series
      3). DeZurik/APCO – Series 100

3. Type V608: Swing Check Valve, 2 Inches and Larger

a. AWWA C508, flanged end, cast iron body, bronze mounted valve, solid bronze hinges, stainless steel hinge shaft.
b. Valve 2" through 12" rated 175-pound and 14" through 36" rated 150-pound cold water, non-shock. Valve fitted with adjustable outside lever and spring. Increasing-pattern body valve may be used where increased outlet piping size is shown.
c. Manufacturers:
   1). Stockham.
   2). Val-Matic.
   3). DeZurik.

4. Type V612: Double Disc Swing Check Valve, 2 Inches and Larger
   a. Lug wafer style, spring loaded, cast or ductile iron body, aluminum-bronze or ductile iron doors, resilient seats, stainless steel hinge pin, stop pin spring.
   b. Valve 2 inches through 12 inches rated 200-pound cold water and valve 14 inches through 54 inches rated 150-pound cold water.
   c. Manufacturers:
      1). Stockham.
      2). DeZurik.

5. Type V614: Stainless Steel Check Valve, 2 Inches and Smaller
   a. Type 316 stainless steel body, disc, cap, and trim. Screwed ends and cap, swing-type disc; Class 150.
   b. Manufacturers and Products.
      1) Stockham.
      2) Or equal.

6. Type V625: Slanting Disc Check Valve, 2 Inches and Larger
   a. Two-piece cast iron construction, Body shall be ASTM A126, Grade B cast iron. Disc shall be bronze ASTM B584. Pivot pins and bushing shall be stainless steel. The valve shall be provided with a bottom mounted hydraulic buffer. The buffer shall contact and control the sic closure rate.
   b. Manufacturer:
      1) DeZurik.
      2) Val-Matic.

7. Type V631: CPVC Ball Check Valve, 4 Inches and Smaller
   a. ASTM D1784 Cell Class 23477B chlorinated polyvinyl chloride body, single or dual union socket weld ends, rated 150 psi at 73 °F, 110 psi at 140 °F, Viton seat and seal.
   b. Manufacturers:
      1) Asahi/America, Inc.
      2) Nibco.
      3) Spears.

8. Type V632: CPVC Foot Valve with Strainer, 4 Inches and Smaller
   a. ASTM D1784 Cell Class 23477B chlorinated polyvinyl chloride body, single or dual union socket weld ends, rated 150 psi at 73 °F, 110 psi at 140 °F, CPVC screen, Viton seat and seal.
   b. Manufacturers:
      1) Asahi/America, Inc.
      2) Nibco.
      3) Spears.

9. Type V635: Check Valve for Air Service, 2 Inches and Larger:
   a. Check valves for low pressure process air service shall be carbon steel type with 150# flanged ends, rated 150 psig at 300 °F. Valve shall have stainless steel split

disc mounted on Type 316 stainless steel center post, such that wafer type butterfly valve can be mounted directly downstream of check valve when discs of both valves are in the OPEN position.

b. Manufacturers:
   1) Techno Corporation, Style 5003
   2) Crane, Style H

10. Type V641: Double Check Valve Assembly, 2-1/2 Inches through 10 Inches
    a. General:
       1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
       2) Valve Body: Bronze
       3) End Connections: Flanged, ANSI B 16.1.
       4) Maximum Working Pressure: 175 PSI, (350 Hydrostatic Test Pressure).
       5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
    b. Manufacturers:
       1) Febco.
       2) Watts.
       3) Hersey.

11. Type V642: Reduced Pressure Backflow Preventer, 3/4 Inches and Larger
    a. General, (3/4 Inches through 2 Inches):
       1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
       2) Valve Body: Bronze
       3) End Connection: Threaded, NPT ANSI/ASME B1.20.1
       4) Maximum Working Pressure: 175 PSI, (350 Hydrostatic Test Pressure).
       5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
       6) Shut-off Valves: Full port resilient seated, bronze ball valves with bronze ball valve test cocks.
       7) Size(s) and rating(s) as shown in the schedules following this Section.
       8) Manufacturers:
          a) Febco.
          b) Watts.

    b. General, (2 Inches and Larger):
       1) Regulatory Compliance: AWWA-C510-92, CSA B64.5, FCCHR of USC Section 10, ASSE 1048, IAPMO (UPC), SBCCI.
       2) Valve Body: Ductile or Cast Iron, Class 125
       3) End Connections: Flanged, ANSI B 16.1
       4) Maximum Working Pressure: 175 PSI, (350 Hydrostatic Test Pressure).
       5) Temperature Range: 32 Degrees to 140 Degrees Fahrenheit.
       6) Shut-off Valves: Non-rising stem, resilient seated gate valves with bronze ball valve test cocks.
       7) Accessories: Drain line with air gap.
       8) Size(s) and rating(s) as shown in the schedules following this Section.
       9) Manufacturers:
          a) Febco.
          b) Watts.

G. Self-Contained Automatic Valves:
   1. Type V710: Pressure Regulating Valve, 2-1/2 Inches and Smaller
      a. General:
         1) Maximum Inlet Pressure: 200 psig.
         2) Outlet Pressure Ranges: 20 to 80 psig.

3) Maximum Allowable Outlet Pressure: 10% above spring setting, or 5 psig above setting, whichever is greater.
4) Maximum Operating Differential: 5 psi.
5) Maximum Operating Temperature: -20 Degrees to 150 Degrees Fahrenheit.

b. Construction Materials:
1) Body: Bronze.
2) Spring Case: Cast Iron.
3) Valve Disk and Holder: Nitrile (NBR) and bronze.
4) Diaphragm: Nitrile (NBR)

c. Manufacturers:
1) Fisher.
2) Mueller.

2. Type V711: High-Pressure Regulating Valve, 2 Inches and Smaller
a. General:
1) Maximum Inlet Pressure: 300 psig.
2) Outlet Pressure Ranges: 5 to 150 psig.
3) Maximum Operating Temperature: 150 Degrees Fahrenheit.

b. Construction Materials:
1) Body: Stainless Steel.
2) Spring Case: Stainless Steel.
3) Valve Disk and Holder: Nitrile (NBR) and bronze.
4) Diaphragm: Nitrile (NBR)

c. Manufacturers:
1) Fisher.
2) Mueller.

3. Type V712: High-Pressure Regulating Valve, 3 Inches and Smaller
a. General:
1) Maximum Inlet Pressure: 150 psig.
2) Outlet Pressure Ranges: 5 to 125 psig.
3) Maximum Operating Temperature: 140 Degrees Fahrenheit.

b. Construction Materials:
1) Body: Machined PVC
2) Seals: Viton

c. Manufacturers:
1) Plast-O-Matic Valves, Inc.

4. Type V713: Pressure Reducing Valve, 1 Inch through 4 Inches
a. General:
1) Maximum Inlet Pressure: 250 psig (Cast Iron), 300 psig (Steel).
2) Droop: 10% of outlet pressure setting.
3) Maximum Differential Pressure: 150 psig or body rating limit, whichever is lower.
4) Body: Ductile Iron, Cast Steel, or Bronze.
5) Disc Retainer and Diaphragm Washer: Cast Iron, Cast Steel, or Bronze.
6) Stem, Nut and Spring: Stainless Steel
7) Diaphragm: Nylon Reinforced Buna-N Rubber

b. Manufacturers:
1) Cla-Val.
2) Fisher.

5. Type V714: Pressure-Reducing Valve, 4 Inches and Larger
a. Manufacturers: Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to

the performance, functions, features, and materials of construction as specified herein.

1) Materials, equipment, components and accessories specified in this section shall be, products of:
   a) Cla-Val
   b) Singer Valve

b. Valve Size & Model

c. Pressure Reducing Valves
   1) Mfg. & Model: Cla-Val: 90-01/690-01 Pressure Reducing Valve
   2) Mfg. & Model: Singer Valve: 106/206-PR Pressure Reducing Valve
   3) Size: As shown on the drawings

d. Function
   1) The pressure reducing valve shall maintain a constant downstream pressure regardless of changing flow rate and/or inlet pressure.

e. Main Valve Design
   1) The valve shall be hydraulically operated, single diaphragm-actuated, globe or angle pattern. The valve shall consist of three major components: the body, with seat installed; the cover, with bearings installed; and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls.

f. Main Valve Body
   1) No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be constructed of ASTM A536-65/45/12 ductile iron. The flanges shall be designed to ANSI Class 150 standards. Flange drilling to ANSI shall be standard. No fabrication or welding shall be used in the manufacturing process.
   2) The valve cover shall have a separate stem cap on valves larger than 2 in giving access to the stem for alignment check, spring installation and ease of assembly.
   3) On valve(s) 1in and larger, bonnets shall be accurately located to bodies utilizing locating pins. Locating pins shall eliminate corrosion resulting from the use of uncoated ductile iron to ductile iron surfaces. Valves with lipped spigot covers shall not be acceptable due to risk of rust and difficulty in assembly.
   4) Valve(s) 3 in to 8 in shall have the AISI 316 Stainless Steel seat with integral bottom guide, bolted in place. The AISI 316 Stainless Steel seat ring shall be easily replaceable without special tools. Valves 10 in and larger shall incorporate a two-piece seat and bottom guide design.
   5) The valve(s) shall form a drip-tight seal between the stationary stainless steel seat ring and the resilient disc, which has a rectangular cross-section and is retained by clamping on three and one half sides. The resilient disc shall be constructed of Buna-N for normal service conditions.
   6) All external fasteners shall be AISI 18-8 Stainless Steel with AISI 18-8 Stainless Steel washers. Mild steel studs or bolts will not be acceptable.
   7) The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across

this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

8) The stainless steel stem shall be provided with wrench flats on all valves 1 in to 16 in, for ease of assembly and maintenance. Wrench flats will be fully accessible when inner valve is assembled.

9) The valve cover shall have a separate stem cap on valves larger than 2 in giving access to the stem for alignment check, spring installation and ease of assembly.

10) On valve(s) 1 in and larger, bonnets shall be accurately located to bodies utilizing locating pins. Locating pins shall eliminate corrosion resulting from the use of uncoated ductile iron to ductile iron surfaces. Valves with lipped spigot covers shall not be acceptable due to risk of rust and difficulty in assembly.

11) Valve(s) 3 in to 8 in shall have the AISI 316 Stainless Steel seat with integral bottom guide, bolted in place. The AISI 316 Stainless Steel seat ring shall be easily replaceable without special tools. Valves 10 in and larger shall incorporate a two-piece seat and bottom guide design.

12) The valve(s) shall form a drip-tight seal between the stationary stainless steel seat ring and the resilient disc, which has a rectangular cross-section and is retained by clamping on three and one half sides. The resilient disc shall be constructed of Buna-N for normal service conditions.

13) All external fasteners shall be AISI 18-8 Stainless Steel with AISI 18-8 Stainless Steel washers. Mild steel studs or bolts will not be acceptable.

14) All repairs and maintenance shall be possible without removing the valve from the line. To facilitate easy removal and replacement of the inner valve assembly and to reduce unnecessary wear on the guide, the stem shall be vertical when the valve is mounted in a horizontal line.

15) Each valve shall be air tested prior to shipment. The standard test shall include leakage test, seat leakage test, and stroke test. Refer to IOM 622B for further details. Where the set-point is provided, the valve manufacturer will preset the pilot.

16) Valve(s) 6 in and larger shall provide smooth frictionless motion and maximum low flow stability. The diaphragms shall not be used as a seating surface.

17) Valve shall meet NSF-61/ANSI standards for drinking water contact.

g. Valve Coating

1) Valve coating shall be NSF 61 and FDA approved, valve(s) shall have a protective fusion bonded epoxy coating internally and externally. The protective fusion bonded epoxy coating shall conform to the AWWA C116 (current version) specification. No machining of any external parts after final coating will be acceptable to ensure a continuous coating surface throughout the entire valve.

h. Pilot

1) The pilot shall have a spring range as specified in the schedule below

2) The pressure reducing pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to permit flow when controlled pressure is less than the spring setting. The pilot control is held open by the force of the compression on the spring above the diaphragm, and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring setting.

3) The pilot control system shall include a fixed orifice. No variable orifices shall be permitted. The pilot system shall include an opening speed control as standard equipment.

4) The pilot control shall have a second downstream sensing port which can be utilized to install a pressure gauge.

5) A direct factory representative shall be made available for start-up service, inspection and necessary adjustments.
6) Maximum working temperature: 180° F / 82° C
7) Maximum working pressure: 300 psi / 27.6 bar

i. Pilot Tubing and Fittings
1) Shall have standard ASTM B16 brass pilot fittings with flexible stainless steel braided Teflon lined Pilot tubing.

j. Flow Control Valves
1) Shall have brass or bronze body and stainless steel stem.
2) Shall control opening and closing speed of the main valve.
3) Shall have visible position markings.

k. Isolation Valves
1) Shall be brass body ball valves with wing handle operator.
2) Shall be all stainless steel construction and shall a have a 40 mesh screen.
3) Strainers shall be provided at locations as necessary to protect the pilot and solenoid system from contaminates.

l. Additional Provisions
1) Provide a pressure gauge on the inlet and outlet sides of the main valve. Pressure gauges shall be 0-300 psi range glycerin filled with 4" dial. Pressure gauges shall be provided with isolation valves to isolate gauges from pilot system.

m. Warranty
1) The valve(s) shall be covered by a minimum three year (3) warranty against defects in materials and workmanship. The electrical components shall have a minimum one year (1) warranty. The stainless steel seat shall be covered by a lifetime replacement warranty.

V714 SCHEDULE								
TAG NO.	P&ID DRAWING	FLOW STREAM ID	BODY SIZE (in)	BODY STYLE	FLOW MAX/MIN (gpm)	INLET PRESSURE MAX/MIN (psi)	OUTLET PPRESSURE (psi)	PORT
55PCV01	08-I551	BWS	16	Globe	6,000/1,000	120/60	40	Reduced
40PCV01	08-I401	BWS	20	Globe	6,000/1,000	40/5	3	Reduced

6. Type V730: Pressure Relief Valve, 2 Inches and Smaller
a. Direct diaphragm, spring controlled, Type 316 stainless steel body, spring case, Type 316 stainless steel diaphragm, stainless steel valve stem.
b. Capable of opening when upstream-pressure reaches a maximum set point.
c. Manufacturers:
1) Fisher.
2) Or equal.

7. Type V731: Pressure Relief Valve, 1/4 Inch through 2 Inches
a. General:
1) Maximum Line Pressure: 150 psi
2) Setting Range: 15-150 psi
b. Capable of opening when upstream-pressure reaches a maximum set point.
c. Construction Materials:
1) Body: PVC, CPVC
2) Spring Case: PVC
3) Spring Keepers: PVC
4) Diaphragm: PVC, PTFE
5) Orifice Seal: EPDM, FKM
6) Adjustment Screw: 316 SS
d. Manufacturers:

1) Primary Fluid Systems, Inc.
2) Or equal.

8. Type V732: Pressure Relief Valve, Pressure Sustaining Valve, 1 Inch and Larger
   a. Hydraulically operated, diaphragm, actuated, pilot controlled globe valve, cast iron body, ANSI B16.1 flanged ends, rated 175 psi, stainless steel trim, stainless steel stem, externally mounted strainers with cocks, to open when upstream pressure reaches a maximum set point.
   b. Manufacturers:
      1) Cla-Val.
      2) Or equal.

9. Type V750: Well Service Air Valve, 1/2 Inch and Larger
   a. Fully automatic float operated valve, suitable for vertical turbine pump discharge service, designed to exhaust air which is present in pump column on pump start-up and allow air to re-enter the column on pump shutdown or should a negative pressure occur.
   b. Valves used in potable water service shall be NSI/ANSI 61 certified.
   c. Valves 3" and smaller shall be equipped with a dual port throttling device to provide adjustable control of the exhaust rate and allow free air to flow into the valve through a separate inlet port. Valves 4" larger shall be equipped with a regulated exhaust device, which shall allow free airflow in and out of the valve, close upon rapid air exchange, and control the air exhaust rate to reduce pressure surges.
   d. Valve interiors and exteriors shall be coated with an NSF/ANSI 61 certified fusion bonded epoxy in accordance with AWWA C550.
   e. Connections:
      1) Inlet-Valve sizes 3 in. and smaller shall have full size NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for a wrench connection. Valve sizes 4 in. and larger shall have bolted flange inlets equal to the valve size. Flanges shall be in accordance with ANSI B16.1 for Class 125 or Class 250 iron flanges and ANSI B16.42 for Class 300 ductile iron flanges.
   f. Outlets-Valve sizes 6 in. and smaller shall have NPT outlets; Valves 8 in. and larger shall have ANSI B16.1 Class 125 outlet flanges. The valve shall have two additional NPT connections for the addition of Air Release Valves, gauges, testing, and draining.
   g. Materials: The Well Service Air Valve body, cover, and baffle shall be constructed of ASTM A126 Class B cast iron for Class 125 and Class 250 valves. Class 300 ductile iron valves shall be constructed of ASTM A536 Grade 65-45-12 cast ductile iron. The float, guide shafts, and bushings shall be constructed of Type 316 stainless steel. Non-metallic guides and bushings are not acceptable. Resilient seats shall be Buna-N.
   h. Manufacturers:
      1) Val-Matic.
      2) DeZurik.

10. Type V752: Wastewater Combination Air Valves, 1 Inch and Larger
   a. Valve shall be automatic float operated valve designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. The valve shall open during draining or if a negative pressure occurs. The valve shall also release accumulated air from a piping system while the system is in operation and under pressure.
   b. Valve shall perform functions of both air release and Air/Vacuum valves and be furnished as a single body.
   c. Valve shall be suitable for use with domestic sewage.

d. Valve body and structure shall be constructed of cast iron or ductile iron. Float, guide shafts and bushings shall be stainless steel.
e. Manufacturers:
1) Val-Matic.
2) DeZurik.

11. Type V755: Clean Water Combination Air Valve, 1 Inch and Larger
a. Valve shall be automatic float operated valve designed to exhaust large quantities of air during the filling of a piping system and close upon liquid entry. Valve shall open during draining or if negative pressures occur. Valve shall also release accumulated air from a piping system while system is in operation and under pressure.
b. Valve shall perform functions of both air release and Air/Vacuum valves and be furnished as a single body.
c. Valves used in potable water shall be NSF/ANSI certified.
d. Valve body and structure shall be constructed of cast iron or ductile iron. Float, guide shafts and bushings shall be stainless steel.
e. Manufacturers:
1) Val-Matic.
2) DeZurik.

12. Type V780: Safety Relief Valve for Air Service, 1-1/2 Inch through 3 Inches
a. Spring loaded, adjustable pressure relief valve for process air service, with stainless steel trim; seat material suitable for elevated temperatures above 300 °F, test pull ring or lever.
b. Manufacturers:
1) Kunkle.
2) Apollo Valve

13. Type V785: Safety Relief Valve for Air Service
a. Exposed spring, full nozzle with stainless steel trim, cast steel body, seat material suitable for elevated temperatures above 300 °F.
b. Manufacturers:
1) Kunkle.

H. Miscellaneous Valves:
1. Type V901: Diaphragm Valve, 1/2 Inch and Larger
a. Diaphragm valves shall be weir type with solid CPVC body and bonnet. Provide with Type 316 stainless steel bushing bolts, and other integral metallic components (etc., sleeve and stem). All metallic components shall be isolated for contact with fluid and the surrounding atmosphere. Valves 1/2" through 2" shall have true union socket ends. Valves 2-1/2" and larger shall have ANSI flanged ends. Manual operator shall be indicating, rising stem type with hand wheel. Valve working pressure shall be 100 psig at 120 °F. Valve must also be suitable for testing at elevated pressure per respective flow stream as indicated in Piping Schedule. Diaphragm shall be PTFE or Viton.
b. Manufacturers:
1). George Fisher.
2). Asahi/America, Inc.

2. Type V902: Pinch Valve
a. Iron body, fanged ends, TFE Teflon sleeves, upper and lower pinch bars, and hand wheel operator.
b. Manufacturer:
1). Red Valve Co.

3. Type V903: Anti-Siphon/Back Pressure Valves, 2 Inch and Smaller
   a. Spring controlled diaphragm, CPVC body, with a safety vent, to close when upstream pressure reaches a minimum set point and serve as an anti-siphon device. Rated 150 psi. The safety vent shall be connected to a leak containment system which shall include clear polyethylene tubing connecting to a vented, CPVC spill chemical neutralization bucket appropriate for the chemical service.
   b. Construction Materials:
      1) Body: CPVC
      2) Diaphragm: PTFE
   c. Manufacturers:
      1) Plast-O-Matic Valves, Inc.
      2) Or equal.

4. Type V910 Telescoping Valve, 4 Inches through 36 Inch
   a. Valve configuration shall be as shown on the Drawings and detailed within the Supplements following End of Section.
   b. Complete assembly consisting of rising stem, slip tube, seal flange, lifting bail, valve stand with indicator and motor, when required, and Type 316 stainless steel anchor bolts and mounting hardware.
   c. Slip tube shall be Type 304 stainless steel, manufactured from seamless pipe or tube, with a minimum wall thickness of 1/8" and must be of sufficient length to facilitate valve travel and maintain an appropriate insert depth.
   d. A stainless steel companion flange and neoprene slip seal gasket shall be provided. The gasket shall be a minimum 1/4-inch thick, mounted to allow sliding and shall be watertight throughout the travel of the slip tube.
   e. Lift shall be handwheel type and stem shall be of the rising type, stainless steel, thrust bearings, automatic self-locking, and provide infinite valve positioning. A clear plastic Butyrate stem cover shall be provided with a mylar strip type position indicator, calibrated in 1/4-inch increments to illustrate valve position.
   f. Manufacturers and Products:
      1). Troy Valve
      2). Waterman; TS-2.
      3). Golden-Harvest
      4). Amwell; Type RP.

5. Type V915: Mud Valve
   a. Cast iron body tapered seat, bronze disc and seat ring, frame flanged, nonrising type stem, bronze extension stem, 2" square operating nut for floor box operation, and stem guides for maximum unsupported stem length of 5 feet.
   b. Manufacturers and Products:
      1). Waterman; MV11.
      2). Clow; F-3075.
      3). Troy Valve; A25600RB

6. Type V916: Mud Valve
   a. Type 316 stainless steel body tapered seat, disc and seat ring, frame flanged, nonrising type stem, stainless steel extension stem, 2" square operating nut for floor box operation, and stem guides for maximum unsupported stem length of 5 feet.
   b. Manufacturers and Products:
      1). Waterman.
      2). Clow.
      3). Troy Valve

7. Type V940 Solenoid Valve, 2 Inches and Smaller

a. Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA Class A, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (OPEN or CLOSED when de-energized) as indicated.
b. Minimum operating pressure differential no less than 5 psig, maximum operating pressure differential no greater than 125 psig.
c. Manufacturers and Products:
1). ASCO
2). Skinner

8. Type V941 Plastic Body Solenoid Valve, 2 Inches and Smaller
a. Two-way internal pilot operated diaphragm type, PVC body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA 4X, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Size and normal position (OPEN or CLOSED when de-energized) as indicated.
b. Minimum operating pressure differential no less than 5 psig, maximum operating pressure differential no greater than 140 psig.
c. Manufacturers and Products:
1). Plast-O-Matic Valves, Inc.
2). Or Equal.

2.6 TAGGING REQUIREMENTS

A. See Section 22 05 53, MECHANICAL IDENTIFICATION.

B. The tags shall be attached to the valves by soldered split key rings so that ring and tag cannot be removed. The tag shall bear the 1/4" die-stamped equipment identification number as indicated in the Contract Documents.

2.7 ACCESSORIES

A. T-Handled Operating Wrench:
1. 2 each galvanized operating wrenches, 4 feet long.
2. Manufacturers and Products:
a. Mueller; No. A-24610.
b. Clow No.; F-2520.
3. 2 each galvanized operating keys for cross handled valves.

B. Cast Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 6" ID shaft.
1. Box: Cast iron with minimum depth of 9".
2. Lid: Cast iron, minimum depth 3", marked for the appropriate service.
3. Extensions: Cast iron.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.2 INSTALLATION

A. Flange Ends:
1. Flanged valve bolt holes shall straddle vertical centerline of pipe.

2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:
1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. Valve Orientation:
1. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4' 6" or less above finished floor, unless otherwise shown.
2. Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 4' 6" and 6' 9" above finish floor, unless otherwise shown.
3. Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.
4. If no plug valve seat position is shown, locate as follows:
   a. Horizontal Flow: The flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve.
   b. Vertical Flow: Install seat in the highest portion of the valve.

D. Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flow meters, for isolation during maintenance.

E. Install safety isolation valves on compressed air.

F. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

G. Extension Stem for Operator: Where the depth of the valve is such that its centerline is more than 3 feet below grade. Furnish an operating extension stem with 2"operating nut to bring the operating nut to a point 6" below the surface of the ground and/or box cover.

H. Torque Tube: Where operator for quarter-turn valve is located on floor stand. Furnish extension stem torque tube of a type properly sized for maximum torque capacity of the valve.

I. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

3.3 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other, in both directions for two-way valve and applications.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for any discrepancies with Manufacturer's data.

E. Set, verify, and record set pressures for all relief and regulating valves.

F. Automatic valve to be tested in conjunction with control system testing.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.4 MANUFACTURER'S SERVICES

A. A Manufacturer's representative for the equipment specified herein shall be present at the jobsite for the minimum person-days listed for the services herein under, travel time excluded:
   1. 2 person-days for installation assistance, inspection, and certification of the installation. Provide certificate.
   2. 2 person-days for functional and performance testing.
   3. 2 person-days for pre-startup classroom or jobsite training of OWNER'S personnel.

B. Training of OWNER'S personnel shall be at such times and at such locations as requested by OWNER.

C. See Section 01 79 00, demonstration and training.

3.5 MANUFACTURER'S CERTIFICATE(S)

A. Provide Manufacturer's certificate(s) in accordance with Section 01 79 00.

3.6 SUPPLEMENTS

A. The supplements listed below, following "END OF SECTION," are a part of this Specification.
   1. Power Operated Valve Schedule.
   2. Solenoid Operated Valve Schedule.
   3. Pneumatic Operated Valve Schedule.

END OF SECTION

SECTION 40 24 00 - PROCESS PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Basic requirements for Process Piping Specialties.

B. Related sections:
1. Section 01 60 00 – Product Requirements.
2. Section 03 30 00 – Cast-In-Place Concrete.
3. Section 09 90 00 – Painting and Protective Coatings.
4. Section 22 05 29 – Process Supports and Anchors.
5. Section 40 23 39 – Process Piping – General.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this section:
1. American National Standards Institute (ANSI):
   a. B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
   b. B16.5, Pipe Flanges and Flanged Fittings.
2. American Society for Testing and Materials (ASTM):
   a. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
3. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.3 SUBMITTALS

A. Shop Drawings: Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide required piping specialty items, whether shown or not shown on the Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded pipe joints are not.

2.2 CONNECTORS

A. Teflon Bellows Connector:
1. Type: Two convolutions unless otherwise shown, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ANSI B16.5 standard.
3. Working Pressure Rating: 140 psi, minimum, at 120 ° F.
4. Thrust Restraint: Limit bolts to restrain the force developed by the specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 214.
   b. Resistoflex; No. R6904.

B. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
2. Materials: Nitrile tube and neoprene cover.
3. End Connections: Flanged, drilled 125-pound ANSI B16.1 standard, with full elastomer face and steel retaining rings.
4. Working Pressure Rating: 140 psig, minimum, at 180° F for sizes 12" and smaller.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
   a. Goodall Rubber Co.; Specification E-1462.
   b. Garlock; Style 204.

C. Sleeve Type Coupling Manufacturers:
1. Dresser.
2. Rockwell.

D. Closure Collar Concrete: As specified in Section 03 30 00, CAST-IN-PLACE CONCRETE.

2.3 EXPANSION JOINTS

A. Elastomer Bellows:
1. Type: Reinforced, molded wide-arch.
2. End Connections: Flanged, drilled 125-pound ANSI B16.1 standard with split galvanized steel retaining rings.
3. Washers: Over the retaining rings to help provide a leak proof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: 250° F.
7. Rated Deflection and Pressure:
   a. Lateral Deflection: 3/4" minimum.
   b. Burst Pressure: Four times the working pressure.
   c. Compression deflection and minimum working pressure as follows:

Size (inch)	Deflection (inch)	Pressure (psig)
2-1/2 to 12	1.06	150
14	1.65	130
16 to 20	1.65	110

8. Manufacturers and Products:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.
   c. Goodall Rubber Co.; Specification E-711.

B. Teflon Bellows:
1. Type: Three convolutions, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ANSI B 16.5 standard.
3. Working Pressure Rating: 100 psig, minimum, at 120° F.
4. Thrust Restraint: Limit bolts to restrain the force developed by the specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 215.
   b. Resistoflex; No. R6905.

C. Copper Pipe Expansion Compensator:
1. Material: All bronze.
2. Working Pressure Rating: 125 psig, minimum.
3. Accessories: Anti-torque device to protect the bellows.

4. Manufacturers and Products:
   a. Flexonics; Model HB.
   b. Hyspan; Model 8509 or 8510.

D. Galvanized and Black Steel Pipe Expansion Compensator:
1. Material: Carbon steel with stainless steel bellows.
2. Working Pressure Rating: 150 psig, minimum.
3. Accessories: Anti-torque device to protect the bellows.
4. Manufacturers and Products:
   a. Flexonics; Model H.
   b. Hyspan; Model 8503.

E. Flexible Metal Hose:
1. Type: Close pitch, annular corrugated with single braided jacket.
2. Material: Stainless steel, ASTM A276, Type 321.
3. End Connections:
   a. 3" and Larger: Shop fabricated flanged ends to match mating flanges.
   b. 2-1/2" and Smaller: Screwed ends with one union end.
4. Minimum Burst Pressure: 600 psig at 70° F for 12" and smaller.
5. Length: Provide hose live-length equal to the lengths shown on the Drawings.
6. Manufacturers and Products:
   a. Flexonics; Series 401M.
   b. Anaconda; BWC21-1.

F. Bellows Type Expansion Joints:
1. Expansion joints: Flexible bellows type with equalizing rings, or as otherwise specified or indicated on the Drawings.
2. Manufacturers:
   a. Expansion joints: One of the following or equal:
      1) Senior Flexonics Pathway, Inc., Controlled Flexing Expansion Joint.
      2) Flex-Weld, Inc., Keflex, Series 308.
      3) Victaulic Depend-o-Lok, Omniflex stainless bellows expansion joint.
   b. Pipe alignment guides: One of the following or equal:
      1) Senior Flexonics Pathway, Inc.
      2) Flex-Weld, Inc.
   c. Intermediate supports: Provide with protective saddles. One of the following or equal:
      1) Unistrut Corporation, Roller-type.
      2) Bergen-Paterson Pipe Support Corp.
3. Design:
   a. Expansion joint rating: 150 pounds per square inch gauge, at 300 degrees Fahrenheit.
   b. Bellows: Multi-ply stainless steel, equipped with a self-draining liner guide.
   c. Axial travel of expansion joints: Not less than 1.50 inches.
   d. Ends: 150 pound ASME flanges, Victaulic Depend-o-Lok Airmaster/Fluidmaster coupled ends, or plain suitable for welding connections, as required for piping in which installed.

2.4 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Manufacturers and Products:
1. Flexonics; Model TCS, with tie bolts.
2. Keflex;Type 152-TR, with tie bolts.

2.5 SERVICE SADDLES

A. Double-Strap Iron:
   1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
   2. Run Diameter: Compatible with the outside diameter of the pipe on which the saddle is installed.
   3. Taps: Iron pipe threads.
   4. Materials:
      a. Body: Malleable or ductile iron.
      b. Straps: Galvanized steel.
      c. Hex Nuts and Washers: Steel.
      d. Seal: Rubber.
   5. Manufacturers and Products:
      a. Smith-Blair; Series 313 or 366.
      b. Dresser; Style 91.

B. Nylon-Coated Iron:
   1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
   2. Run Diameter: Compatible with the outside diameter of the pipe on which the saddle is installed.
   3. Materials:
      a. Body: Nylon-coated iron.
      b. Seal: Buna-N.
      c. Clamps and Nuts: Stainless steel.
   4. Manufacturer and Product:
      a. Smith-Blair; Style 315 or 317.

2.6 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Materials:
   1. In accordance with the applicable piping material specified in the Pipe Data Sheets.
   2. Galvanically compatible with piping.

B. Union Type:
   1. 2" and Smaller: Screwed or solder-joint.
   2. 2-1/2" and Larger: Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.

C. Working Pressure Rating: Suitable for specified system working pressure.

D. Manufacturers and Products:
   1. Dielectric Flanges and Unions:
      a. Epco Sales, Inc.
      b. Capitol Insulation Unions.
   2. Insulating Couplings:
      a. Dresser; STAB-39.
      b. R. H. Baker; Series 216.

2.7 WALL PIPES

A. Ductile Iron Wall Pipe:
   1. For penetrations through concrete walls, floors, slabs, or roofs that are to be watertight.
   2. Diameter and Ends: Same as connecting ductile iron pipe.
   3. Thickness: Equal to or greater than remainder of pipe in line.

4. Fittings: In accordance with applicable Pipe Data Sheet.
5. Thrust Collars:
   a. Provide for all wall pipes.
   b. Rated for thrust load developed at 250 psi.
   c. Safety Factor: 2, minimum.
   d. Material and Construction:
      Ductile iron or cast iron, cast integral with wall pipe wherever possible. Fabricate welded attachment of ductile iron thrust collar to pipe where casting impossible. Perform in pipe manufacturer's shop by qualified welders. Electric arc welds of ductile iron with NI-55 or FC-55 nickel-iron-carbon weld rod. Continuously weld on each side all around.
6. Manufacturers: American Cat Iron Pipe Co.; U.S. Pipe and Foundry Co.
7. Coating After Fabrication: Prepare and coat wall pipe in accordance with and as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No. 2

B. Steel or Stainless Steel Wall Pipe:
1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.
3. Thrust Collar: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe. Continuously fillet weld on each side all around.
4. Coating After Fabrication: Prepare and coat wall pipe in accordance with and as specified in Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No. 2
5. Restraint: Provide lugs for use with thrust ties as specified.

2.8 PIPE SLEEVES

A. Steel Pipe Sleeve:
1. Material: 3/16" minimum thickness steel pipe.
2. Seep Ring:
   a. 3/16" minimum thickness center steel flange for water stoppage on sleeves in exterior or water-bearing walls.
   b. Outside Diameter: 3" greater than pipe sleeve outside diameter.
   c. Continuously fillet weld on each side all around.
3. Factory Finish:
   a. Galvanizing:
      Hot-dip applied, meeting requirements of ASTM A153.
      Electroplated zinc or cadmium plating is unacceptable.
   b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, PAINTING AND PROTECTIVE COATINGS, System No.2.

B. Insulated and Encased Pipe Sleeve:
1. Manufacturer: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

C. Modular Mechanical Seal:
1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication: Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts, nuts, and pressure plates.
3. Size: According to Manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Link-Seal.

2.9 MISCELLANEOUS SPECIALTIES

A. Strainers for Process Water Service, 2" and Smaller:

1. Type: Bronze Body, Y-Pattern, 200 psi non-shock rated, with screwed gasketed bronze cap.
2. Screen: Heavy gauge Type 304 stainless steel or Monel, 20-mesh
3. Manufacturers:
   a. Armstrong International, Inc.; Model F
   b. Mueller Steam Specialty; Model 351M.

B. Strainers for CPVC, Plastic Piping Systems, 4" and Smaller:
1. Type: Y-pattern CPVC body, 150 psi non-shock rated, with screwed CPVC cap; and PTFE Teflon seals as recommended by manufacturer for service.
2. End Connections: Screwed or solvent weld, 2" and smaller. Class 150 ANSI flanged, 1-1/2" and larger.
3. Screen: Heavy-gauge CPVC, 1/32" mesh, minimum 2 to 1 screen area to pipe size ratio.
4. Manufacturers and Products: Hayword; Series 85/80, or equal.

C. Spray Nozzles:
1. Design:
   a. Operating pressure 10 pounds per square inch gauge, at which pressure each nozzle discharges not less than 3.5 gallons per minute.
      1) Spray: Flat, heavy sheet, fan with uniform distribution.
      2) Fan spray angle: 105 degrees.
      3) Spray deflection with a replaceable deflector insert free to rotate away from the orifice opening and mechanically locked in place and counterweighted.
   b. Spray nozzles structurally suitable for pressure up to 200 pounds per square inch gauge.
   c. Nozzles, easy flush type.
   d. Provide split eyelet connectors or weld-0-lets for nozzle connections.
2. Materials:
   a. Spray Nozzles: Brass.
   b. Nozzles provided with ¼ inch national pipe thread, and the orifice diameter not less than ¼ inch.
   c. Replaceable Spray Deflector: Neoprene rubber.
3. Manufacturers:
   a. Spray Nozzles: Spray System Co, Model 22561, or approved equal.
   b. Split eyelet connectors: Spray Systems Co, Series 8370 and Series 15475, or approved equal.

D. Quick Couplings:
1. Provide female NPT by male quick-connect hose adaptors. All adapters and couplers shall satisfy dimensional requirements of MIL-C-27487E and shall be cast iron and sized shown on the Drawings.
2. Manufacturers and Products: Swagelock; Series QH.

E. Quick Disconnect Cam Operating Couplings for Chemical Service:
1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Material: Glass-filled polypropylene and PVDF with Teflon gaskets and as recommended for the service by Manufacturer.
3. End Connections: NPT threaded or flanged to match piping connections.
4. Hose shanks for chemical installations.
5. Plugs and Caps: Female dust cap for each male end, male dust plug for each female end.
6. Pressure Rating: 125 psi, minimum at 70° F.
7. Manufacturers:
   a. OPW; Kamlock
   b. Ryan Herco; 1300 Series
   c. Goodall; Basic Eight

F. Chemical Injection Quills:
   1. Retractable injection quill, service rated for 250 psi, including stainless steel check valve, ball valve, solution tube adaptor, packing nut, restraint system, and limit chains, and 300 Series O-ring gaskets.
   2. Manufacturer and Products: SAF-T-FLO; or equal.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

B. Install process piping specialties in accordance with manufacturer's directions, as shown on the Drawings, and as specified herein.

3.2 PIPING FLEXIBILITY PROVISIONS

A. General:
   1. Install thrust protection.
   2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

B. Flexible Joints at Concrete Backfill or Encasement: Install within 18" or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures:
   1. Install 18" or less from the face of structures; joint may be flush with face.
   2. Install a second flexible joint, whether or not shown.
      a. Pipe Diameter 18" and smaller: Within 18" of the first joint.
      b. Pipe Diameter Larger than 18": Within one pipe diameter of the first joint.

3.3 PIPING TRANSITION

A. Applications:
   1. Provide complete closure assembly where pipes meet other pipes or structures.
   2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
   3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
   4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
   5. Concrete Closures: Use to make connections between dissimilar pipes where standard rubber gasketed joints or flexible couplings are impractical, as approved.
   6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:
   1. Flexible Transition Couplings: Install in accordance with coupling Manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
   2. Concrete Closures:
      a. Locate away from structures so that there are at least two flexible joints between the closure and pipe entering the structure.
      b. Clean pipe surface before closure collars are placed.
      c. Wet non-metallic pipe thoroughly prior to pouring collars.
      d. Prevent concrete from entering pipe.
      e. Extend collar a minimum of 12" on each side of joint with minimum thickness of 6" around outside diameter of pipe.

f. Make entire collar in one placement.
g. After concrete has reached initial set, cure by covering with well moistened earth.

3.4 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:
1. Grooved Joint and Flanged Piping Systems: Elastomer Bellows Expansion Joint.
2. Nonmetallic Pipe: Teflon Bellows Expansion Joint.
3. Screwed and Soldered Piping Systems: Copper or Galvanized and Black Steel Pipe Expansion Compensator, as applicable.
4. Pipe Run Offset: Flexible Metal Hose.

C. Bellows Type Expansion joints:
1. Install bellows type expansion control joints at piping connections to mechanical equipment to prevent damaging stresses due to normal expansion and contraction with temperature changes in piping and connected equipment.
2. Install bellows type expansion joints so as to allow 2-1/4 inch expansion per 100 linear feet of piping.
3. Install expansion joints adjacent to an anchor, and provide 1 concentric guide on piping within 12 pipe diameters, but not more than 5 feet, from the end of the joint opposite the anchor.
a. Locate a similar guide approximately 30 diameters but not more than 10 feet from the first.
4. For expansion joints not installed adjacent to an anchor provide 2 concentric guides similarly located at each end of the joint.
5. Space intermediate supports a minimum of 10 feet, and tack weld the protective saddles to the pipe.

D. Anchors and Anchor Walls: Install as specified in Section 22 05 29, PROCESS SUPPORTS AND ANCHORS, to withstand expansion thrust loads and to direct and control thermal expansion.

3.5 SERVICE SADDLES AND THRUST TIES

A. Service Saddles:
1. Ferrous Metal Piping (except stainless steel): Double-strap iron.
2. Plastic Piping: Nylon-coated iron.

B. Thrust Ties:
1. Install where shown and where required to restrain the force developed by the specified test pressure.
2. Steel Pipe: Attach with fabricated lugs.
3. Ductile Iron Pipe: Attach with socket clamps against a grooved joint coupling or flange.
4. Flanged Coupling Adapters: For exposed installations, install Manufacturer's anchor studs through the coupling sleeve.

C. Installation: Install in accordance with Manufacturer's written instructions.
1. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
2. Remove pipe coating if necessary to present smooth surface.

3.6 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

A. Tie Bolts: Tighten snug prior to applying any pressure to the system.

3.7 INSULATING FLANGES, COUPLINGS, AND UNIONS

A. Applications:
   1. Copper to ferrous metal piping connections.
   2. Cathodically protected piping penetration to buildings and watertight structures.
   3. Submerged to un-submerged metallic piping connections.
   4. Where required for electrically insulated connection.

B. Installation of Insulating Kits: Drill oversize to accommodate insulating sleeves through the bolt holes, assuming standard bolt sizes.

C. Pipe Installation:
   1. Insulating joints connecting immersed piping to non-immersed piping shall be installed above maximum water surface elevation.
   2. All submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete basins shall be isolated from the concrete reinforcement steel.

3.8 WALL PIPES

A. Applications:
   1. As specified in Section 40 23 39, PROCESS PIPING - GENERAL
   2. Watertight and Below Ground Penetrations:
      a. Wall pipes with thrust collars.
      b. Provide taps for stud bolts in flanges to be set flush with wall face.
      c. Existing Walls: Rotary drilled holes.
   3. Wall Pipe Installation:
      a. Isolate embedded metallic piping from concrete reinforcement.
      b. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.9 PIPE SLEEVES

A. Application:
   1. As specified in Section 40 23 39, PROCESS PIPING - GENERAL.
   2. Above Grade in Non-submerged Areas: Hot-dip galvanized after fabrication.
   3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.

B. Installation:
   1. Support non-insulating type securely in form work to prevent contact with reinforcing steel and tie-wires.
   2. Caulk joint with rubber sealant or seal with wall penetration seal.

3.10 MISCELLANEOUS SPECIALTIES

A. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 40 42 00 – PROCESS MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Types of mechanical insulation specified in this section:
      a. Piping System Insulation:
         1) Fiberglass.
         2) Cellular Glass.
         3) Flexible Unicellular.

B. Related sections:
   1. Section 22 05 29 – Process Supports and Anchors.
   2. Section 22 05 53 – Mechanical Identification.
   3. Section 40 23 39 – Process Piping – General.

1.2 DESCRIPTION OF WORK

A. Extent of mechanical insulation required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Refer to Section 22 05 29, PROCESS SUPPORTS AND ANCHORS for protection saddles, protection shields, and thermal hanger shields.

C. Refer to Section 22 05 53, MECHANICAL IDENTIFICATION for installation of identification devices for piping, ductwork, and equipment.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.
   1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.
   2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

1.4 SUBMITTALS

A. Product Data: Submit Manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing Manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with Manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, Manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
1. Armstrong World Industries, Inc.
2. Babcock & Wilcox; Insulating Products Div.
3. CertainTeed Corp.
4. Knauf Fiber Glass GmbH.
5. Manville Products Corp.
6. Owens-Corning Fiberglas Corp.
7. Pittsburgh Corning Corp.
8. Rubatex Corp.

2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C547, Class 1 unless otherwise indicated.

B. Cellular Glass Piping Insulation: ASTM C552, Type II, Class 2.

C. Flexible Unicellular Piping Insulation: ASTM C534, Type I.

D. Jackets for Piping Insulation: ASTM C921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.
1. Encase pipe fittings insulation with one-piece pre-molded PVC fitting covers, fastened as per Manufacturer's recommendations.
2. Encase exterior piping insulation with PVC jacket with weather-proof construction.

E. Staples, Bands, Wires, and Cement: As recommended by Insulation Manufacturer for applications indicated.

F. Adhesives, Sealers, and Protective Finishes: As recommended by Insulation Manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSULATION

A. Process Piping: As indicated in Section 40 23 39, PROCESS PIPING - GENERAL.

B. Insulate each piping system specified above with one of the following types and thicknesses of insulation:
1. Fiberglass: 1" thickness.
2. Cellular Glass: 1-1/2" thickness.
3. Flexible Unicellular: 1/2" thickness.

3.2 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with Manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

3.3 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION

SECTION 40 42 13.16 - POLYETHYLENE ENCASEMENT FOR DUCTILE IRON AND CAST IRON PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes: Polyethylene encasement; shall be used on all underground ductile iron and cast iron pipe, fittings, valves, and appurtenances.

1.2 QUALITY CONTROL

A. Supervision:
   1. Provide full time supervisor trained and familiar with the work to be undertaken.

B. Workmanship: All workmen shall be skilled and experienced in the specified work.

1.3 SUBMITTALS

A. Shop drawings: Submit shop drawings to the Engineer within 30 days after award of Contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Polyethylene encasement materials shall be manufactured of virgin polyethylene possessing the following characteristics:
   1. Type, Class, Grade, in accordance with ASTM Specification.
   2. Other Characteristics D-1248-68 or latest revision thereof.
   3. Type 1
   4. Class C Black where exposure to weather (including sunlight) may be more than 48 hours.
   5. Exposure to weather shall be kept to a minimum and in no case shall it exceed 10 days.
   6. Grade E-1.
   7. Flow Rate 0.4 maximum.
   8. Tensile Strength 1200 psi minimum.
   9. Elongation 300 percent minimum.
   10. Dielectric Strength Volume resitivity, ohm-Cm3 = 1015 800 volts per mil thickness.

B. Polyethylene tube material shall have a thickness of 0.008 inches (8 mils). The minus tolerance on thickness shall not exceed 10 percent of the nominal thickness.

C. The minimum tube size for each pipe diameter shall be as listed in Table 1. For pipe sizes greater than 24 inches, tube size may be determined by multiplying the nominal pipe diameter by 2.25 to obtain minimum flat tube width.

TABLE 1

NOMINAL PIPE DIAMETER (INCHES)	**POLYETHYLENE FLAT** TUBE WIDTH (INCHES)
4	16
6	20
8	24
10	27
12	30
14	34

16	37
18	41
20	45
24	53

D. Adhesive tape shall be general purpose adhesive tape 1-inch wide and approximately 8 mils thick, such as Scotchtape No. 50, Pol. No. 900, Tapecoat CT or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Polyethylene encasement shall be installed on pipe and fittings at location specified on the construction drawings. Although not intended to be a completely air- and water-tight enclosure, the polyethylene shall prevent contact between the pipe and the surrounding backfill.

B. Pipe: This standard includes two different methods for the installation of polyethylene encasement.
   1. Method A:
      a. Cut polyethylene tube to a length approximately 2 feet longer than the length of the pipe section. Slip the tube around the pipe, centering it to provide a 1 foot overlap on each adjacent pipe section, and bunching it accordion-fashion lengthwise until it clears the pipe ends.
      b. Lower the pipe into the trench and make up the pipe joint with the preceding section of pipe. A shallow bell hole must be made at joints to facilitate installation of the polyethylene tube.
      c. After assembling the pipe joint, make the overlap of the polyethylene tube. Pull the bunched polyethylene from the preceding length of pipe, slip it over the end of the new length of pipe, and secure in place with one circumferential turn of adhesive tape plus enough overlap to assure firm adhesion. Then slip the end of the polyethylene from the new pipe section over the end of the polyethylene from the new pipe section over the end of the first wrap until it overlaps the joint at the end of the preceding length of pipe. Tape it in place. Take up the slack width to make a snug, but not tight, fit along the barrel of the pipe, securing the fold at quarter points with adhesive tape.
      d. Repair any rips, punctures, or other damage to the polyethylene with adhesive tape or with a short length of polyethylene tube cut open, wrapped around the pipe, and secured with adhesive tape. Proceed with installation of the next section of pipe in the same manner.
   2. Method B:
      a. Cut polyethylene tube to a length approximately 1 foot shorter than the length of the pipe section. Slip the tube around the pipe, centering it to provide 6 inches of bare pipe at each end. Make polyethylene snug, but not tight. Tape down and secure ends as described in B.1.
      b. Before making up a joint, slip a 3 foot length of polyethylene tube over the end of the preceding pipe section, bunching it accordion-fashion lengthwise. After completing the joint, pull the 3 foot length of polyethylene over the joint, overlapping the polyethylene previously installed on each adjacent section of pipe by at least 1 foot. Make snug, tape down, and secure each end as described in B.1.
      c. Repair any rips, punctures, or other damage to the polyethylene as described in B.1. Proceed with installation of the next section of pipe in the same manner.

C. Pipe-shaped appurtenances: Bends, reducers, offsets, and other pipe-shaped appurtenances shall be covered with polyethylene in the same manner as the pipe.

D. Odd-shaped appurtenances: Valves, tees, crosses, and other odd-shaped pieces which cannot practically be wrapped in a tube shall be wrapped with a flat sheet or split length of polyethylene tube. The sheet shall be passed under the appurtenance and brought up around the body. Seams shall be made by bringing the edges together, folding over twice, and taping down. Slack width and overlaps at joints shall be handled as described in B.1. Tape polyethylene securely in place at valve stem and other penetrations.

E. Openings in encasement: Openings for branches, service taps, blow-offs, air valves, and similar appurtenances shall be made by making an x-shaped cut in the polyethylene and temporarily folding the film back. After the appurtenance is installed, tape the slack securely to the appurtenance and repair the cut as well as any other damaged areas in the polyethylene with tape.

F. Junctions between wrapped and unwrapped pipe: Where polyethylene wrapped pipe joins a pipe which is not wrapped, extend the polyethylene tube to cover the unwrapped pipe a distance of at least 2 feet. Secure the end with circumferential turns of tape.

END OF SECTION

SECTION 40 92 16 - VALVE AND GATE OPERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Valve and Gate Operators.
   2. Handwheel Operators.
   3. Key Operated Valves.
   4. Bench Stands.
   5. Floor Stands.
   6. Accessory Equipment and Floor Boxes

B. Related sections:
   1. Section 01 33 00 – Submittal Procedures.
   2. Section 01 60 00 – Product Requirements.
   3. Section 01 78 23 – Operation and Maintenance Data.

1.2 GENERAL

A. Certain valve operators are specified in Division 44 to be furnished by equipment manufacturer as part of their equipment package and/or system. These valve operators are to be installed by the Contractor as specified herein. In addition to installation, the Contractor shall be responsible for test, inspection, and assisting the equipment suppliers in start-up services as required to the place the valve operators into continuous, reliable operation.

1.3 SCHEDULES

A. Operator schedules are combined with Process Valve Schedules

1.4 REFERENCES

A. Aluminum Association (AA)
   1. DAF-45 – Design for Aluminum Finishes

1.5 SUBMITTALS

A. Submittals shall be made as required in Section 01 33 00, SUBMITTALS of Division 01, GENERAL REQUIREMENTS. The following specific information shall be provided:
   1. Shop Drawings:
      a. Product data sheets for make and model.
      b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
      c. Power and control wiring diagrams, including terminals and numbers.
      d. Complete motor nameplate data.
      e. Open/close and throttle actuators sizing calculations including factor of safety used and final torques used for actuation selection.
      f. Refer to specific valve type for additional submittal requirements.
   2. Quality Control Submittals:
      a. Special shipping, storage and protection, and handling instructions.
      b. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

c. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

1.6 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.7 QUALITY ASSURANCE

A. Provide valve operators integral with the valve or gate, except for valve operators utilizing T-wrenches or keys, and portable operators intended to operate more than 1 valve.

B. Provide all similar operators by 1 manufacturer.

C. Provide gates and hand operating lifts by 1 manufacturer.

D. Provide hydraulic gate lifts by 1 manufacturer.

E. Provide hydraulic valve operators and motorized operators by 1 manufacturer.

1.8 MAINTENANCE

A. Extra materials:
1. Key operated Valve Keys or Wrenches: Furnish a minimum of 4 keys with 4 foot shafts and 3 foot pipe handles or wrenches with 4 foot shafts and 3 foot handles for operating key operated valves.

PART 2 - PRODUCTS

2.1 GENERAL

A. Size operator to operate valve for the full range of pressures and velocities.

B. Valve to open by turning counterclockwise.

C. Factory-mount the operator, actuator, and accessories.

2.2 VALVE OPERATORS

A. Manual Operator:
1. General:
a. Operator force not to exceed 40 pounds under any operating condition, including initial breakaway, and gear reduction operator when force exceeds 40 pounds.
b. Operator self-locking type or equipped with self-locking device.
c. Position indicator on quarter-turn valves.
d. Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators, threader steel reach rods with internally threaded bronze or ductile iron nut.
2. Exposed Operator:
a. Galvanized and painted hand wheels.

b. Lever operators allowed on quarter-turn valves 8" and smaller.
c. Cranks on gear type operators.
d. Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.
e. Valve handles to take a padlock, and wheels a chain and padlock.

3. Buried Operator:
   a. Buried service operators on valves larger than 2-1/2" shall have a 2" AWWA operating nut. Buried operators on valves 2" and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
   b. Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.
   c. Buried valves shall have extension stems, bonnets, and valve boxes.

2.3 VALVE AND GATE OPERATORS

A. Stem Covers:
1. Aluminum pipe; threaded cap on top; bolted aluminum flange on bottom; 1 by 12 inch slots cut at 18 inches on center in front and back of pipe; capable of covering threaded portion of greased stems that project above operators when gates or valves are opened or closed.

B. Stem Cover Flanges, Pipes and Caps:
1. Etched and anodized to produce chemical finishes in accordance with AA C 22, medium matte finish, and AA A 41 clear anodic coating, or described in AA publication 45, after fabrication

C. Gate Stem Covers: Concentric with stem

D. Position Indicators:
1. Tail rods on hydraulic cylinders, or dial indicators with clear full-open and closed position indicators, calibrated in number of turns or percentage of opening.

E. Manual or Power Operator Size:
1. Sized to deliver maximum force required under most severe specified operating condition, including static and dynamic forces, seat and wedge friction, and seating and unseating forces with safety factor of 5, unless otherwise specified.

F. Operator Size: Capable of supporting weight of suspended shafting unless carried by bottom thrust bearings; shaft guides with wall mounting brackets.

G. Provisions for Alternate Operation: Where specified or indicated on the Drawings, position and equip crank- or handwheel-operated geared valve operators or lifts for alternate operation with tripod mounted portable gate operators.

H. Operation: Counterclockwise to open with suitable and adequate stops, capable of resisting at least twice normal operating force to prevent overrun of valve or gate in open or closed position.

I. Open Direction Indicator: Cast arrow and legend indicating direction to rotate operator on handwheel, chain wheel rim, crank, or other prominent place.

J. Buried Operator Housing: Oil and watertight, specifically designed for buried service, factory packed with suitable grease, completely enclosed space between operator housing and valve body so that no moving parts are exposed to soil; provide operators with 2 inch square AWWA operating nut.

K. Worm Gear Operators: Provide gearing on worm gear operators that is self-locking with gear ratio such that torque in excess of 160 foot-pounds will not need to be applied to operate valve at most adverse conditions for which valve is designed.

L. Traveling Nut Operators: Capable of requiring maximum 100 foot-pounds of torque when operating valve under most adverse condition; limit stops on input shaft of manual operators for fully open and closed positions; non-moving vertical axis of operating nut when opening or closing valve.

2.4 HANDWHEEL OPERATORS

A. Manufacturers: One of the following, or equal:
   1. Rodney Hunt Company.
   2. Waterman Industries, Incorporated.

B. Mounting: Floor stand or bench stand. Unless otherwise indicated on the Drawings position operator 36 inches (nominal) above top of walkway surface.

C. Bearings above and below Finished Threaded Bronze Operating Nut: Ball or roller.

D. Wheel Diameter: Minimum 24-inch.

E. Indicator: Counterclockwise opening with arrow, and word OPEN cast on top of handwheel indicating direction for opening.

F. Pull to Operate: Maximum 40 pounds pull at most adverse design condition.

G. Stem Travel Limiting Device: Setscrew locked stop nuts above and below lift nut.

H. Grease Fittings: Suitable for lubrication of bearings.

2.5 HAND-CRANKED GEARED OPERATORS

A. Type: Single removable crank; fully enclosed.

B. Mounting: Floor and Bench Stand. Unless otherwise indicated on the Drawings, position the operator 36-inches (nominal) above the top of the walkway surface.

C. Operating Nut: When scheduled for portable operators.

D. Geared Lifts: 2-speed with minimum ratio of 4 to 1.

E. Teeth on Gears, Spur Pinions, Bevel Gears, and Bevel Pinions: Cut.

F. Lift Nuts: Cast manganese bronze.

G. Exterior Surfaces on Cast Iron Lift Parts: Smooth.

H. Bearings above and below Flange on Lift Nuts: Ball or roller; capable of taking thrust developed by opening and closing of gates under maximum operating head; with bronze sleeve bearings and sufficient grease fittings for lubrication of moving parts, including bearings and gears.

I. Crank Rotation Indicator: Cast arrow with word OPEN in prominent, readily visible location indicating correct rotation of crank to open gate.

J. Hand Cranks: 15 inch radius; requiring maximum 25 pounds pull to operate gate at maximum operating head with:
   1. Revolving brass sleeves.
   2. Gears, spur pinions, bevel gears, and bevel pinions with cut teeth.
   3. Cast manganese bronze lift nuts.
   4. Cast iron lift parts with smooth exterior surfaces.

K. Indicator: Dial position type mounted on gear operator; enclosed in cast-iron or aluminum housing with clear plastic cover; marked with fully open, 3/4, 1/2, 1/4, and closed positions.

2.6 FLOOR BOX AND STEM

A. Manufacturers: One of the following, or equal:
   1. Waterman Industries, Inc.
   2. Neenah Foundry; R 7506.
   3. Clow; No. F5690.

B. Floor Boxes: Cast iron with:
   1. Plain type, for support of non-rising type stem.
   2. Complete with stem, operating nut, and stem guide brackets.
   3. Stem Guide: Space such that stem UR ratio does not exceed 200.
   4. Anchor Bolts: Type 304 SST.
   5. Counter type indicator.
   6. Hinged, lockable lid with directional arrow.
   7. 2-inch square AWWA operating nut.
   8. Packing gland providing drip-tight seal around valve shaft.

2.7 FLOOR STAND AND EXTENSION STEM

A. Manufacturers: One of the following, or equal:
   1. Clow; Figure F-5515.
   2. Mueller, Figure A-26426.
   3. Rodney Hunt Company.
   4. Waterman Industries, Incorporated.

B. Floor Stand Assemblies: Heavy-duty cast iron, suitable for mounting specified operator.
   1. Nonrising, indicating type.
   2. Complete with stem, coupling, hand wheel, stem guide brackets, and yoke attachment.
   3. Stem Guide: Space such that stem UR ratio does not exceed 200.
   4. Anchor Bolts: Type 304 SST.

2.8 BENCH STANDS

A. Manufacturers: One of the following, or equal:
   1. Rodney Hunt Company.
   2. Waterman Industries, Incorporated.

B. Bench Stands: Handwheel operators or hand crank, geared operators conforming to hand-cranked geared operator requirements, except capacity to be mounted on haunch, wall bracket, or self-contained gate yoke.

2.9 ACCESSORY EQUIPMENT

A. T-Handled Operating Wrench:
   1. 2 each galvanized operating wrenches, 4 feet long.

2. Manufacturers and Products:
   a. Mueller; No. A-24610.
   b. Clow No.; F-2520.
3. 2 each galvanized operating keys for cross handled valves.

B. Extension Bonnet for Valve Operator: Complete with stem and accessories for valve and operator.
1. Manufacturers and Products:
   a. Metallic Valves:
      1). Pratt.
      2). Allis-Chalmers.
   b. Plastic Valves: ASAHI/America.

C. Chain Wheel and Guide:
1. Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6' 9" above finished floor. Use appropriate "L" type tie-back anchors where chains hang in normally traveled areas. Hand wheel direct-mount type.
2. Complete with chain.
3. Galvanized or cadmium-plated.
4. Manufacturers and Products:
   a. Clow Corp.; Figure F-5680.
   b. Walworth Co.; Figure 804.
   c. DeZurik Corp.; Series W or LWG.

D. Wall Brackets or Haunches: As indicated on the Drawings.

E. Stems: Stainless steel; sized to match output of operator; minimum gate or valve operating stem diameter; maximum 200 slenderness ratio.

F. Stem Couplings: Stainless steel; internally threaded to match stem; lockable to stem by set screw.

G. Stem Guides: Cast iron with silicon bronze bushing; maximum 200 slenderness ratio; capable of being mounted with a wall bracket; adjustable in 2 directions.

H. Wall Brackets: Cast iron, capable of withstanding the output of the operator; adjustable in 2 directions.

I. Stem Stuffing Boxes: Cast iron, with adjustable gland and packing.

J. Fasteners and Anchor Bolts: 316 stainless steel.

K. Geared Valve Operators: Provided with cut gears, either spur or worm; sized to operate valves at most adverse design condition; with maximum 40 pound pull at handwheel or chain wheel rim.

L. Geared Valve Traveling Nut Operators: Acceptable only where specified or indicated on the Drawings.

M. Accessory Equipment for Valves and Gates Requiring Remote Operators: Operating stems, stem couplings, stem guides, wall brackets, and stem stuffing boxes.

PART 3 - EXECUTION

3.1 SHIPPING, STORAGE, HANDLING, AND PROTECTION

A. As specified in Section 01 60 00, PRODUCT REQUIREMENTS.

3.2 INSTALLATION

A. Install floor boxes in concrete floor with lid flush with floor.

B. After installation of gate and stem covers, mark stem covers at point where top of stems are at full-open position and at closed position.

C. Attach floor stand to structure with anchor bolts.

D. Install stem stuffing boxes where operating stems pass through intermediate concrete floor slabs.

3.3 SCHEDULES

A. Geared Operators: Provide geared operators for following valves:
   1. Butterfly valves larger than 6 inches, nominal size, on liquid service.
   2. Butterfly valves larger than 10 inches, nominal size, on gas and air service.
   3. Plug valves 6 inches, nominal size, and larger.

B. Handwheel operators: Provide handwheel operators for valves mounted at 6 feet or less above floors.

C. Chain Wheel Operators; Provide chain wheel operators for valves mounted more than 6 feet to centerline above floors.

END OF SECTION

DIVISION 44

POLLUTION CONTROL EQUIPMENT

SECTION 44 42 56.30 - NON-POTABLE WATER PACKAGE PUMP STATION SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This specification section covers the labor and materials necessary to furnish and install a factory built complete, operable triplex pump station for the non-potable water pump system to be utilized for pumping non-potable water into the plants non-potable water system. System to include all necessary pumps, piping, valves, VFD's, magnetic flow meter, pump controls, appurtenances, and enclosure and mounting as shown in the plans and specified herein.

B. Pump system components shall be of the same manufacturer or supplier to obtain standardization of performance, operation, spare parts, maintenance and manufacturer's services.

C. A. Contractor shall furnish and install one factory built base mounted, automatic pump station. The station shall be complete with all equipment specified herein, factory assembled on a common steel base.

1.2 SUBMITTALS

A. Submittals shall be made as required for all equipment. The following specific information shall be provided:

1. Shop Drawings: Shop drawings shall include descriptive information as required to fully describe the Pumps, Controls, Motors, and overall performance and shall identify any deviations from the specified requirements.
2. Requirements for routine maintenance required prior to plant startup.
3. List of all requested exceptions to the Contract Documents.
4. Motor information to be submitted in accordance with Division 26, ELECTRICAL.
5. Quality control submittals.
6. Instrumentation and control submittals as listed in Section 26 90 00, GENERAL INSTRUMENTATION AND CONTROL.
7. Factory Test Reports (Balance & Vibration).

1.3 OPERATION AND MAINTENANCE DATA

A. O&M Manuals: Content, format, and schedule for providing as specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

B. Maintenance Summary Forms: As specified in Section 01 78 23, OPERATION AND MAINTENANCE DATA.

1.4 MANUFACTURER

A. The pumping system shall be, as manufactured by Gorman-Rupp Company, Mansfield, Ohio, or equal.

B. In event the contractor submits equipment for substitution, the contractor shall, at his own expense, make all resulting changes to the enclosures, buildings, piping or electrical systems as required to accommodate the proposed equipment. Revised detail drawings illustrating the substituted equipment shall be submitted to the engineer prior to acceptance. If the cost to the contractor is less for the proposed substitution, then the contract price shall be reduced by an amount equal to the savings

1.5 DELIVERY, STORAGE, HANDLING

A. Equipment shall be delivered to the jobsite completely factory.

B. Electrical motors and components shall be kept thoroughly dry at all times and shall be stored indoors. Equipment storage shall be protected and maintained in accordance with the manufacturer's recommendations. Equipment shall not be stored directly on the ground.

C. Contractor shall utilize equipment and tools of adequate size suitable for unloading, transporting, storing and supporting the equipment during installation. Caution shall be employed to prevent equipment damage resulting from abrupt contact with other materials or equipment.

1.6 QUALITY ASSURANCE

A. In order to unify responsibility for proper operation of the complete pumping station, it is the intent of these Specifications that all system components be furnished by a single supplier (unitary source). The pumping station must be of standard catalog design, totally warranted by the manufacturer. Under no circumstances will a system consisting of parts compiled and assembled by a manufacturer's representative or distributor be accepted

B. Pumps shall be horizontal, self-priming centrifugal type equal in construction and performance to the "U" Series self-priming industrial pumps as manufactured by the Gorman-Rupp Company, Mansfield, Ohio. Model number U4B60S-B, or equal.

C. Upon request from the engineer, the pump station manufacturer shall prove financial stability and ability to produce the station within the specified delivery schedules. Evidence of facilities, equipment and expertise shall demonstrate the manufacturer's commitment to long term customer service and product support.

D. The term "pump manufacturer" or "pump station manufacturer" shall be defined as the entity which designs, machines, assembles, hydraulically tests and warranties the final product. Any entity that does not meet this definition will not be considered a "pump manufacturer" or "pump station manufacturer" and is not an acceptable supplier. For quality control reasons and future pump and parts availability, all major castings of the pump shall be sourced and machined in North America.

E. The pump manufacturer shall submit to the contractor for Engineer's review, certified copies of factory hydraulic pump test results for each pump. Test results shall be submitted prior to shipment upon Engineer's request and shall show compliance with specified performance requirements.

1.7 WARRANTY

A. The pump station manufacturer shall warrant all equipment to be of quality construction, free of defects in material and workmanship. A written warranty shall include specific details described below to be provided after the final acceptance of the equipment by the Owner and Engineer. The warranty shall stipulate that the equipment furnished is suitable for the purpose intended and free from defects of material and workmanship for the duration of the warranty. In the event the equipment fails to perform as specified, the Manufacturer will promptly repair or replace the defective equipment without additional cost to the Owner.

1. In addition to defects in material and workmanship, fiberglass reinforced polyester station enclosures (where applicable) are warranted for sixty (60) months to be resistant to rust, corrosion, corrosive soils, effects of airborne contamination or physical failures occurring in normal service for the period of the pump station warranty

2. All other equipment, apparatus, and parts furnished shall be warranted for sixty (60) months, excepting only those items that are normally consumed in service, such as light bulbs, oils, grease, packing, gaskets, O rings, etc. The pump station manufacturer shall be solely responsible for warranty of the station and all components.

B. Upon request from the Engineer and/or the owner, the manufacturer shall demonstrate proof of financial responsibility with respect to performance and delivery date. In addition, the manufacturer shall provide proof of evidence of facilities, equipment, and skills required to produce the equipment specified herein and provide technical service and replacement parts.

C. Components failing to perform as specified by the engineer, or as represented by the manufacturer, or proven defective in service during the warranty period, shall be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the owner.

D. It is not intended the manufacturer assume liability for consequential damages or contingent liabilities arising out of failure of any product or parts thereof to operate properly, however caused by or resulting from or arising out of defects in design or manufacture, delays in delivery, replacement, or otherwise.

1.8 FACTORY TEST

A. All components including the pumps, motors, valves, piping and controls will be tested as a complete working system at the manufacturer's facility. Tests shall be conducted in accordance with Hydraulic Institute Standards at the specified head, capacity, rated speed and horsepower. Factory operational test shall duplicate actual performance anticipated for the complete station.

B. Motor, commercial tests shall be made, including no-load current at rated voltage, high potential, and locked rotor current.

C. Certified copies of test reports on actual pumps and motors being supplied shall be provided to Engineer for review.

D. Upon request from the engineer, the operational test may be witnessed by the engineer, and/or representatives of his choice, at the manufacturer's facility.

1.9 DESCRIPTION PUMPS

A. Quantity

High Flow Pumps	-	Two (2)
Low Flow Pumps	-	One (1)

B. Design Requirements

High Flow Pumps		
Liquid Pumped-		Non-Potable Water
Design Flow Rate		550 GPM
Total Dynamic Head -		191 feet
Minimum Efficiency at Design	-	50 percent
Maximum Shut-Off Head		200 feet
Maximum NPSH Required	-	10 feet
Maximum Pump Speed	-	1800 RPM

1.10 SUBMITTALS

A. Provide submittal for approval as specified in Section 01 33 00, SUBMITTAL PROCEDURES including no less than the following:

1. Full set of mechanical drawings including skid framing and anchor bolt locations for station, connection dimensions, and equipment layout, all to scale
2. Full electrical schematic, including three line power schematic, ladder logic, PLC and SCADA system interface. The electrical ladder logic drawings shall illustrate motor branch and control circuits to extent necessary to validate function and integration of circuits to form a complete working system
3. Properly indicated pump curves, whose total dynamic head includes pumping system internal losses, manufacturer's name (other than pumping system manufacturer), pump model number, and motor type, RPM and horsepower
4. Properly marked cut sheets for each major component of the pumping system, both mechanical and electrical
5. Copies of UL and ETL authorizations for control panels, and for complete pumping system.
6. Complete description of the system including operation sequence, alarm sequence, SCADA interface (if required), receiving instructions, storage instructions and warranty statement

1.11 OPERATION AND MANINTENANCE

A. Operation and maintenance manuals shall be provided in two copies to the Owner.

B. Operation and maintenance manuals shall have been prepared for this specific project, and shall not be a general manual applicable to many systems. Manufacturers' technical manuals shall be included for each piece of equipment that is field serviceable.

C. Manuals shall include the following:

1. The approved submittal and shall be produced in the same format as the submittal, bound in a three ring binder, and tabbed.
2. Manufacturer's manuals shall be included after the submittal pages for each field serviceable device
3. Functional description of each major component, complete with operating instructions
4. Instructions for operating pumps and pump controls in all modes of operation.
5. Calibration and adjustment of equipment for initial start-up, replacement of control components, or as required for routine maintenance
6. Support data for commercially available components not produced by the station manufacturer, but supplied in accordance with the specifications, shall be supported by literature from the prime manufacturer and incorporated as appendices
7. Electrical schematic diagram of the pump station circuits shall be in accordance with NMTBA and JIC standards. Schematics shall illustrate, to the extent of authorized repair, pump motor branch, control and alarm system circuits including interconnections. Wire numbers and legend symbols shall be shown. Schematic diagrams for individual components, not normally repairable by the station operator, need not be included. Details for such parts shall not be substituted for an overall system schematic. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall system diagram
8. Mechanical layout drawing of the pump station and components, prepared in accordance with good commercial practice, shall provide installation dimensions and location of all pumps, motors, valves and piping..

1.12 CODES

A. Without exception, pumping system shall be UL and ETL listed as finally assembled.

B. Control panel with controls shall be built in accordance to NEC, and U.L and ETL standards.

1. Without exception, the electrical components and enclosure shall be labeled as a complete U.L. and ETL listed industrial control panel assembly.
2. Manufacturer's U.L. and ETL labels shall be applied to the door.

PART 2 - PRODUCTS

2.1 UNIT BASE

A. The pad for the pump station shall be a reinforced concrete pad that meets the specifications of the manufacture. The pad shall be a minimum of 8 inches thick and be placed on a 1 foot Class 7 sub base. All concrete shall conform to SPECIFICATION SECTION 03 00 00 CONCRETE.

B. The unit base shall comprise a base plate, perimeter flange, and reinforcements. Base plate shall be fabricated of steel not less than 1/4" thick. Perimeter flange and reinforcements shall be designed to prevent flexing or warping under operating conditions. Base plate and/or flange shall be drilled for hardware used to secure unit base to concrete pad as shown on the contract drawings. Unit base shall contain provisions for lifting the complete pump unit during shipping and installation

2.2 MODULAR PUMP STATION ENCLOSURE

A. Enclosure Construction and Design:

1. The enclosure is to be square/rectangular with outside dimensions of 16' long by 10' wide and having a maximum outside height of 9' at the roof peak.
2. A minimum of (4) four lifting eyes arranged on the corners shall be provided to ease handling and installation onto a concrete pad furnished by the contractor.
3. Enclosure walls and roof shall be seamless, one-piece sprayed fiberglass panels laminated to form a structural composite as follows: 1/8" thick fiberglass outside surface, 1" thick ura foam polyurethane core, 7/16" oriented strand board (OSB), and 3/32" thick fiberglass inside surface. OSB shall replace foam at all cut-out openings and penetration points.
4. Each wall panel shall overlap at the corner and form an internal connection joint using stainless steel hardware. All panel joints shall be thoroughly sealed with silicone caulk. The enclosure shall have a minimum R 10 insulation factor and shall be capable of with-standing 150 mph wind loads.
5. All exterior surfaces shall be textured (green, tan, or gray colored) isopthalic gel coat finish incorporating ultra violet inhibitors.
6. All interior surfaces shall be sprayed white isopthalic gel coat finish offering the same characteristics as the exterior surfaces.
7. The roof panel shall be an arched, one-piece design incorporating the same materials of construction as the side walls. The roof shall be removable as a unit, allowing for complete access to the pumping equipment with a crane. The pitch of the roof shall be sufficient for good moisture drainage, and withstand a minimum snow load of 40 pounds per square foot.
8. The 3'0" wide x 6'8" high entrance door(s) shall be constructed of the same laminated fiberglass and foam core materials as the remainder of the station. OSB will replace the insulation in areas where auxiliary equipment will be mounted. Each door shall be hung with (3) three stainless steel ball bearing type hinges incorporating a three point closure system with a lockable door handle. An adjustable door positioner and holder shall be

mounted at the top of the door. A gasket consisting of solid rubber and sponge shall seal the door while closed. The door and all hardware shall be mounted to withstand 150 MPH winds. A wall mounted drip molding will be installed above each door.

9. After the pumping equipment is installed, the fully assembled station enclosure shall be positioned on the concrete mounting pad and sealed with butyl sealant tape as furnished by the pump station manufacturer. The interior base flange shall be drilled positioning and fastened to the pad using expansion anchors on 24" maximum centers.

B. Enclosure Functional Equipment:

1. The interior of the station shall be illuminated by factory installed 120 volt fluorescent light fixtures. All lights will be prewired and run to a load center through PVC conduit and a weatherproof switch shall be installed adjacent to each station entrance. The lighting circuit shall be protected by a thermal-magnetic circuit breaker.
2. A thermostatically controlled 120 VAC exhaust fan with screen and weatherproof shutters shall be installed in the wall approximately opposite the fresh air intake vent. The fan shall have a minimum capacity of 1600 CFM at free air and be capable of changing the air in the enclosure a minimum of six times per hour. The exhaust fan shall be protected by a thermal-magnetic circuit breaker.
3. The enclosure will be complete with one (1) set of intake louvers. The intake louvers will be completely self-contained and shall not require the use of motors, solenoids, or other electrically operated devices. Intake louver will consist of two (2) 15" wide and 18-7/8" high shutters that open automatically at 75o F, and close at 60o F. Shutter operation will be the result of the expansion and contraction of wax in an enclosed plunger which shall drive the louver vanes through a mechanical linkage. The intake shutters will have the actuator mounted out of the flow of the intake air and shall maintain the shutter vanes in the open position. Intake shutter frame will be constructed of anodized aluminum with zinc plated steel actuator mounting and linkage. The shutter vanes will pivot on plastic bearings. The two (2) intake shutters will be mounted in an aluminum fixed vane louver assembly to prevent the entrance of rain or snow.
4. A high capacity electric blower type station heater shall be provided for the protection of the pumping equipment. The heater shall maintain an inside/outside differential temperature of 60 degrees F while operating on the primary voltage supplied to the station. The heater shall be provided with an adjustable thermostat, circuit breaker, and contactor.
5. The station enclosure shall be furnished with extra wide doors. A double hung door design with 3-point locking hardware, door closer, and hinges on each section shall allow complete access to the 6'-0" x 6'-8" full door opening without the need for a center sill.
6. A wall mounted duplex GFI utility receptacle providing 120 volt AC power shall be installed and prewired through PVC conduit with the station lighting. The receptacle shall be protected by thermal magnetic circuit breaker.
7. Consists of a three piece assembly including duck bill check valve, SST strainer top, and PVC spacer to provide a gas and water tight drain receptacle for use in concrete pad within Modular Enclosure. (Note: A 4" PVC drain pipe and PVC coupling shall be required to be provided and installed by others.)

2.3 PUMPS

A. Pumps shall have a 4 inch suction connection and 4 inch discharge connection, and be horizontal, self-priming centrifugal type equal in construction and performance to the "U" Series self-priming industrial pumps as manufactured by the Gorman-Rupp Company, Mansfield, Ohio. Model number U4B60S-B, or equal.

B. Construction of the pumps shall be as follows:

1. Consideration shall be given to the handling of waste, in which occasionally debris will lodge between the pump suction check valve and seat, resulting not only in loss of the

suction leg, but also in the syphoning of the liquid from the pump casing to the approximate center line of the impeller. Such occurrence shall be considered normal with proper installation of air release line free to atmosphere.

2. In consideration of such occurrence and of the unattended operation anticipated, each pump shall be designed as to retain adequate liquid in the pump casing to insure unattended automatic repriming while operating at its rated speed in a completely open system without suction check valves and with a dry suction leg.

3. Pump volute or casing shall contain no openings, such as recirculation ports, of a lesser diameter than sphere sizes specified. Screens or any internal devices that create a maintenance nuisance or interfere with priming and performance of the pump shall not be permitted.

C. Pump case shall all be manufactured from 304 stainless steel.

D. Diffusers, shaft, inner bowls, seal spring and retainer clip, and coupling guards shall be manufactured from 304 stainless steel.

E. Impellers and shaft spacers, priming and drain plugs shall be manufactured from 316 stainless steel. Impeller shall be 6-vaned, semi-open, with integral pump-out vanes on the back shroud. The impeller shall thread onto a pump shaft of 304 stainless, and be secured with an impeller locking screw

F. Entire rotating assembly, which includes bearings, shaft, seal and impeller shall be removed as a unit without disturbing pump volute or piping. Means shall be provided for external adjustment of the impeller to the wear place.

G. Pumps shall also be fitted with a replaceable wear plate and made of 304 Stainless Steel.

H. Shaft shall be contained within a bearing pedestal of ample size to contain heavy ball bearing thrust loads and radial bearings of adequate size to withstand all imposed loads. Bearings shall be oil lubricated, with the bearing pedestal cooled by pumped liquid

I. Pump shall incorporate suction check valve that can be removed or installed through removable cover plate opening without disturbing the suction piping. Sole function of the check valve shall be to eliminate repriming with each cycle. Pumps requiring suction check valves to perform will not be acceptable.

J. Pump shaft shall be sealed against leakage by a mechanical cartridge seal. Rotating and stationary seal faces shall be silicon carbide. Cage and spring, stainless steel: elastomers, viton.

1. Each seal face must be grounded to produce a flatness tolerance not to exceed three light bands, or 34.8 millionths of an inch as measured by an optical flat and monochromatic light. To insure seal faces are in full contact at all times, stationary seal seat shall be double floating and self-aligning during periods of shock loads that will cause deflection, vibration, and axial or radial movements of the pump shaft.
2. Mechanical seal shall be installed within a seal housing adjacent to an oil filled reservoir in the pump pedestal, the oil serving as both lubricating and cooling media.

K. Pumps must be equipped with a removal cover plate allowing complete access to the pump interior to permit the clearance of stoppages and to provide simple access for service and repair without disturbing suction or discharge piping.

L. Replacement of wear plate, impeller, and seal shall be accomplished through the removal cover plate

M. Pumps to be supplied with a drain kit for ease of maintenance. The kit to contain 10' length of reinforced plastic hose with a female quick connect fitting at one end, and factory installed drain fittings in each pump. Fittings include a stainless steel pipe nipple, stainless steel bushing, stainless steel gate valve and aluminum male quick connect fitting

N. Pump connections shall be ANSI flanged, class 300.

O. Reprime Performance

1. During unattended operation, the pump shall retain adequate liquid in the casing to insure automatic repriming while operating at its rated speed in a completely open system. The need for a suction check valve or external priming device shall not be required.
2. Pump must be capable of reprime of 17 vertical feet at the specified speed and impeller diameter. Reprime lift is defined as the static height of the pump suction above the liquid, while operating with only one-half of the liquid remaining in the pump casing. The pump must reprime and deliver full capacity within five minutes after the pump is energized in the reprime condition. Reprime performance must be confirmed with the following test set-up:

    a. A check valve to be installed downstream from the pump discharge flange. The check valve size shall be equal (or greater than) the pump discharge diameter.
    b. A ten foot length of 1 inch air release pipe shall be installed between pump and the discharge check valve. This line shall be open to atmosphere at all times duplicating the air displacement rate anticipated at a typical pump station fitted with an air release valve.
    c. The pump suction check valve shall be removed. No restrictions in the pump or suction piping will prevent the siphon drop of the suction leg. Suction pipe configuration for reprime test shall incorporate a 6 feet minimum horizontal run, a two (2) 45 degree elbows and vertical run at the specified lift. Pipe size shall be equal to the pump suction diameter.
    d. Impeller clearances shall be set as recommended in the pump service manual.
    e. Repeatability of performance shall be demonstrated by testing five consecutive reprime cycles. Full pump capacity (flow) shall be achieved within five minutes during each cycle.
    f. Liquid to be used for reprime test shall be water.
3. Upon request from the engineer, certified reprime performance test results, prepared by the manufacturer, and certified by a registered professional engineer, shall be submitted for approval prior to shipment.

P. Drive unit

1. Pump motors shall be 50 HP, horizontal TEFC, 1800 RPM, NEMA design B with cast iron frame with copper windings, induction type, with normal starting torque and low starting current characteristics, suitable for continuous service. The motors shall not overload at the design condition or at any head in the operating range as specified.
2. Drive Transmission
    a. Power to pumps transmitted V-belt drive assemblies. The sheave/belt combination shall provide the speed ratio needed to achieve the specified pump operating conditions.
    b. Each drive assembly shall utilize at least two V-belts providing minimum a combined safety factor of 1.5. Single belt drives or systems with a safety factor of less than 1.5

are not acceptable. Computation of safety factors shall be based on performance data published by the drive manufacturer.

c. Precise alignment tolerances of the drive assemblies shall be achieved by means of a belt/sheave laser alignment system resulting in the reduction of vibration, accelerated wear, and premature failure.

d. The pump manufacturer shall submit power transmission calculations which document the following:
   1) Ratio of pump/motor speed.
   2) Pitch diameter of driver and driven sheaves.
   3) Number of belts required per drive.
   4) Theoretical horsepower transmitted per belt, based on vendor's data.
   5) Center distance between pump and motor shafts.
   6) Arc-length correction factor applied to theoretical horsepower transmitted.
   7) Service factor applied to established design horsepower.
   8) Safety factor ratio of power transmitted/brake horsepower required.

3. Belt guards
   a. Pump drives to be enclosed on all sides by a guard constructed of fabricated steel or combination of materials including expanded, perforated, or solid sheet metal. No opening to a rotating member shall exceed 1/2 inch.
   b. Guards must be completely removal without interference from any unit component, and shall be securely fastened and braced to the unit base.
   c. Metal to be free from burrs and sharp edges. Structural joints shall be continuously welded. Rivet spacing on panels shall not exceed five inches. Tack welds shall not exceed four inch spacing.
   d. The guard shall be finished with one coat of gray W.R. non lift primer and one coat of orange acrylic alkyd W.R. enamel in accordance with section 3, Color Definitions of ANSI 253.1; Safety Color Code for Marking Physical Hazards.

Q. Finish

1. Pumps, piping, and exposed steel framework shall be cleaned prior to coating using an approved solvent wipe or phosphatizing cleaner. The part must thoroughly dry before paint application. Open joints shall be caulked with an approved polyurethane sealant. Exposed surfaces shall be applied with one coat of Tnemec Series 69 Polymide Epoxy Primer and one finish coat of Series 73 Aliphatic Acrylic Polyurethane for a total dry film thickness of 4-6 mils. Finish coat shall be semi-gloss white for optimum illumination and enhancement. The coating shall be corrosion, moisture, oil, and solvent resistant when completely dry. The factory finish shall allow for over-coating and touch-up for 6 months after coating

2.4 VALVES AND GAUGES

A. Pump check valves shall be provided on the discharge of each pump. Check valves shall be of the silent type. Check valves shall begin to close as forward velocity diminishes and shall be fully closed at zero velocity preventing flow reversal. Each pump shall be equipped with a full flow type check valve capable of passing a 3" spherical solid. Valve shall be constructed with flanged ends and fitted with an external lever and torsional spring. Valve seat shall be constructed of stainless steel, secured to the body to ensure concentricity, sealed by an O ring, and shall be replaceable. The valve body shall be cast iron incorporating a clean out port large enough to allow removal and/or replacement of the valve clapper without removing valve or piping from the line. Valve clapper shall have a molded neoprene seating surface incorporating low pressure sealing rings. Valve hinge pin and internal hinge arm shall be stainless steel supported on each end in brass bushings. Shaft nut shall have double O rings which shall be shall be easily replaceable without requiring access to interior of valve body. All internal hardware shall be stainless steel. Valve shall be rated at 175 PSI water working pressure, 350 PSI hydrostatic test pressure. Valves other than

full flow type or valves mounted in such a manner that prevents the passage of a 3" spherical solid shall not be acceptable

B. Suction Strainer

1. A strainer shall be installed on the suction of the piping. This strainer shall be able to remove objects greater than 6 mm in diameter to prevent damage to the pumps or piping.

C. Suction Check Valve

1. Pump shall incorporate suction check valve that can be removed or installed through removable cover plate opening without disturbing the suction piping. Sole function of the check valve shall be to eliminate repriming with each cycle. Pumps requiring suction check valves to perform will not be acceptable.

D. Automatic air release valves:

1. An automatic air release valve shall be furnished for each pump designed to permit the escape of air to the atmosphere during initial priming or unattended repriming cycles. Upon completion of the priming cycle or repriming cycle, the valve shall close to prevent recirculation. Valves shall provide visual indication of valve closure, and shall operate solely on discharge pressure. Valves which require connection to the suction line shall not be acceptable.
2. All valve parts shall be constructed of cast iron, stainless steel, or similar corrosion resistant materials. Diaphragms, if used, shall be of fabric reinforced neoprene or similar inert material.
3. A cleanout port, three inches in diameter, shall be provided for ease of inspection, cleanout, and service.
4. Valves shall be field adjustable for varying discharge heads.
5. Connection of the air release valves to the station piping shall include stainless steel fittings.

2.5 PIPING

A. All piping shall be flanged header pipe and shall be centrifugally cast, ductile iron, complying with ANSI/AWWA A21.51/C115 and class 53 thickness.

B. Flanges shall be cast iron class 125 and Comply with ANSI B16.1.

C. Pipe and flanges shall be threaded and suitable thread sealant applied before assembling flange to pipe.

D. Bolt holes shall be in angular alignment within 1/2 degrees between flanges. Flanges shall be faced with a gasket finish having concentric grooves a minimum of 0.01 inch deep by approximately 0.03 inch wide, with a minimum of three grooves on any given surface spaced a maximum of 1/4 inch apart

E. Piping shall be painted as specified in section 2.12. All piping shall be fusion bonded epoxy coated internally and externally to NSF 61 standards.

2.6 PIPING SUPPORT

A. All piping supports shall cover 120 degrees of arc under the piping and support the weight of the piping and the water it contains.

B. Piping support shall be welded to the skid, and shall be bolted to tabs which are welded to the piping.

C. Piping supports not supporting at least 120 degrees of arc under the piping shall not be accepted.

D. Thrust shall be resisted through the use of a fabricated steel thrust block.

1. Fabricated steel thrust block may be manufactured from two pieces of ASTM A36 plate bolted together. One piece of plate shall be welded along the axis of the pipe and the other to either the skid or the lower level piping, as required.
2. In the event that the fabricated steel thrust block manufactured from two pieces of plate is deemed inadequate for any reason by the pumping system manufacturer, the fabricated steel thrust block may be manufactured from ASTM A36 structural steel shapes.
3. Pumping system manufacturer shall have on staff a Professional Engineer responsible for thrust calculations and design of the thrust block.
4. Provision of pumping system thrust blocks by the pumping system manufacturer does not relieve the installing contractor from properly thrust blocking his pipe so as to transmit no thrust to the pumping system.

2.7 PRESSURE GAUGES

A. A pressure gauge shall be mounted on each header, complete with isolation ball valve.

B. Each gauge shall be filled to reduce wear due to vibration.

C. Gauge accuracy shall be within 0.5%, and shall comply with ASME B40.1 Grade 2A.

D. Gauge diameter shall be 4.5" minimum.

E. Gauge materials of construction:

1. Connection and bourdon tube shall be from 316 stainless steel.
2. Movement shall be from stainless steel with an internal stop at 1.3 times the gauge range.
3. Dial shall be from white aluminum with black lettering and a stop at the 6 o'clock position.
4. Pointer shall be adjustable from black aluminum.
5. Turret style case shall be from black glass reinforced thermoplastic (PBTP), and shall have built in rear flange lugs, with a solid front and blow-out back, rated at NEMA 4X.
6. Window shall be from acrylic.
7. Window gasket shall be from Buna-N.
8. Filling material shall be glycerin.

F. Range shall be selected so that operating pressure is in the mid range of the gauge.

G. Gauge range shall in no case be less than 50% higher than the highest pressure attainable from the pumps at shutoff head conditions.

H. Gauge shall resist shocks to 100G.

I. Pressure gauge shall be model 233.34 as manufactured by Wika.

J. 2.5" pressure gauge shall be mounted at each pump discharge, prior to its check valve. Gauge shall have a stainless steel case, bronze bourdon tube, and an accuracy of 2/1/2%. Gauge shall be a Wika model 213.53, with a range greater than the shutoff head of the pump.

2.8 PRESSURE TRANSDUCER

A. Pressure transducers shall be mounted on the discharge headers and shall provide all pressure signals for the control logic.

B. Pressure transducer shall be supplied with an isolating ball valve.

C. Pressure transducer shall be a media isolated instrument, having no silicone oil, internal o-rings, or welds.

D. Pressure transducer wetted material shall be 17-4PH stainless steel NACE compatible housed in 304 stainless steel with a male threaded process connection.

E. Pressure transducer shall provide a digital pulse output linear with the sensed pressure, from a two wire 10-28 VDC supply, reverse polarity protected.

F. Pressure transducer shall have an accuracy of plus/minus 0.20% BFSL.

G. Resolution of the transducer shall be greater than the resolution of the analog to digital conversion for PLC operation.

H. Transducer shall be rated for pressures greater than station discharge pressure, and shall provide gauge pressure output, rather than absolute pressure.

2.9 MAGNETIC FLOWMETER

A. The pumping system shall have a 6" flow sensor installed, which shall be utilized for control and to display the pumping system flow rate, and to display total flow through the pumping system controller operator interface device (OID). Flow meter shall be electromagnetic flow meter comprised of two major components, a primary head and a signal converter. Flow meter signal converter shall produce two separate signals, pulse and 4-20mA, in linear proportion to flow rate. Flow meter shall read flows from 0-40 fps, with a worst case inaccuracy of 0.5% of indicated value (not a percentage of full scale) at 1.3 fps or greater. Flows less than 1.3 fps shall have a lower accuracy with accuracy applying to the indicated value (not full scale). Flow meter shall be sized so that maximum system flow lies between 16 and 24 fps through the meter. Meter shall be installed according to manufacturer's recommendations. Manufacturer shall have a US based manufacturing and assembly center. Flow meter shall be as manufactured by Krohne, or equal.

B. Primary Head: The flow tube shall be a ANSI B16.5 class 150 flanged for sizes less than 24" and AWWA class D flanged for sizes above 24" with a 304SS spool. Wetted liner shall be hard rubber. Liner shall extend beyond the ends of the flow tube and over the flange faces. Liner shall remain stable and in place under a 500 mBar absolute vacuum or pressure situation. Liner shall be rated for the medium pumped. Magnetic coils shall be wound by the flow meter manufacturer and held in place in such a way as to prevent any fluctuation in the magnetic field generated. Magnetic coils in flow tubes 6" and smaller shall be epoxied together through a fusion bonding process, which renders the magnetic coil a single solid piece with no loose windings. Electrodes shall be from Hastelloy C4. They shall be inserted from the inside of the flow tube, and shall be sealed along their length. Electrodes sealed at one or more discrete points shall not be accepted. The wires connecting the electrodes to the primary head shall be fastened in place along their entire length to prevent the transmission of erroneous data or signal noise acquired through signal wire movement. All wiring shall be brought into the primary head connection box and terminated. The shroud protecting the coils and electrodes shall be welded in place, and internally pressure tested to 1.5 atmospheres with air pressure. On completion, the flow tube shall be finish painted on all outside metallic surfaces. Primary head shall be NEMA 6 rated.

C. Signal Converter: The signal converter shall be NEMA 4X rated, and shall house the microprocessor-based electronics required for magnet excitation and flow measurement. Functions and data requirements shall be set by either a PC or by a hand held programmer. Unit shall process flow using a bipolar pulsed DC signal. Power supply shall be 115/230VAC 48-64 Hz. Outputs shall be 4-20 mA and pulsed output scalable at 0-100Hz or 0-1000 Hz for full scale range. Signal converter shall also include a binary output to indicate direction of flow.

D. Grounding rings: Where magnetic flow meters are placed in a pipeline that insulates the water from ground (e.g. epoxy lined steel pipe or plastic pipe) grounding rings are required at both ends of the flow meter to eliminate electrical eddy currents that may exist within the medium being pumped. Grounding rings and flow meter body must be grounded properly, in accordance with manufacturer's recommendations.

E. Calibration and Testing: Meter shall be hydraulically calibrated on a testing device that is at least 10 times more accurate than the meter, and shall not be calibrated against a master meter. Each and every flow meter produced by the flow meter manufacturer shall be flow tested and hydraulically calibrated according to this procedure. Manufacturer's test and calibration equipment shall be internationally certified, and shall be re-certified every three years. Calibration shall be accomplished through direct volumetric comparison, on rigs certified as having a measurement error of equal to or less than 0.03%. A calibration certificate shall be issued for each and every flow meter produced by the flow meter manufacturer. Calibration certificate shall be traceable to the US National Bureau of Standards. Meters shall be calibrated under standard conditions to a measurement error of less than 0.50% of rate.

F. Best resolution of flowmeter shall be with 5 diameters of straight pipe upstream of the center of the flowmeter, and 2 such diameters downstream of the center of the meter. In space critical situations, the meter manufacturer shall authorize the system manufacturer to attach 90 degree elbows directly to both flanges of the meter, without compromising the accuracy to worse than 1% of indicated value (not full scale). Meter manufacturer shall have provided system manufacturer with a written authorization and test data, which shall be kept on file at the system manufacturer's place of business, and made available for inspection on request.

2.10 PAINT

A. Structural steel and supports shall be deslagged then grit-blasted per SSPC-SP6 to commercial blast condition.

B. The cleaned steel surface shall be immediately coated with an aliphatic polyurethane coating to a thickness of no less than 5 mils and applied through an electrostatic method to insure proper adhesion.

C. This aliphatic polyurethane coating shall meet or exceed the following testing criteria:

1. Direct impact resistance of 140 in/lbs (per ASTM D 2794)
2. Taber abrasion loss no greater than 60.2 mg (per ASTM D 4060)
3. Adhesion to substrate of 1500 PSI (per ASTM D 4541)
4. Salt fog resistance at 1400 hours (ASTM B117-85) to the following standards:
   a. Rust rating of 10 (D 610)
   b. Corrosion rating of 4 (D 1654)
   c. Blistering rating of 10 (D 714)

D. Manufacturer shall provide a touch up kit for owners use.

E. Powder coating will not be an accepted paint process.

2.11 BOLTS

A. All bolts and nuts used in the assembly of the pumping system shall be grade 5 and zinc plated to retard corrosion. As required in specific locations to protect the finish and prevent loosening, bolts shall be provided with anti-corrosion washers and lock washers.

2.12 CONTROL ENCLOSURE

A. Controls shall be housed in a NEMA 4X enclosure with integral latches.

B. The control enclosure shall be constructed of 12 gauge grade 316 stainless steel and the back plate assembly shall be constructed of 12 gauge grade 316 stainless steel. 60" wide and larger to be 10 gauge or thicker.

C. All indicating lights, reset buttons, selector switches and the operator interface device (OID) shall be mounted on enclosure door and shall be rated NEMA 4X.

D. All enclosure cut-outs to be done by laser for proper fit, sealing and coating retention.

E. All internal components shall be mounted and secured to the removable back plate assembly.

F. All internal components shall be mounted and secured to the removable back plate assembly. All equipment and wiring shall be mounted within the enclosure and labeled for proper identification.

G. All adjustments and maintenance shall be able to be done from the front of the control enclosure.

H. A Fan cooling system shall be included to cool the enclosure and reject heat from the VFD. VFD status and internal parameters must be viewable without the opening of the enclosure door.

I. Entire control panel shall provide minimum of 65KA short circuit protection.

J. A complete wiring circuit and legend with all terminals, components, and wiring identification shall be provided.

K. Equipment shall be provided within the controls enclosure to assure compliance with current NEC and UL codes.

L. Main disconnect shall be interlocked with door. Cabinet to be lockable.

2.13 LIGHTNING AND SURGE ARRESTOR

A. Electrical equipment shall be protected by a U.L. 1449 Second Edition Listed TVSS to suppress voltage surges on incoming power.

B. Surge arrestor shall be connected to the line side of the pumping system landing lugs and shall be properly grounded.

C. The device shall be rated according to IEEE C62.41.1-2002, C62.41.2-2002, and C63.45-2002 to provide a surge capacity of no less than 80kA per phase. 40 kA phase to neutral and phase to ground.

D. Response time shall not be greater than 1/2 nanosecond.

E. TVSS shall withstand no less than 5000 Category C3 (C High) impulses with less than 10% drift.

F. Manufacturer of TVSS shall be ISO 9001:2000 certified.

2.14 CIRCUIT BREAKER AND MAIN DISCONNECT

A. A circuit breaker main disconnect shall be provided to isolate all controls and motor starting equipment from incoming power.

B. UL/CSA short-circuit interrupting capacity rating of the circuit breaker shall be not less than 65,000 amps.

C. Main disconnect shall have a through the door operator, and shall be sized in accordance with current NFPA 70 and UL requirements.

D. Disconnect shall be as manufactured by Square D.

2.15 CONTROL POWER

A. Power for the controls shall be provided by a control power transformer which shall provide 120 volt, single phase power for the pumping system control operation.

B. Control power transformer shall not be used for any load other than controls.

C. The control power transformer shall be protected on the primary side by control limiting fuses of adequate size and voltage rating.

D. All control components on the load side of the transformer shall be protected by time delay circuit breakers of adequate size.

E. The control power transformer shall be as manufactured by Acme.

2.16 VARIABLE FREQUENCY DRIVE

A. Variable frequency drives shall be as specified in Section 26 29 23, VARIABLE FREQUENCY MOTOR CONTROLLERS.

2.17 SKID CONDUIT

A. All on skid conduit shall be flexible conduit with water tight connections at enclosure and termination device.

B. All conduits shall be fastened to the skid every 24".

2.18 MICROPROCESSOR CONTROLS, VARIOUS SPEEDS

A. All control logic shall be handled by an industrial microprocessor logic controller as specified in Section 26 90 20 PROGRAMMABLE LOGIC CONTROLLERS.

B. Controller shall provide demand controlled sequential pump start up, shutdown and alarm features through its pressure sensing, flow sensing and voltage sensing devices. Controller shall operate VFDs using dual PID loops, one for acceleration, and one for pressure maintenance. All logic for system control, and timing shall be handled by the controller.

C. Controller shall be capable, if so selected by operator, of alternating equal sized pumps based on accumulated run time for each pump.

D. Controller shall automatically reconfigure itself for fewer pumps if one or more pumps fail to start when required.

E. Operation type shall be selectable by means of the controller parameters, either for constant speed pumps or for variable speed pumps.

F. Adjustable set point, with all other functions settable relative to set point.

G. Adjustable timing functions for delay on start, delay on stop, must run, and delay on activation of alarms.

H. Control software shall be parameter driven, fully documented, and allow user to easily change all operational parameters.

I. Provide operator interface terminal (OIT) as specified in Section 26 90 20, PROGRAMMABLE LOGIC CONTROLLERS.

J. Provide Ethernet Switch as specified in Section 26 90 20, PROGRAMMABLE LOGIC CONTROLLERS.

K. Coordinate Ethernet/IP address with the Owner and the Engineer.

L. Conditions that shall be displayed on the OIT:

1. Discharge pressure
2. Current flow rate
3. System Status
4. Each alarm on its occurrence, retained until it is reset.
5. Current number of pumps running
6. Pump run time - Run time for each pump shall be viewable by means of a set of commands. The interface shall include non-resetable and resettable totals for each pump.
7. Total Flow - The interface shall include non-resetable and resettable totals of system flow which shall be accessible through the interface device.

M. Panel face switches and lights:

1. Individual pump run lights – Green
2. General alarm light – Red
3. Individual pump Hand/Off/Automatic switches
   a. Pump switches in the Hand position shall bypass the controller completely and force the pumps to run continuously. The only alarms remaining active shall be inlet pressure fault and system phase failure.
4. System Manual-Off-Auto push button switch
   a. System Manual-Off-Auto push button switch in manual operation shall allow operator to start any pump manually by placing the pump switches in the Auto position. Operation of the pumps in this mode shall include the full alarm system being active and protecting the pumps and system.
   b. System Manual-Off-Auto push button switch in automatic operation shall allow controls to start pumps sequentially by placing the pump switches in the Auto position. Operation of the pumps in this mode shall include the full alarm system being active and protecting the pumps and system.

N. All pumping system shutdowns shall be of the controlled type which sequence pumps off at user selectable intervals. Activation of any automatically reset alarm, three times within thirty minutes, shall cause a hard lockout of the pumping system requiring manual reset.

PART 3 - CONTROL SYSTEMS

3.1 PRESSURE CONTROL SYSTEMS

A. The pressure control system shall start and stop the pump motors in response to changes in pump discharge pressure, as set forth herein.

B. The manual mode of control shall start the pump(s) and allow the pump(s) to operate continuously until manually stopped by changing out of the manual mode of control. The automatic mode of control shall start and stop the pumps based on discharge pressure.

C. The primary control system shall utilize a pressure transducer for primary pump control.

D. In primary mode of control, rising and falling pump discharge pressure will register in the pump control panel PLC and control the pumps as required using the setpoints entered into the local operator interface system.

E. The pressure control system shall utilize a pump alternator to select the lead VFD pump for a pumping cycle. Alternation of pumps shall occur at the end of a pumping cycle.

F. Resolution of the transducer shall be greater than the resolution of the analog to digital conversion for PLC operation.

3.2 FLOW MONITORING

A. The control system shall monitor the discharge flow of the non-potable water pumps. In either the manual or automatic mode of operation, if any of the pumps are operating and a 'low flow' condition is observed by the flow meter for a predetermined period of time, the respective pump will be disabled. In either the manual or automatic mode of operation, the alarm must be 'reset' at the control panel before the control system will return to normal operation. The control panel shall be equipped with one 24 VDC LED pilot light to indicate a low flow condition has occurred. The 'low flow' alarm time delay setpoint shall be adjustable utilizing the local control panel operator interface.

3.3 ALARMING

A. Alarms and Protectives

1. Low discharge pressure alarm (manual reset)
   a. Low Discharge Pressure alarm circuit shall shut down pumping system if discharge pressure reaches a predetermined low level. OIT, mounted in enclosure door, shall signal low discharge pressure. Pumping system shall not operate until alarm has been reset.
2. High discharge pressure alarm
   a. High Discharge Pressure alarm circuit shall shut down pumping system if discharge pressure reaches a predetermined high level. OIT shall signal high discharge pressure. Pumping system shall not operate until pressure is reduced and alarm has been reset.
3. Phase failure alarm (manual reset)
   a. Individual motor phase failure and low voltage safety circuitry shall retire any pump that experiences low voltage, phase failure or phase unbalance at the load-side of each pump motor contactor (as sensed by the solid state overload relay). Each pump motor shall have its individual protective device and time delay to allow for transient low voltage during motor starting allowing maximum motor protection.

b. Separate system power phase failure and low voltage alarm circuit shall also be provided to retire the pumping system if it experiences low voltage, phase failure, or phase reversal as monitored at the load side of the control enclosure disconnect switch. Phase monitor shall have a time delay to allow for transient low voltage during motor starting allowing maximum motor protection. The individual pumps or pumping system shall not operate until the voltage problem has been corrected and alarm has been manually reset.

4. Pump cycle fault alarm
5. General alarm output indicating light
6. Individual pump fault alarm (phase failure or overload, manual reset)

B. Each active alarm shall be indicated on the OIT clearly indicating the current fault. A general alarm light may also be illuminated for visual indication of an existing alarm.

PART 4 - EXECUTION

4.1 SYSTEM FACTORY FLOW TEST

A. The entire pumping system shall be flow tested across its entire range at the manufacturer's facility prior to shipment.

B. Factory flow test rig shall include flow meter and gauges that are NIST traceable. Test rig shall be able to supply power to the pumping system control panel to support the operation of all pumps.

C. Check motor and control data plates for compatibility to site voltage. Install and test the station ground prior to connecting line voltage to station control panel.

D. All electrical controls and circuits shall be included in the system test, as shall their interface to the motors and the outputs to the SCADA system.

E. Prior to applying electrical power to any motors or control equipment, check all wiring for tight connection. Verify that protective devices (fuses and circuit breakers) conform to project design documents. Manually operate circuit breakers and switches to ensure operation without binding. Open all circuit breakers and disconnects before connecting utility power. Verify line voltage, phase sequence and ground before actual start-up

F. System factory flow test results shall be provided in the form of an X-Y plot.

G. Any failure in the flow test, either for any pump or for the system, shall be corrected by the manufacturer at his expense, and the test repeated until satisfactory results are obtained.

4.2 UNLOADING AND SETTING SUPERVISION

A. Setting of the pumping system and connection to suction, discharge and power, anchoring of the pumping system, and thrust blocking of the suction and discharge piping that is connected to the pumping system shall be the responsibility of the installing contractor and not the manufacturer.

B. Crane to off-load and set the pumping system onto the concrete slab shall be provided by installing contractor.

C. Manufacturer shall inform the contractor, prior to system shipment, of the calculated weight of the pumping system.

4.3 INSTALLATION

A. The general contractor shall assume full responsibility for coordination of the entire project, including verification that all structures, piping, coating systems and equipment components be compatible. The general contractor shall initially operate each equipment system, and shall make all necessary adjustments so that each system is placed in proper operation condition.

B. Equipment and materials utilized for this project must be approved by the Engineer prior to installation. Approval for installation or incorporation in this project will be made only after submittal of manufacturer's shop and installation drawings, test results or other data as specified herein.

C. Installation of equipment shall be in full conformance with the manufacturer shop drawings and requirements as approved by the Engineer. Wherever a conflict arises between manufacturer's instructions and the contract documents, the contractor shall follow the Engineer's decision at no additional cost to the owner.

4.4 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite for the minimum person-days listed for the services hereinunder, travel time excluded:

1. Installation, Startup and Testing Services:
   a. 1 person days for installation assistance, inspection, and certificate of Proper Installation.
   b. 1/2 person-day for functional and performance testing.
   c. Provide Qualifications of Manufacturer's Representative.
2. Training Services:
   a. 1/2 person-day of prestart classroom or jobsite training of owner's personnel.
   b. Training of Owner's personnel shall be at such times and at such locations as required and approved by the Owner.

B. The representative or factory service technician will inspect the completed installation. He will calibrate and adjust instrumentation, correct or supervise correction of defects or malfunctions, and instruct operating personnel in proper operation and maintenance procedures.

4.5 MANUFACTURER'S CERTIFICATES

A. Provide Manufacturer's certificate(s) in accordance with Section 01 79 00, DEMONSTRATION AND TRAINING of Division 1, GENERAL REQUIREMENTS.

4.6 FIELD TEST:

A. Prior to plant startup, all equipment described herein shall be inspected for proper alignment, quiet operation, proper connections, and satisfactory performance by means of a functional test. Tests shall demonstrate that all equipment is electrically, mechanically, structurally, and otherwise acceptable; it is safe and in optimum working condition; and conforms to the specified operating characteristics.

B. The pump and motor assembly shall be field tested to verify vibration is not in excess of the limits stated in the latest revision of Hydraulic Institute and NEMA MG 1.

C. The pumps, motors, and controls shall be given an operational test in accordance with the standards of the Hydraulic Institute. Recordings of the test shall substantiate the correct

performance of the equipment at the design head, capacity, suction lift, speed and horsepower as herein specified.

D. After construction, debris and foreign material has been removed from the point of suction, contractor shall supply clear water volume adequate to operate station through several pumping cycles. Observe and record operation of pumps, suction and discharge gage readings, ampere draw, pump controls, and controls. Check calibration of all instrumentation equipment, test manual control devices, and automatic control systems. Be alert to any undue noise, vibration or other operational problems.

E. Units apparently failing to meet the Specifications to the satisfaction of the Engineer must be more accurately tested in accordance with Hydraulic Institute Standards. If the pump fails the second test, the unit will be rejected, and the Contractor shall furnish a unit that will be rejected, and the Contractor shall furnish a unit that will perform as specified.

END OF SECTION

SILOAM SPRINGS WASTEWATER TREATMENT PLANT
ON-SITE REUSE
CITY OF SILOAM SPRINGS ARKANSAS
SILOAM SPRINGS, AR
ADH REVIEW SET

SILOAM SPRINGS, AR

LOCATION MAP

PROJECT SITE

VICINITY MAP

NO SCALE

GARVER PROJECT NO. 15048100
MARCH 2016

GARVER

2049 East Joyce Blvd.
Fayetteville, AR 72703
(479) 527-9100

GARVER

CERTIFICATE OF AUTHORIZATION ARKANSAS ENGINEER
GARVER LLC No. 766

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
CHRISTOPHER R. BUNTIN
No. 12716
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR
SILOAM SPRINGS WASTEWATER ON-SITE REUSE

COVER SHEET

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

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0 1"
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DRAWING NUMBER
01-G001

SHEET NUMBER 01

File: L:\2015\15048100 Siloam Springs Reuse\Drawings\SSWWTPREUSE G100.dwg Last Save: 3/24/2016 9:37 AM Last saved by: JTMartin
Last plotted by: Martin, Jerry T. Plot Style: AEC mono.ctb Plot Scale: 1:0.4255 Plot Date: 3/24/2016 10:51 AM Plotter used: DWG To PDF.pc3

INDEX OF DRAWINGS

SHEET NUMBER	DRAWING NUMBER	Sheet Description
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02	01-G101	INDEX OF DRAWINGS
03	01-G102	GENERAL NOTES/LEGEND
	SITE CIVIL - 05	
04	05-C101	EXISTING SITE LAYOUT
05	05-C102	EXISITNG SITE POTABLE AND NON-NONPOTABLE WATER SYSTEM
06	05-C103	PROPOSED NPW IMPROVEMENTS
07	05-C200	REUSE PUMP STATION
08	05-C201	YARD PIPING PLAN 1
09	05-C202	YARD PIPING PLAN 2
10	05-C203	YARD PIPING PLAN 3
11	05-E101	ELECTRICAL PLAN
	DETAILS	
12	CD-101	CIVIL DETAILS 1
13	CD-102	CIVIL DETAILS 2
14	CD-103	CIVIL DETAILS 3
15	CD-104	CIVIL DETAILS 4
16	CD-105	CIVIL DETAILS 5

GARVER

CERTIFICATE OF AUTHORIZATION
GARVER LLC No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER R. BUNTIN

Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR
SILOAM SPRINGS WASTEWATER
ON-SITE REUSE

INDEX OF DRAWINGS

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: ###

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0 1"
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DRAWING NUMBER
01-G101

SHEET NUMBER **02**

GENERAL CIVIL NOTES

1. SAFETY SHALL BE THE SOLE RESPONSIBILITY OF THE CONTRACTOR. THE ENGINEER SHALL NOT BE RESPONSIBLE FOR SAFETY, MEANS, OR METHODS OF THE CONTRACTOR.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR CONTACTING ALL APPROPRIATE AGENCIES BEFORE WORK COMMENCES TO VERIFY THE TYPE LOCATION, PROTECTION REQUIREMENTS, DEPTH OF ALL EXISTING UTILITIES, DRAINAGE FACILITIES, AND OTHER OBSTRUCTIONS. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COSTS ASSOCIATED WITH REPAIRING AND/OR REPLACING ANY SUCH ITEMS DAMAGED DURING CONSTRUCTION.
3. **CAUTION: UNDERGROUND UTILITIES SHOWN ARE TAKEN FROM EXISTING RECORDS AND ARE SHOWN FOR THE CONVENIENCE OF THE CONTRACTOR ONLY. THE CONTRACTOR SHALL CONTACT ALL UTILITY OWNERS AND CONFIRM LOCATIONS OF UTILITIES AT LEAST 48 HOURS BEFORE BEGINNING CONSTRUCTION. THE CONTRACTOR SHALL COORDINATE ACCURATELY LOCATING AND UNCOVERING ALL EXISTING UTILITIES, CHEMICAL LINES, AND UNDERGROUND ELECTRIC WITH PLANT SUPERVISOR BEFORE BEGINNING CONSTRUCTION. ANY DAMAGE RESULTING FROM THE CONTRACTOR'S OPERATIONS SHALL BE REPAIRED AT THE CONTRACTOR'S EXPENSE. WHERE CROSSING OF EXISTING UTILITIES OCCUR, PROVIDE 12" MINIMUM CLEARANCE EXCEPT POTABLE WATER MAINS. CROSS BELOW ALL POTABLE WATER MAINS, MAINTAINING 18" MINIMUM VERTICAL SEPARATION.**
4. SEWER AND WATER SERVICE SHALL BE MAINTAINED DURING ENTIRE CONSTRUCTION PERIOD OR TEMPORARY FACILITIES PROVIDED.
5. CONTRACTOR IS RESPONSIBLE FOR ALL DEWATERING ACTIVITIES AND ASSOCIATED PERMITS REQUIRED FOR ALL EXCAVATIONS REQUIRED TO COMPLETE THE PROJECT.
6. APPROXIMATE LOCATIONS OF OVERHEAD POWER LINES MAY OR MAY NOT BE SHOWN ON PLANS. CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR VERIFYING ALL LOCATIONS IN THE FIELD AND PLAN WORK IN THESE AREAS ACCORDINGLY.
7. CONTRACTOR SHALL BE RESPONSIBLE FOR SITE DRAINAGE AND COMPLIANCE WITH ALL GOVERNMENTAL STORM WATER REGULATIONS AND PERMITS (SWPPP) AS REQUIRED. CONTRACTOR SHALL BE RESPONSIBLE FOR ANY PERMITS REQUIRED FOR WORK WITHIN STREAMS.
8. IT SHALL BE THE CONTRACTOR'S SOLE RESPONSIBILITY TO PROVIDE TRAFFIC CONTROL AND SIGNAGE FOR THE DURATION OF PROJECT AS REQUIRED BY THE NATIONAL MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES -PART VI , AND/OR ALL OTHER APPLICABLE GUIDELINES OF AHTD, COUNTY, CITY OR ANY OTHER AUTHORITIES HAVING JURISDICTION OVER THE PROJECT AREAS.
9. CONTRACTOR SHALL MAINTAIN TRAFFIC FLOW TO RESIDENCES AND BUSINESS WITH MINIMUM DISRUPTION OF ACCESS.
10. ALL STREETS AND DRIVEWAYS SHALL BE OPEN CUT UNLESS NOTED OTHERWISE.
11. ALL EXCAVATION BACKFILL OUTSIDE TRAFFIC WAYS SHALL BE COMPACTED TO MIN 95% STANDARD PROCTOR DENSITY TO PREVENT SETTLEMENT.

PAVING AND GRADING NOTES

1. ALL PAVING MATERIALS AND CONSTRUCTION SHALL MEET THE AHTD STANDARD SPECIFICATIONS UNLESS OTHERWISE NOTED.
2. ANY PAVEMENT DAMAGED DURING CONSTRUCTION SHALL BE REPAIRED TO EQUAL OR BETTER CONDITION AT THE CONTRACTORS EXPENSE.
3. ANY DISTURBED AREAS NOT SPECIFICALLY DESIGNATED TO BE GRADED SHALL BE RESTORED TO EQUAL OR BETTER CONDITION AND SHALL BE GRADED TO DRAIN AS APPROVED BY THE ENGINEER.
4. FINAL PAVEMENT SURFACES SHALL NOT BE PLACED UNTIL ALL MAJOR CONSTRUCTION ACTIVES HAVE CONCLUDED.
5. ANY CHANGES TO FINAL GRADE ELEVATIONS AS SHOWN ON THE PLANS SHALL BE APPROVED BY THE ENGINEER.
6. ALL ASPHALT AND CONCRETE PAVING REMOVED AND REPLACED SHALL BE NEAT SAW CUT.
7. ALL OPEN CUT TRAFFIC WAYS (ROADS, PARKING LOTS, DRIVES ,ETC.) AND ALL AREAS LYING WITHIN PRISM OF TRAFFIC WAYS, SHALL HAVE CRUSHED STONE BACKFILL COMPACTED WITH VIBRATORY COMPACTOR MAXIMUM 6" LIFTS AND COMPACTED TO MINIMUM 100%-98% MODIFIED PROCTOR DENSITY TO PREVENT SETTLEMENT FOR ITS ENTIRE TRENCH HEIGHT AND WIDTH. COMPACTED "PUG-MIX "SHALL BE USED AND MAINTAINED IN TOP 12" OF TRENCH HEIGHT AS REQUIRED TO PREVENT AGGREGATE LOSS DUE TO TRAFFIC.

YARD PIPING NOTES

1. MINIMUM COVER OVER PIPING SHALL BE 3'-0", BELOW FINISHED GRADE.
2. PROVIDE MINIMUM PIPE COVER, AS SPECIFIED, UNLESS OTHERWISE APPROVED. IN SOME CASES, EXISTING CONDITIONS PROHIBIT UNIFORM GRADES BETWEEN THE ELEVATIONS SHOWN, AND FIELD ADJUSTMENTS TO UNIFORM GRADES ARE REQUIRED AS APPROVED BY ENGINEER.
3. SIZE OF FITTINGS SHOWN ON PLANS SHALL CORRESPOND TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE INDICATED. TYPE OF JOINT AND FITTING MATERIAL SHALL BE AS SPECIFIED FOR ADJACENT STRAIGHT RUN OF PIPE.
4. ALL JOINTS SHALL BE WATERTIGHT.
5. ALL BURIED PIPING SPECIFIED TO BE PRESSURE TESTED, EXCEPT FLANGED, WELDED, OR SCREWED PIPING, SHALL BE PROVIDED WITH THRUST RESTRAINT. THRUST RESTRAINT FOR ALL PIPING SHALL BE BY CONCRETE THRUST BLOCKS AT ALL DIRECTION CHANGES, UNLESS OTHERWISE NOTED. SEE THRUST RESTRAINT DETAILS.
6. CONTRACTOR SHALL LOCATE AND UNCOVER ALL CONNECTIONS TO EXISTING LINES, AND ANY POSSIBLE CONFLICTS WITH PROPOSED FACILITIES AND VERIFY LOCATION, ELEVATION, PIPE MATERIAL, AND PIPE O.D. PRIOR TO ANY CONSTRUCTION.
7. CONTRACTOR SHALL MAINTAIN AND PROTECT ALL EXISTING BURIED PIPING AND UTILITIES. THE CONTRACTOR IS RESPONSIBLE FOR REPAIRING ANY DAMAGED UNDERGROUND FACILITATES .
8. ALL SMALL DIAMETER PIPING SHALL BE INSTALLED AS SHOWN ON DRAWINGS WITH ALL FITTINGS AND VALVES AS REQUIRED TO PROVIDE A FUNCTIONAL PIPELINE AS SPECIFIED.
9. ALL BURIED VALVES SHALL BE INSTALLED WITH VALVE BOX AS SPECIFIED.
10. ALL PIPELINE SHUTDOWNS SHALL BE COORDINATED WITH THE OPERATORS. A WRITTEN WORK PLAN SHALL BE SUBMITTED AND APPROVED BY THE ENGINEER AND PLANT SUPERVISOR 24 HOURS PRIOR TO ANY SHUTDOWNS.
11. ROCK SHALL BE UNDERCUT A MINIMUM OF 4" AND PIPE BEDDED IN STONE. NO SEPARATE PAY ITEM EXISTS FOR ROCK EXCAVATION. ALL EXCAVATION SHALL BE CONSIDERED TO BE UN-CLASSIFIED EXCAVATION AND SUBSIDIARY TO OTHER BID ITEMS.
12. DISPOSAL OF THE EXISTING PIPE, EXISTING MANHOLES, AND ANY EXCESS MATERIALS RESULTING FROM THE WORK SHALL BE COORDINATED WITH THE OWNER.
13. CONTRACTOR SHALL PREVENT STORM WATER AND DEBRIS FROM ENTERING PIPES AND MANHOLES AT ALL TIMES. ALL PIPES AND MANHOLES SHALL BE SECURELY PLUGGED AT THE END OF EACH DAY.

CIVIL LEGEND

SYMBOL	DESCRIPTION
LINE "A" 24" DI / C	PROPOSED SANITARY SEWER
CTV	CABLE TV
SS	EXISTING SANITARY SEWER
W	EXISTING WATER MAIN
GM	EXISTING GAS MAIN
E	EXISTING OVERHEAD ELECTRIC
PM	EXISTING PROCESS MAIN
FW	FILTERED WATER
W1	POTABLE WATER
W2	NON-POTABLE WATER
PD	PROCESS DRAIN
RW	RAW WATER
SW	SETTLED WATER
WW	WASH WATER
	EXISTING STORM SEWER
	GRAVEL ROAD OR DRIVE
x	FENCE
	WATER EDGE
	TREE LINE
	TREE OR SHRUB
	EXISTING FIRE HYDRANT
	EXISTING YARD HYDRANT
	EXISTING VALVE
	PROPOSED VALVE
WM	EXISTING WATER METER
EMH	EXISTING ELECTRIC MANHOLE
SS	PROPOSED SEWER MANHOLE
SS	EXISTING SEWER MANHOLE
	CATCH BASIN
	SIGN
	TELEPHONE PEDESTAL
	EXISTING STORM SEWER INLET
	BENCH MARK
	SURVEY CONTROL POINT
	UTILITY POLE
	GUIDE WIRE ANCHOR
	CONCRETE WING WALL
	SLOPE DIRECTION INDICATOR
	PROPERTY PIN
	LIGHT POLE
	DEMOLISH OR REMOVE
	EXISTING ASPHALT
	PROPOSED ASPHALT
	PROPOSED STRUCTURE
	EXISTING CONCRETE
	PROPOSED CONCRETE

GENERAL CONVENTIONS LEGEND

SYMBOL	DESCRIPTION
PROJECT NORTH; 1 / A101 TITLE SCALE: 1/8" = 1'-0"	TITLE DENOTES A PLAN VIEW LAYOUT (THIS EXAMPLE IS PLAN VIEW No. 1 ON SHEET A101)
1 / A101 | A201 TITLE SCALE: 1/8" = 1'-0"	TITLE DENOTES AN ELEVATION, SECTION, OR DETAIL VIEW LAYOUT (THIS EXAMPLE IS DETAIL 1 ON SHEET A201 WHICH HAS A BACK REFERENCE ON SHEET A101)
1 TYP / A101 | A301	CALLOUT DENOTES A CUT SECTION TYPICAL REFERENCE (THIS EXAMPLE OCCURS ON SHEET A101 REFERENCING SECTION No. 1 ON SHEET A301)
1 / A101 | A201	CALLOUT DENOTES AN ELEVATION REFERENCE (THIS EXAMPLE OCCURS ON SHEET A101 REFERENCING ELEVATION No. 1 ON SHEET A201)
1 TYP / A101 | A401	CALLOUT DENOTES AN ENLARGED AREA TYPICAL REFERENCE (THIS EXAMPLE OCCURS ON SHEET A101 REFERENCING DETAIL No. 1 ON SHEET A401)
D05 / 2200-001	CALLOUT DENOTES A STANDARD DETAIL REFERENCE
1	CALLOUT DENOTES A KEYED NOTE REFERENCE
N / TRUE	SYMBOL INDICATES NORTH DIRECTION
0 10' 20' 40' 60' (IN FEET)	SYMBOL INDICATES A GRAPHICAL BAR SCALE
2	CLOUDED REGION INDICATES A REVISED AREA
ROOM NAME 101 150 SF	SYMBOL INDICATES A ROOM / AREA DESIGNATION WITH ROOM NUMBER AND SQUARE FOOTAGE
0	SYMBOL INDICATES A STRUCTURAL GRIDLINE OR DATUM
1ST FLOOR EL. 602.50	SYMBOL INDICATES A DATUM IN A SECTION OR ELEVATION

GARVER

CERTIFICATE OF AUTHORIZATION ARKANSAS ENGINEER GARVER LLC No. 766

STATE OF ARKANSAS LICENSED PROFESSIONAL ENGINEER CHRISTOPHER B. BUNTIN No.12716

Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP

SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER ON-SITE REUSE

GENERAL NOTES/LEGEND

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

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DRAWING NUMBER **01-G102**

SHEET NUMBER **03**

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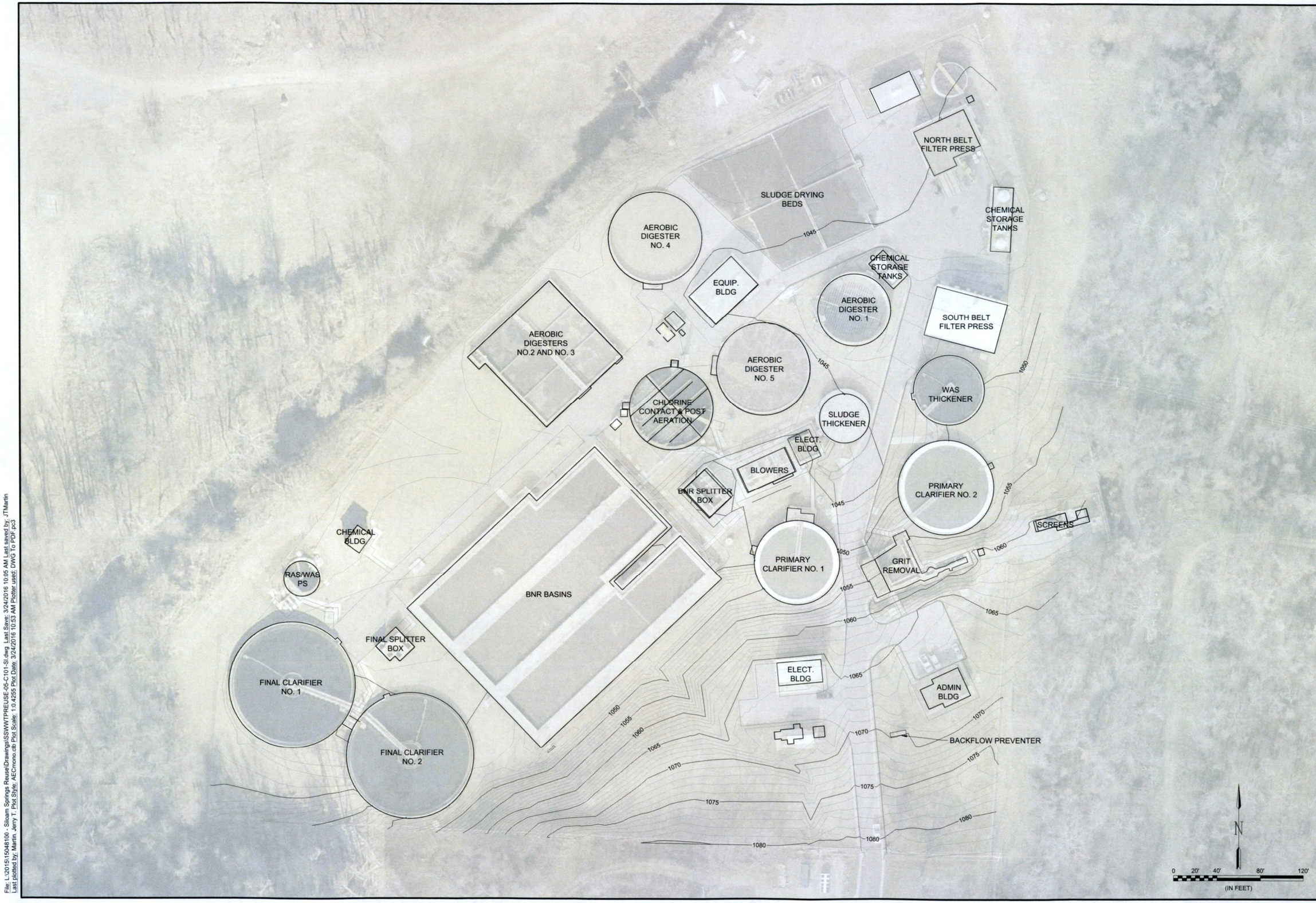

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GARVER

CERTIFICATE OF AUTHORIZATION ARKANSAS ENGINEER
GARVER LLC No. 766

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No.12716
CHRISTOPHER R. BUNTIN
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER
ON-SITE REUSE

EXISTING SITE LAYOUT

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

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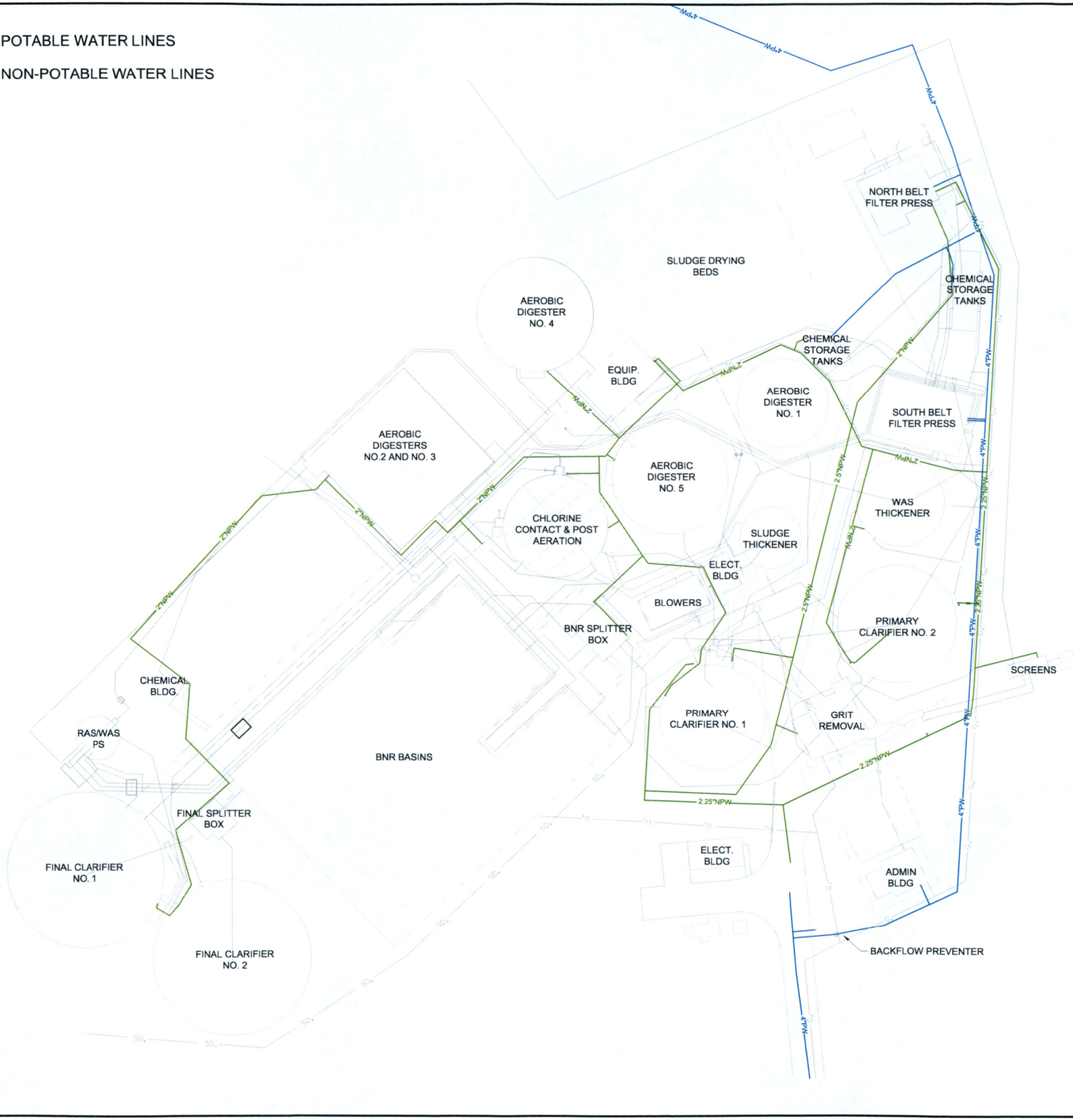
DRAWING NUMBER
05-C101

SHEET NUMBER **04**

PW — EX. POTABLE WATER LINES

NPW — EX. NON-POTABLE WATER LINES



GARVER

CERTIFICATE OF AUTHORIZATION
GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER R. BUNTIN

Digitally Signed 3/24/16

REV	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP

SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER ON-SITE REUSE

EXISITNG SITE POTABLE AND NON-NONPOTABLE WATER SYSTEM

JOB NO.: 15048100
DATE: MARCH 2106
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DRAWING NUMBER
05-C102

SHEET NUMBER **05**

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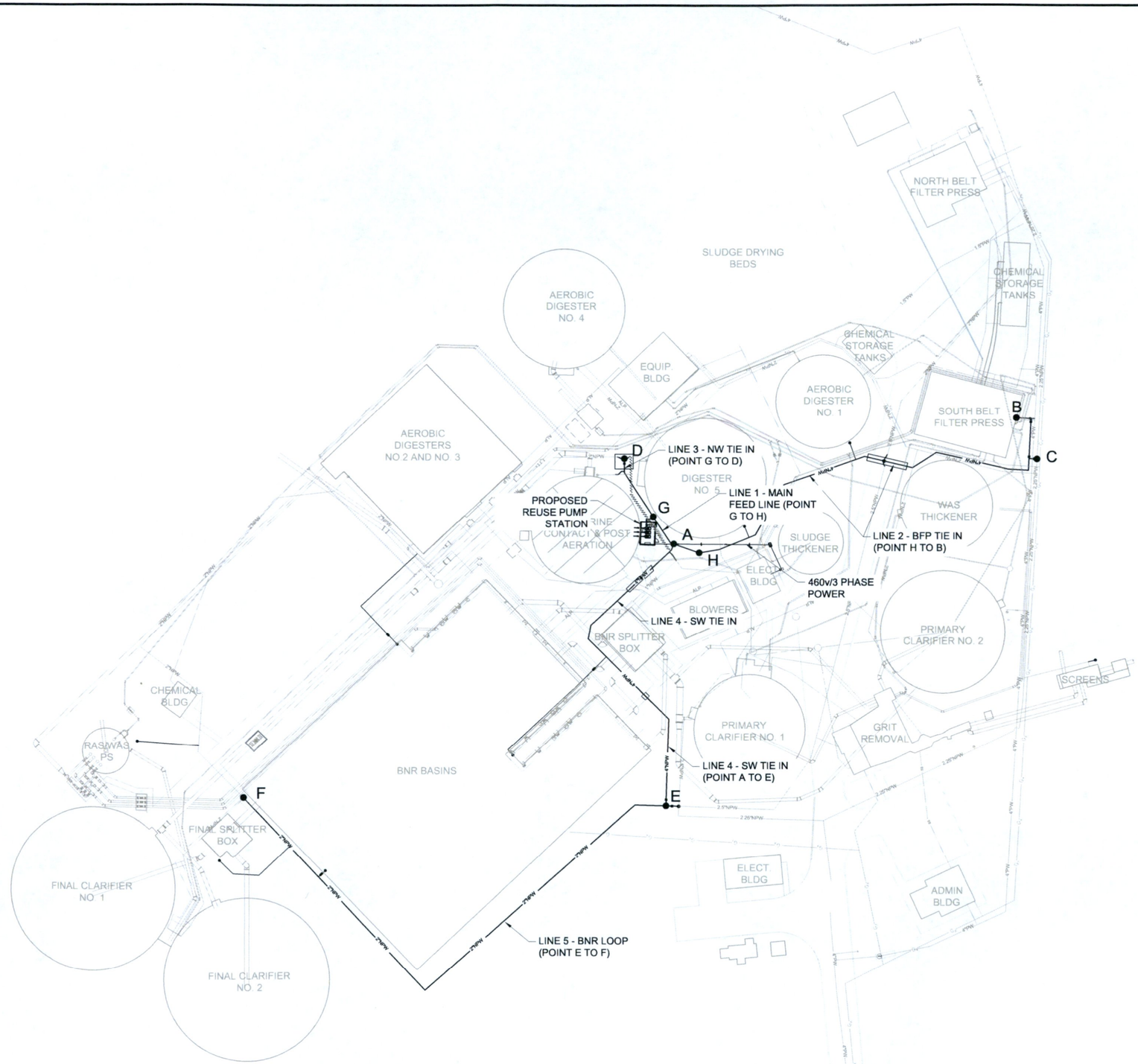

N

0 20' 40' 80' 120'

(IN FEET)

GARVER

CERTIFICATE OF AUTHORIZATION
GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER R. BUNTIN

Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP

SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER ON-SITE REUSE

PROPOSED NPW IMPROVEMENTS

JOB NO.: 15048100
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DRAWING NUMBER
05-C103

SHEET NUMBER **06**

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DIGESTER NO. 1

AEROBIC DIGESTER NO. 5

CHLORINE CONTACT & POST AERATION

SLUDGE THICKENER

ELECT. BLDG

BLOWERS

BNR SPLITTER BOX

LINE 1 - MAIN FEED LINE

LINE 2 - BFP TIE IN

LINE 3 - NW TIE IN

LINE 4 - SW TIE IN

LINE 4 - SW TIE IN

INSTALL 460 V, 3 PHASE POWER SEE 05-E101

1'-0" MIN.

CONTRACTOR TO INSTALL NEW PACKAGED PUMP STATION. COORDINATE PAD AND BASE SIZE WITH MANUFACTURER. INTAKE PIPING SHALL BE INSTALLED INTO CHLORINE CONTACT BASIN. SUCTION PIPING SHALL BE SUPPORTED ON THE EXISTING BASIN WALL. CONTRACTOR TO COORDINATE SUCTION PIPING LAYOUT WITH MANUFACTURE.

(IN FEET)

GARVER

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GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER R. BUNTIN
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER ON-SITE REUSE

REUSE PUMP STATION

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

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0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
05-C200

SHEET NUMBER **07**

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INSTALL 4" TEE AND 4" V105 WITH 4"x2" REDUCERS. CUT 2" NPW LINE AND TIE INTO PROPOSED 4" LINE AS SHOWN.

REMOVE AND REPLACE PAVEMENT AS NEEDED FOR INSTALLATION AND CONNECTION OF PROPOSED 4" NPW LINE

INSTALL TEE IN 4" NPW LINE AND TIE INTO EXISTING YARD HYDRANT SERVICE LINE.

AEROBIC DIGESTER NO. 5

DIGESTER NO. 1

INSTALL YARD HYDRANT AND 2" CONNECTION PIPING. COORDINATE LOCATION WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

LINE 3 - NW TIE IN

CONTRACTOR TO REMOVE EXISTING 2.25" NPW LINE AFTER INSTALLATION OF NEW 4" NPW LINE.

PROPOSED PUMP STATION

INSTALL 2" POST HYDRANT AND 2" CONNECTION PIPING. COORDINATE LOCATION WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

LINE 2 - BFP TIE IN

LINE 1 - MAIN FEED LINE

CHLORINE CONTACT & POST AERATION

INSTALL PULL BOX FOR POWER FEED LINE

SLUDGE THICKENER

460 V, 3 PHASE POWER

CONTRACTOR TO REMOVE AND INSTALL 4" NPW UNDER EXISTING SIDEWALK AND REPLACE SIDEWALK IN KIND

INSTALL NEW CONDUIT LINE INTO EXISTING PULL BOX. ROUTE TO PUMP STATION AS SHOWN

LINE 4 - SW TIE IN

ELECT. BLDG

CONTRACTOR TO TIE POWER FEED INTO EXISTING POWER CONTROL PANEL IN ELECT. BUILDING. ROUTE ELECTRICAL LINE THROUGH EXISTING FEED CONDUIT TO EXISTING PULL BOX.

INSTALL 4" NPW UNDER EXISTING AIR PIPING BY HAND BORING

BLOWERS

BNR SPLITTER BOX

LINE 4 - SW TIE IN

N

0 5' 10' 20' 30'
(IN FEET)

GARVER

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GARVER LLC
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ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER R. BUNTIN
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR
SILOAM SPRINGS WASTEWATER ON-SITE REUSE

YARD PIPING PLAN 1

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

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DRAWING NUMBER
05-C201

SHEET NUMBER 08

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EQUIP. BLDG

CHEMICAL STORAGE TANKS

AEROBIC DIGESTER NO. 1

AEROBIC DIGESTER NO. 5

SOUTH BELT FILTER PRESS

WAS THICKENER

SLUDGE THICKENER

ELECT. BLDG

BLOWERS

ALP

2"NPW

4"NPW

2.5"NPW

2.25"NPW

4"PW

1"NPW

MdN-2

MdN-4

7'-10"

3'-0"

CONTRACTOR TO CUT AND INSTALL 4" 90° BEND AND 4" V141 VALVES ON INFLUENT NPW LINE TO SOUTH BFP BUILDING. CONTRACTOR TO COORDINATE WITH PLANT STAFF ON FACILITIES INTERNAL TO BFP BUILDING AND ENSURING THESE ARE TAKEN OFF THE PW SYSTEM.

INSTALL 2" POST HYDRANT AND 2" CONNECTION PIPING. COORDINATE LOCATION WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

INSTALL 4" CROSS AND REDUCERS TO TIE INTO EXISTING 2.5" NPW LINE

LINE 2 - BFP TIE IN

INSTALL TEE AND V140 VALVE (AS REQUIRED BY SIZE) TO TAP INTO EXISTING NPW LINE.

CONTRACTOR TO CUT AND REPAIR PAVEMENT AS REQUIRED FOR INSTALLATION OF 4" NPW LINE

PROPOSED PUMP STATION

LINE 1 - MAIN FEED LINE

INSTALL 2" POST HYDRANT AND 2" CONNECTION PIPING. COORDINATE LOCATION WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

460 V, 3 PHASE POWER

LINE 4 - SW TIE IN

0 5' 10' 20' 30'
(IN FEET)

File: L:\2015\15048100 - Siloam Springs Reuse\Drawings\SSWWTP\REUSE-05-C202-SI.dwg Last Save: 3/24/2016 10:50 AM Last saved by: JTMartin
Last plotted by: Martin, Jerry T; Plot Style: AECmono.ctb Plot Scale: 1:0.4255 Plot Date: 3/24/2016 10:55 AM Plotter used: DWG To PDF.pc3

GARVER

CERTIFICATE OF AUTHORIZATION
GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
CHRISTOPHER B. GUNTIN
No. 12716
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER
ON-SITE REUSE

YARD PIPING PLAN 2

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
05-C202

SHEET NUMBER **09**

INSTALL 2" POST HYDRANT AND 2" CONNECTION PIPING. COORDINATE LOCATION WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

CHEMICAL BLDG.

CUT AND INSTALL 2" TEE TO SERVE PROPOSED YARD HYDRANT

RAS/WAS PS

CUT AND INSTALL 2" TEE TO SERVE PROPOSED YARD HYDRANT

CUT AND INSTALL 2" TEE ON EXISTING LINE AND CONNECT PROPOSED 2" NPW LINE

FINAL SPLITTER BOX

3'-6"

2'-6"

3'-0"

INSTALL 2" POST HYDRANT AND 2" CONNECTION PIPING. COORDINATE LOCATION WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

FINAL CLARIFIER NO. 1

FINAL CLARIFIER NO. 2

INSTALL 2" ELEVATED HYDRANT ON UPPER LEVEL OF BASIN WITH CONNECTION PIPING. COORDINATE LOCATION WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

INSTALL DRAIN BOX

INSTALL 2" ELEVATED HYDRANT ON UPPER LEVEL OF BASIN WITH CONNECTION PIPING. MAINTAIN SLOPE TO DRAIN BOX ON CONNECTION PIPING. COORDINATE LOCATION AND ROUTING WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

BNR BASINS

INSTALL 2" ELEVATED HYDRANT ON UPPER LEVEL OF BASIN WITH CONNECTION PIPING. COORDINATE LOCATION WITH PLANT STAFF. (PART OF DEDUCTIVE ALTERNATE 3)

INSTALL DRAIN BOX

15'-0"

LINE 5 - BNR LOOP

CUT AND INSTALL 2" TEE TO SERVE PROPOSED YARD HYDRANT

CHLORINE CONTACT & POST AERATION

PROPOSED PUMP STATION

CONTRACTOR TO REMOVE AND INSTALL 4" NPW UNDER EXISTING SIDEWALK AND REPLACE SIDEWALK IN KIND

AEROBIC DIGESTER NO. 5

SLUDGE THICKENER

ELECT. BLDG

INSTALL 4" NPW UNDER EXISTING AIR PIPING BY HAND BORING

BLOWERS

LINE 4 - SW TIE IN

BNR SPLITTER BOX

CONTRACTOR TO REMOVE AND INSTALL 4" NPW UNDER EXISTING SIDEWALK AND REPLACE SIDEWALK IN KIND

PRIMARY CLARIFIER NO. 1

LINE 4 - SW TIE IN

CUT AND INSTALL 4" CROSS WITH 4"x2.5" REDUCERS TO TIE PROPOSED 4" NPW LINE INTO EXISTING 2.5" NPW LINES

INSTALL 4" TEE AND 2-4" V145 VALVES AND BOXES

ELECT. BLDG

0 10' 20' 40' 60'
(IN FEET)

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ARKANSAS ENGINEER

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LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER R. BUTTIN
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER ON-SITE REUSE

YARD PIPING PLAN 3

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

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DRAWING NUMBER
05-C203

SHEET NUMBER 10

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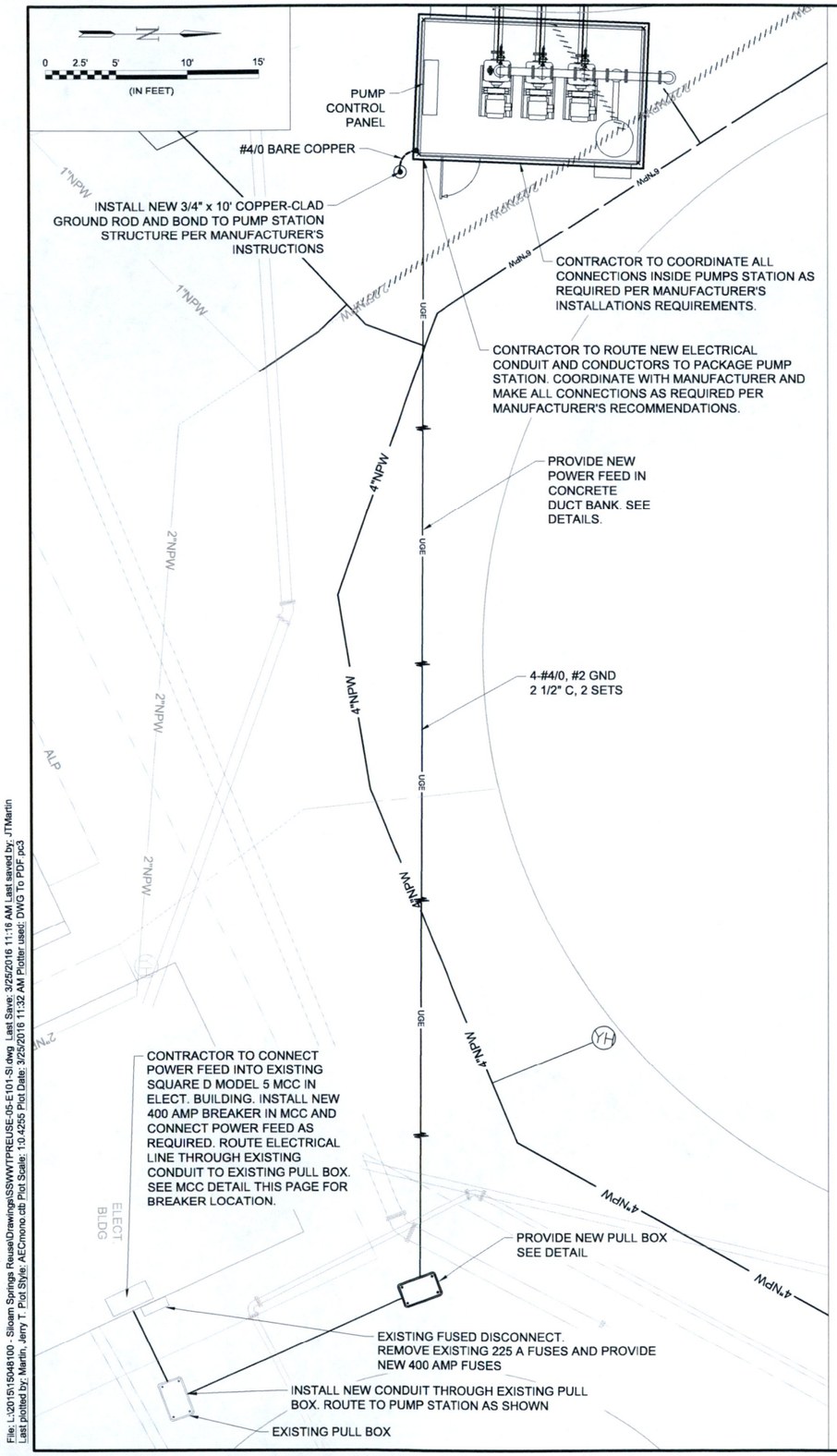
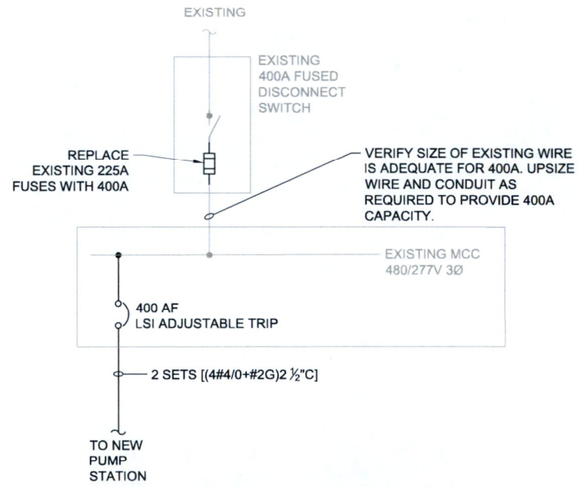
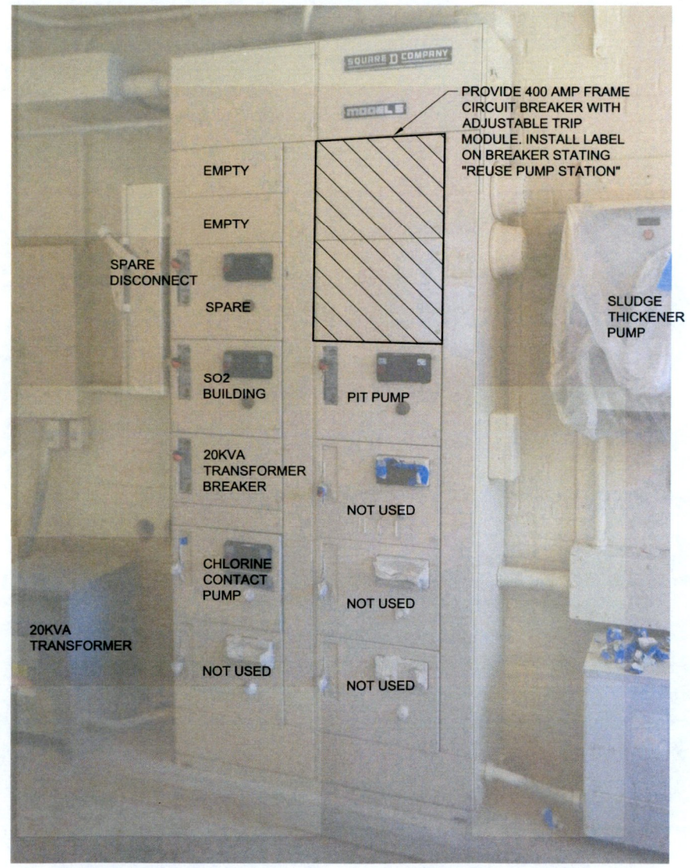


GENERAL NOTES:

1. NUMEROUS UNDERGROUND UTILITIES EXIST THROUGHOUT THE PROJECT SITE. MARK ALL UTILITIES PRIOR TO WORK AND COORDINATE ROUTING WITH EXISTING UTILITIES
2. ALL BELOW GRADE CONDUIT SHALL BE SCHEDULE 40 PVC WITH GALVANIZED ELBOWS IN CONCRETE DUCK BANK.
3. ALL EXPOSED CONDUIT SHALL BE PVC-COATED RIGID STEEL. ALL BOXES, SUPPORTS, HANGERS, UNISTRUT, AND OTHER PORTIONS OF THE CONDUIT SYSTEM SHALL BE PVC-COATED STEEL.
4. THE CONTRACTOR SHALL PROVIDE ALL ITEMS NECESSARY FOR A COMPLETE AND FUNCTIONAL POWER FEED TO THE NEW PUMP STATION.
5. FIELD LOCATE FINAL LOCATIONS OF THE DUCT BANKS AND PULLBOXES. PULLBOXES SHALL BE APPROPRIATELY SIZED BY THE CONTRACTOR FOR THE QUANTITY AND SIZES OF CONDUIT AND WIRE.



PROPOSED ONE-LINE DIAGRAM



EXISTING MCC IN ELECTRICAL BUILDING

GARVER

CERTIFICATE OF AUTHORIZATION
GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No.16232
JONATHAN C. HIFE
Digitally Signed 03/25/2016

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR
SILOAM SPRINGS WASTEWATER ON-SITE REUSE

ELECTRICAL PLAN

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: SHZ
DRAWN BY: JTM

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DRAWING NUMBER
05-E101

SHEET NUMBER **11**

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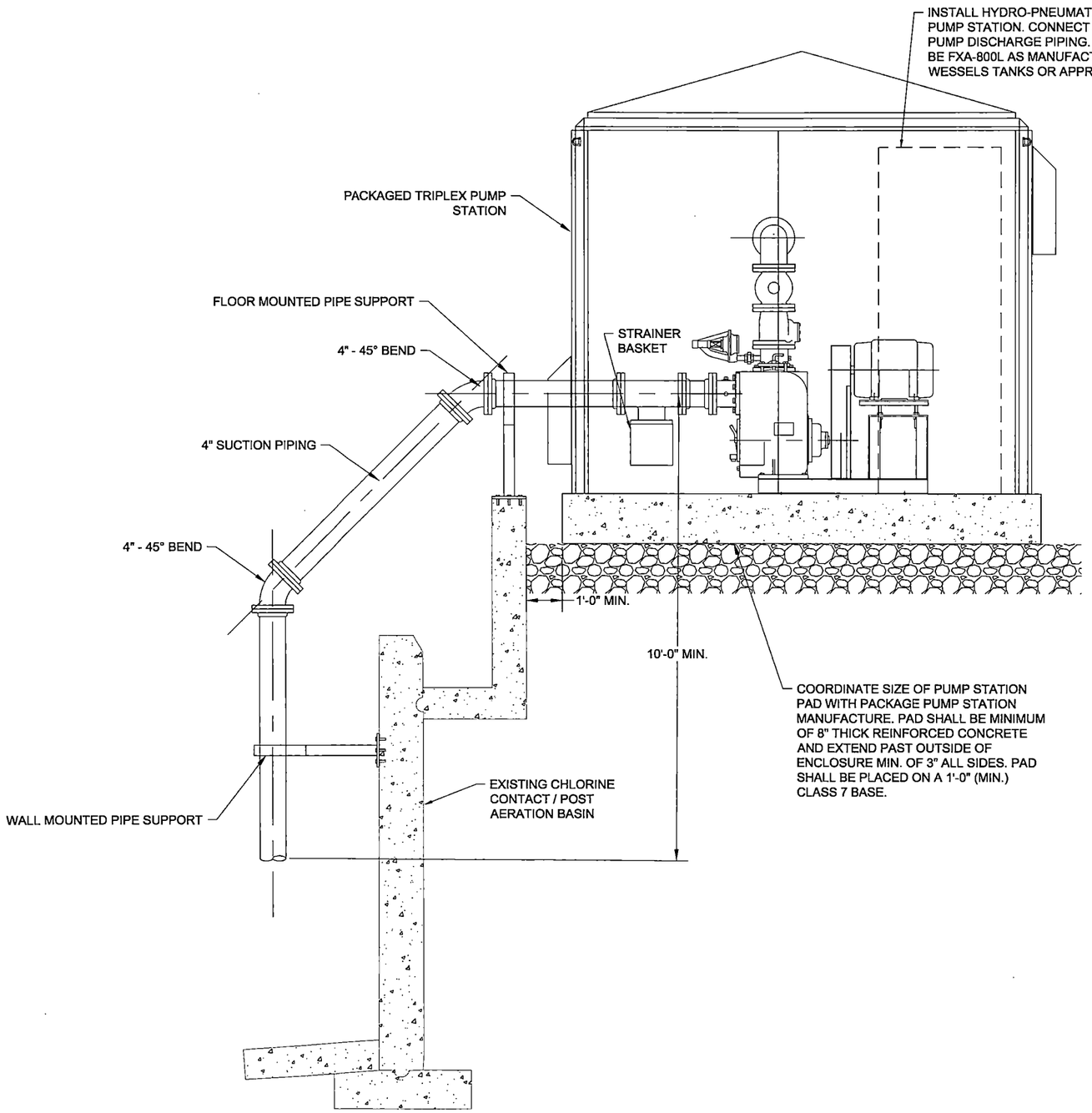
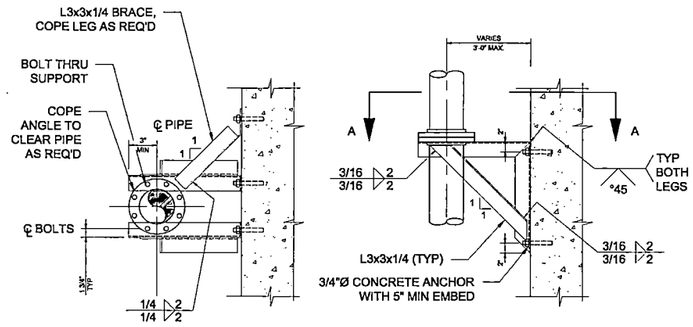
Last plotted by: Martin, Jerry T. Plot Style: AECnono.ctb Plot Scale: 1:0.4259 Plot Date: 3/29/2016 11:32 AM Plotter used: DWG To PDF.pc3



PACKAGE PUMP STATION DETAIL

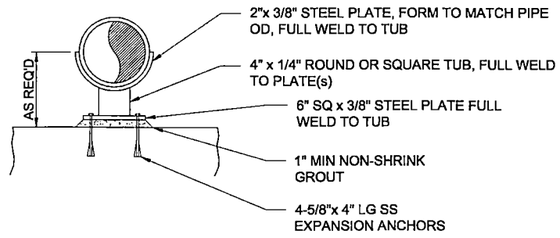


PLAN A-A ELEVATION

NOTES:

1. PIPE SUPPORT IS TO BE USED FOR 4"Ø AND LARGER PIPE.
2. MAXIMUM ALLOWABLE VERTICAL LOAD = 900 POUNDS.
3. IF SUPPORT IS SUBMERGED OR LOCATED BELOW THE TOP OF WALL IN WATER BEARING STRUCTURE, MATERIAL FOR ANCHOR BOLTS AND STRAP SHALL BE STAINLESS STEEL. IN ALL OTHER AREAS, MATERIAL FOR ANCHOR BOLTS AND STRAP SHALL BE HOT-DIP GALVANIZED STEEL UNLESS OTHERWISE INDICATED ON THE DRAWINGS.

WALL MOUNTED VERTICAL PIPE SUPPORT



FLOOR MOUNTED PIPE SUPPORT

GARVER

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GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER R. BUNTIN
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR
SILOAM SPRINGS WASTEWATER ON-SITE REUSE

CIVIL DETAILS 1

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

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DRAWING NUMBER
CD-101

SHEET NUMBER **12**

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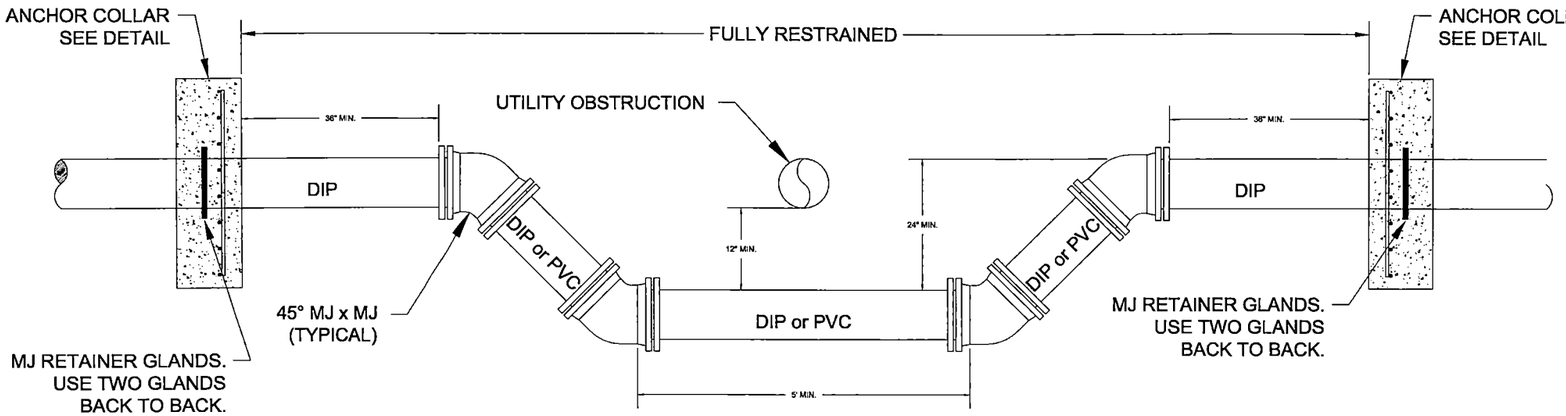
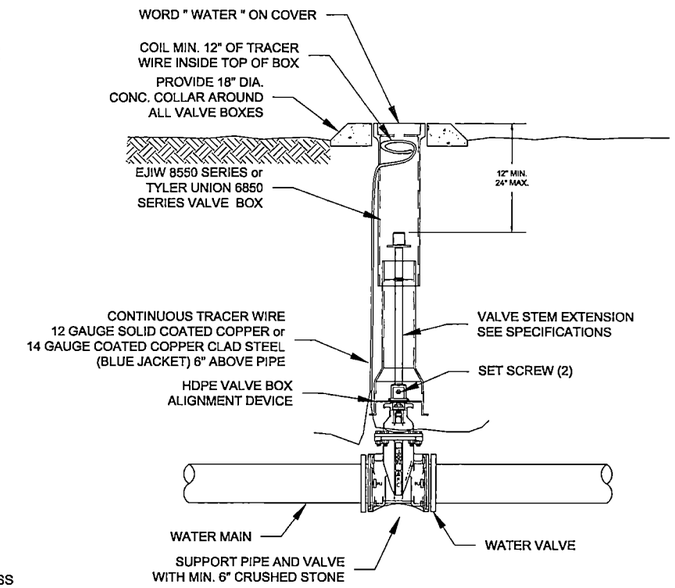
Last plotted by: Martin, Jerry T. Plot Style: AECmono.ctb Plot Scale: 1:1 Plot Date: 3/24/2016 10:56 AM Plotter used: DWG To PDF.pc3



VERTICAL OFFSET

NOTES:

1. OPERATING NUT EXTENSIONS SHALL BE USED WHEN THE TOP OF THE OPERATING NUT IS GREATER THAN 4 FEET FROM THE TOP OF FINISHED SURFACE.
2. THE STEM EXTENSION SHALL BE OF ADEQUATE LENGTH TO REACH FROM THE VALVE OPERATING NUT TO A POINT WITHIN 24-INCHES TO 12-INCHES OF THE FINISHED SURFACE.



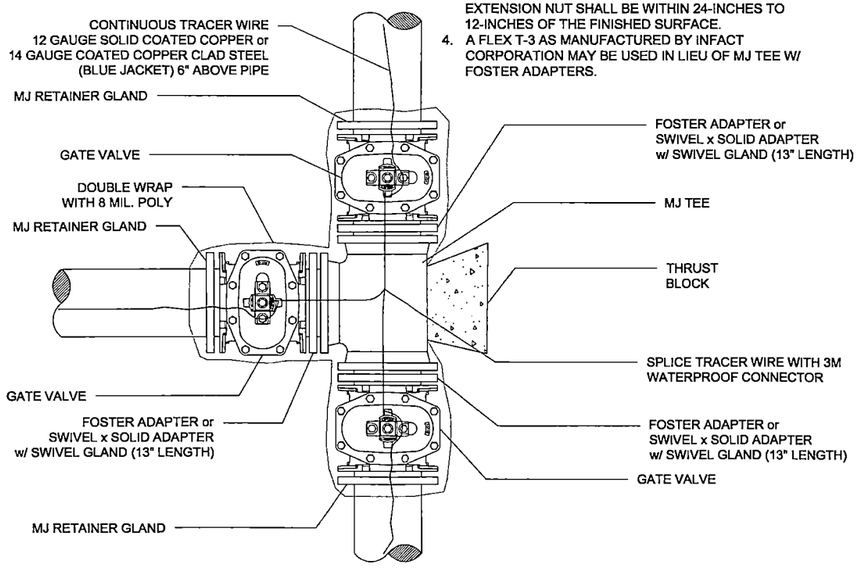
VALVE BOX WITH STEM EXTENSION

PERMITTED VALVES

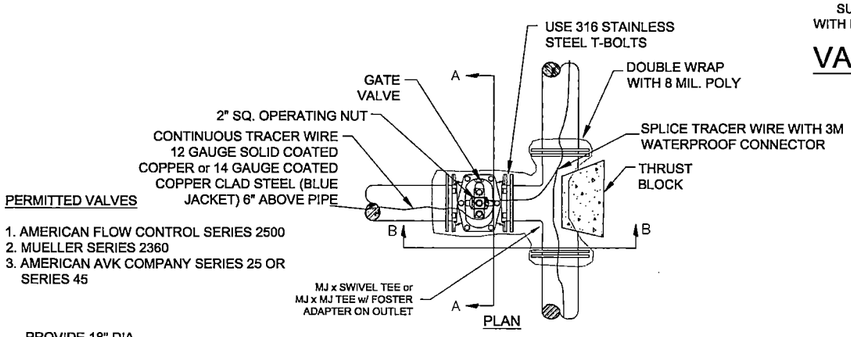
1. AMERICAN FLOW CONTROL SERIES 2500
2. MUELLER SERIES 2360
3. AMERICAN AVK COMPANY SERIES 25 OR SERIES 45

NOTES:

1. ALL VALVES SHALL BE SECURELY ANCHORED TO THE TEE.
2. ALL HARDWARE SHALL BE 316 STAINLESS STEEL.
3. IF DEPTH OF BURY EXCEEDS 4 FT., A VALVE STEM EXTENSION SHALL BE REQUIRED. THE VALVE STEM EXTENSION NUT SHALL BE WITHIN 24-INCHES TO 12-INCHES OF THE FINISHED SURFACE.
4. A FLEX T-3 AS MANUFACTURED BY INFACT CORPORATION MAY BE USED IN LIEU OF MJ TEE W/ FOSTER ADAPTERS.

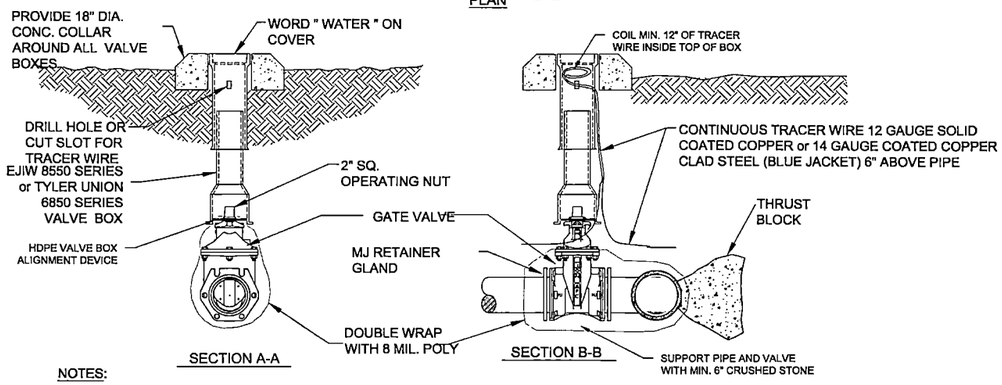


MULTIDIRECTIONAL GATE VALVE DETAIL



PERMITTED VALVES

1. AMERICAN FLOW CONTROL SERIES 2500
2. MUELLER SERIES 2360
3. AMERICAN AVK COMPANY SERIES 25 OR SERIES 45



NOTES:

1. ALL VALVES SHALL BE SECURELY ANCHORED TO THE TEE.
2. ALL HARDWARE SHALL BE 316 STAINLESS STEEL.
3. IF DEPTH OF BURY EXCEEDS 4 FT., A VALVE STEM EXTENSION SHALL BE REQUIRED. THE VALVE STEM EXTENSION NUT SHALL BE WITHIN 24-INCHES TO 12-INCHES OF THE FINISHED SURFACE.

GATE VALVE BOX DETAIL

2" - 12"

GARVER

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GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER B. DUNTIN
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER
ON-SITE REUSE

CIVIL DETAILS 2

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: ~~###~~

BAR IS ONE INCH ON ORIGINAL DRAWING
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DRAWING NUMBER
CD-102

SHEET NUMBER **13**

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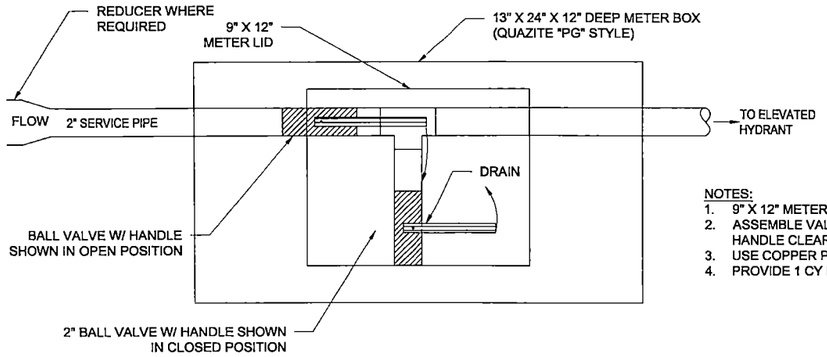
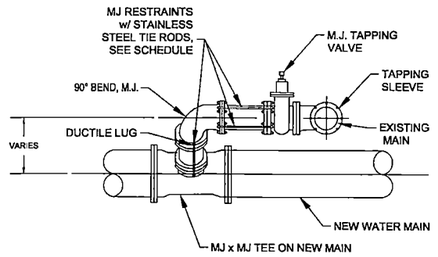
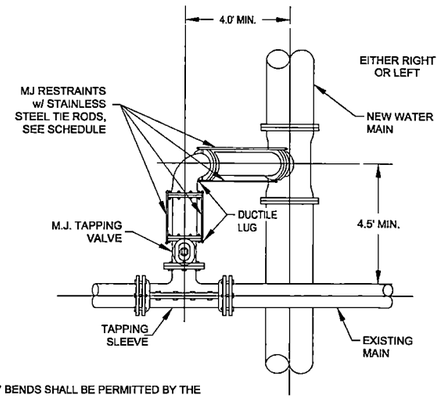


NOTES:
1. 9" X 12" METER LID TO LIFT MORE THAN 90°
2. ASSEMBLE VALVES WITH NIPPLES AS NEEDED FOR HANDLE CLEARANCE AND EASE OF OPERATION
3. USE COPPER PIPE
4. PROVIDE 1 CY ROCK NEST UNDER BOX FOR DRAIN

WATER SHUTOFF/DRAIN ASSEMBLY

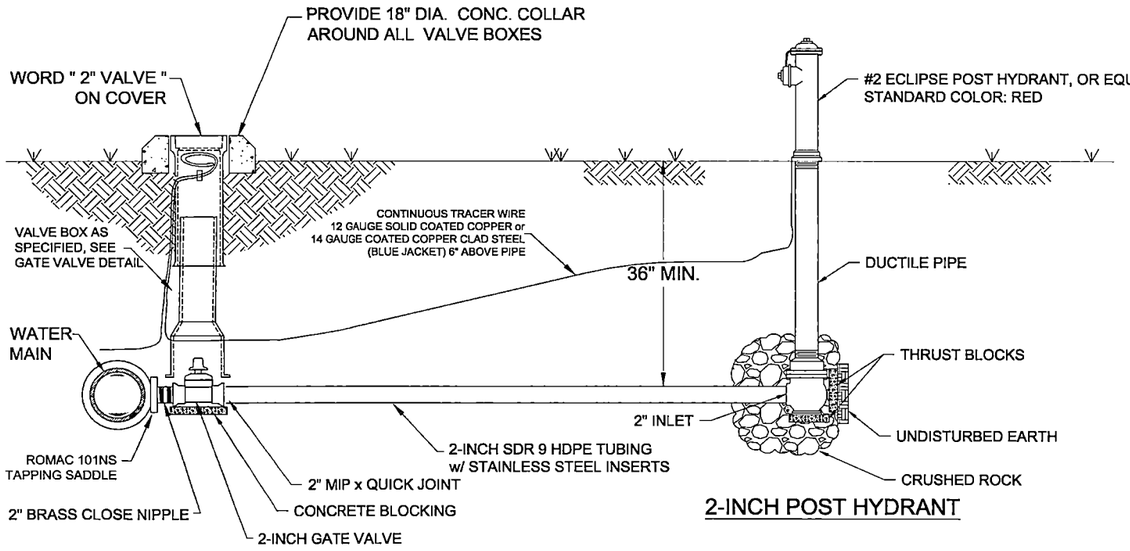


SECTION VIEW



PLAN VIEW

NOTES:
1. SWING CONNECTIONS USING 90° BENDS SHALL BE PERMITTED BY THE CITY ON A CASE BY CASE BASIS.
2. CONTRACTOR SHALL LOCATE EXISTING MAIN IN ADVANCE OF LAYING NEW LINE IN ORDER TO ASSURE ADEQUATE LENGTH TO ADJUST DEPTH OF NEW MAIN.
3. DIMENSIONS SHOWN ARE RECOMMENDED MINIMUMS TO PROVIDE ADEQUATE ROOM FOR TIGHTENING BOLTS ON JOINTS (OTHER DIMENSIONS MAY BE USED).
4. PROVIDE ALL THREAD STAINLESS STEEL TIE RODS WITH DUCTILE LUGS FOR ANCHORING ALL JOINTS.
5. ROTATE TEE UP & ELBOW DOWN AS REQUIRED TO MATCH.
6. TRACER WIRE SHALL BE INSTALLED ON ALL NEW WATER LINES.
7. ALL FITTINGS, VALVES, AND DIP SHALL BE DOUBLE POLY WRAPPED.



2-INCH WATER TAP

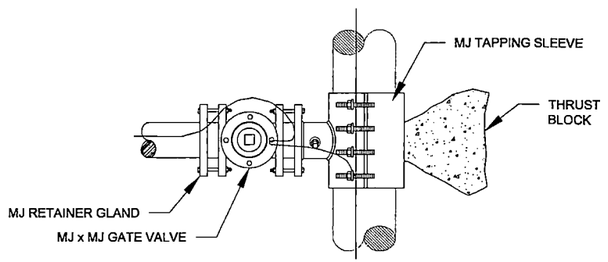
2-INCH POST HYDRANT

NOTES:

1. HYDRANTS SHALL BE SELF-DRAINING, NON-FREEZING, COMPRESSION TYPE WITH 2-3/16" MAIN VALVE OPENING. INLET CONNECTION SHALL BE (2" IP, 2-1/2" IP OR 3" FIP. OUTLET SHALL BE (1-1/4", 1-1/2" 2" OR 2-1/2" IP OR NST).
2. HYDRANTS SHALL HAVE A 3" DUCTILE IRON PIPE RISER WITH A CAST IRON STOCK TOP, AND NON-TURNING OPERATING ROD. PRINCIPAL INTERIOR OPERATING PARTS SHALL BE BRASS AND REMOVABLE FROM THE HYDRANT FOR SERVICING WITHOUT EXCAVATING THE HYDRANT.
3. HYDRANTS SHALL BE SET IN 4 CUBIC FEET OF CRUSHED STONE TO ALLOW FOR PROPER DRAINAGE OF THE HYDRANT. RECOMMENDATIONS OF THE AWWA SHOULD BE FOLLOWED WHEN INSTALLING THE HYDRANTS.
4. POST HYDRANTS SHALL BE ECLIPSE NO. 2 POST HYDRANTS AS MANUFACTURED BY JOHN C. KUPFERLE FOUNDRY COMPANY, ST. LOUIS, MO OR EQUAL.

2" SERVICE LINE AND POST HYDRANT

PROFILE VIEW



PLAN VIEW

NOTES:
1. TAPPING SLEEVE SHALL BE SMITH-BLAIR 663 OR FORD FAST.
2. AFTER THE TAP IS MADE, RE-TORQUE BOLTS ON SLEEVE TO SEAL TO FINAL SHAPE OF PIPE.
3. TAPPING SLEEVE AND VALVE SHALL BE DOUBLE WRAPPED WITH 8 MIL POLY.

TAPPING SLEEVE & VALVE 12" AND SMALLER

GARVER

CERTIFICATE OF AUTHORIZATION GARVER LLC No. 766 ARKANSAS ENGINEER

STATE OF ARKANSAS LICENSED PROFESSIONAL ENGINEER No. 12716 CHRISTOPHER B. BUNTIN

Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP

SILOAM SPRINGS, AR

SILOAM SPRINGS WASTEWATER ON-SITE REUSE

CIVIL DETAILS 3

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

BAR IS ONE INCH ON ORIGINAL DRAWING
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DRAWING NUMBER
CD-103

SHEET NUMBER **14**

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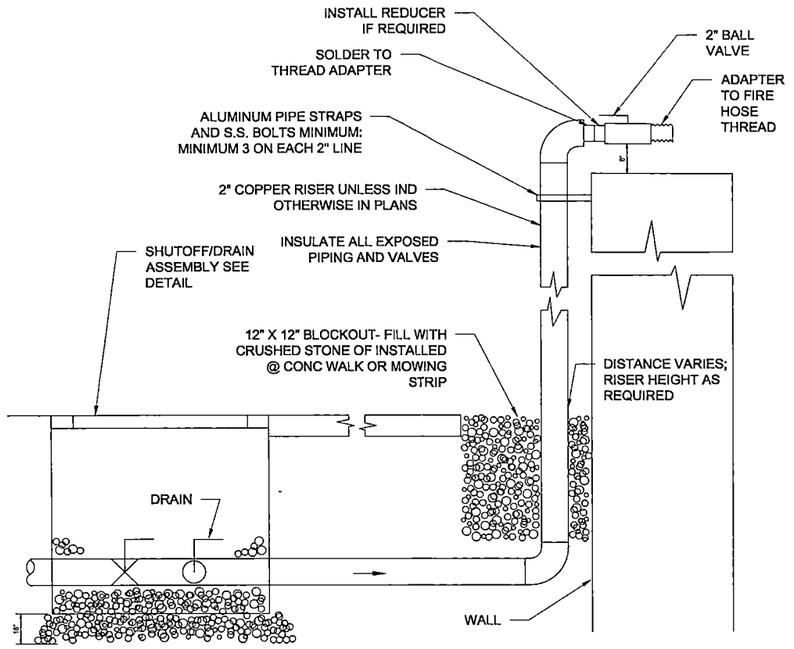
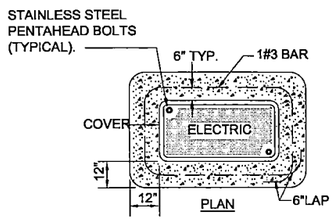
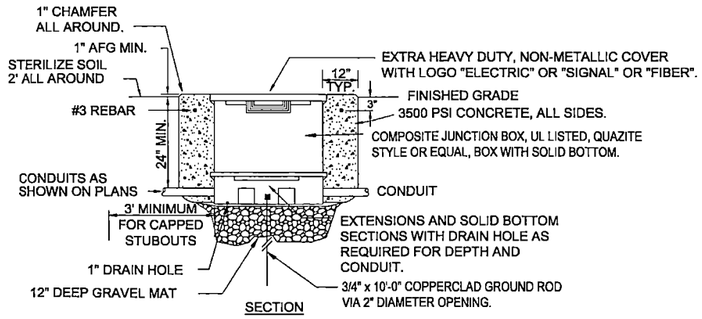


NOTES:

1. RISER HEIGHT AND MOUNTING LOCATION AS SHOWN ON PLANS.
2. PROVIDE 3 ADAPTERS TO ALLOW 1" HOSE TO BE CONNECTED AND 3 ADAPTERS TO ALLOW 3/4" HOSE TO BE CONNECTED TO THE 2" BALL VALVE.
3. ON ALL EXPOSED NON-POTABLE WATER HYDRANTS AND CONNECTIONS, CONTRACTOR SHALL FURNISH MIN 8" x 10" ALUM SIGN STATING "WARNING NON-POTABLE WATER" MOUNTED WITH ALUM OR SS HARDWARE IN AN OBVIOUS, ADJACENT LOCATION (ON HANDRAIL, MT TO CONC TOW, ETC.)

ELEVATED HOSE CONNECTION ON WALLS AND HANDRAILS

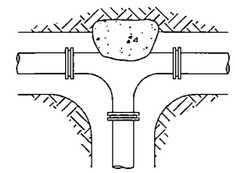




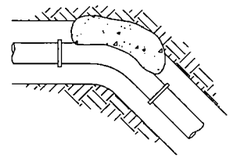
NOTES:

1. UL LISTED PULLBOX AND EXTRA HEAVY-DUTY COVER SHALL BE DESIGNED FOR A TEST LOAD OF 33,750 LBS AND A DESIGN LOAD OF 22,500 LBS.
2. PROVIDE PULLBOX WITH 2-2"C STUBOUTS IN EACH FACE, CAPPED WATERTIGHT.
3. PULLBOX INTERIOR DIMENSIONS SHALL BE 30"L x 17"W x 26"D OR AS REQUIRED FOR NUMBER OF CONDUITS..
4. PROVIDE MINIMUM 3' SLACK CABLE LOOP FOR EACH CABLE.
5. COLOR CODE, TAG AND IDENTIFY ALL CABLES IN UL LISTED PULLBOX.
6. EXACT LOCATION OF EACH UL LISTED PULLBOX SHALL BE APPROVED BY THE OWNER AND ENGINEER.

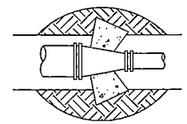
PRECAST PULL BOX DETAIL (PREFAB)



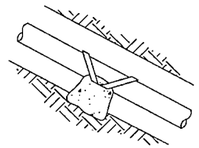
TEE



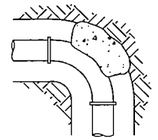
11 1/4°, 22 1/2° AND/OR 45° BEND



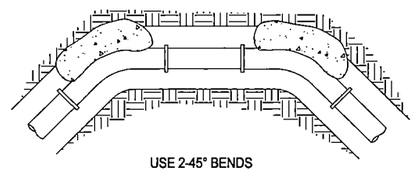
REDUCER



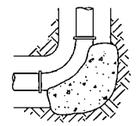
HORIZONTAL RUN



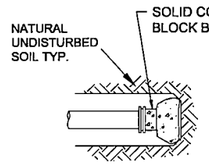
90° BEND *



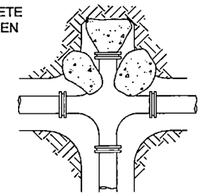
USE 2-45° BENDS IN PLACE OF 90° BEND



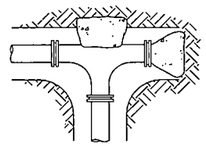
VERTICAL RUN
SEE SHEET W18 FOR VERTICAL TIE-DOWN BLOCKING



END PLUG, CAP OR BLIND FLANGE



CROSS WITH PLUG



TEE WITH PLUG

THRUST BLOCK SCHEDULE
(2000 PSF SOIL, 200 PSI WATER PRESSURE, 100 PSI WATER HAMMER)

BEARING AREA OF THRUST BLOCKS IN SQ. FT. (HORIZONTAL BENDS)						VOLUME OF THRUST BLOCK IN CU. FEET (VERTICAL BENDS)						
FITTING SIZE	PLUG TEE OR CAP	BEND ANGLE 90° *	45°	22 1/2°	11 1/4°	FITTING SIZE	BEND ANGLE 90° *	45°	22 1/2°	11 1/4°	ROD DIAM.	EMBED-MENT
2, 3, & 4	1.9	2.7	1.4	0.7	0.4	2, 3, & 4	35.5	19.2	9.8	4.9	.50"	30"
6	5.6	7.9	4.3	2.2	1.1	6	105.8	57.2	29.2	14.7	.75"	30"
8	9.6	13.6	7.4	3.8	1.9	8	181.9	98.5	50.2	25.2	.75"	30"
12	20.5	29.0	15.7	8.0	4.0	12	387.1	209.5	106.8	53.7	1.0"	30"
16	35.7	50.4	27.3	13.9	7.0	16	672.6	364.0	185.6	93.2	1.0"	36"
18	44.8	63.4	34.3	17.5	18.8	18	844.7	457.2	233.1	117.1	1.0"	36"
24	78.4	110.9	60.0	30.6	15.4	24	1478.7	800.3	408.0	205.0	1.5"	36"

* 90 DEGREE BENDS SHALL ONLY BE USED ON A BY-EXCEPTION BASIS, AND MUST EACH BE SPECIFICALLY APPROVED BY CITY.

THRUST BLOCK NOTES:

1. CONCRETE FOR THRUST BLOCKS - CLASS A CONCRETE SHALL DEVELOP NOT LESS THAN 3000 P.S.I. COMPRESSIVE STRENGTH AT 28 DAYS AND BE PLACED AGAINST UNDISTURBED SOIL.
2. ALL BENDS, BOTH HORIZONTAL AND VERTICAL, SHALL BE BACKED WITH CONCRETE. VERTICAL BENDS SHALL BE PLACED ON CONCRETE PADS WHERE BENDS TURN UP, OR LOADED WHERE BENDS TURN DOWN.
3. DOUBLE WRAP PIPE JOINTS IN 8 MIL "POLYETHLENE" BEFORE PLACING CONCRETE.
4. BEARING AREA SHOWN IN TABLE, IS BASED UPON A 2000 LB/SF. SOIL BEARING, AND UPON A PIPELINE PRESSURE OF 200 psi. PLUS 100 psi. WATER HAMMER. AREAS SHOWN SHALL BE ADJUSTED, SHOULD FIELD CONDITIONS VARY.
5. MJ RESTRAINTS ARE REQUIRED FOR ALL FITTINGS.
6. USE LONG-RADIUS FITTINGS WHEREVER POSSIBLE.
7. ALL BOLTS FOR FITTINGS SHALL BE 316 STAINLESS STEEL.
8. ALL DUCTILE IRON FITTINGS SHALL BE FUSION-BONDED EPOXY COATED INSIDE AND OUTSIDE IN ACCORDANCE WITH ANSI/AWWA C116/A21.16.
9. UNIT WEIGHT OF CONCRETE FOR VERTICAL THRUST BLOCKS IS 150 LBS/CU. FT.
10. ALL CONCRETE SHALL BE FORMED AND FINISHED AND VERIFIED PRIOR TO CONCRETE PLACEMENT.

THRUST BLOCKING

GARVER

CERTIFICATE OF AUTHORIZATION
GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER R. BUNTIN
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR
SILOAM SPRINGS WASTEWATER ON-SITE REUSE

CIVIL DETAILS 4

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
CD-104

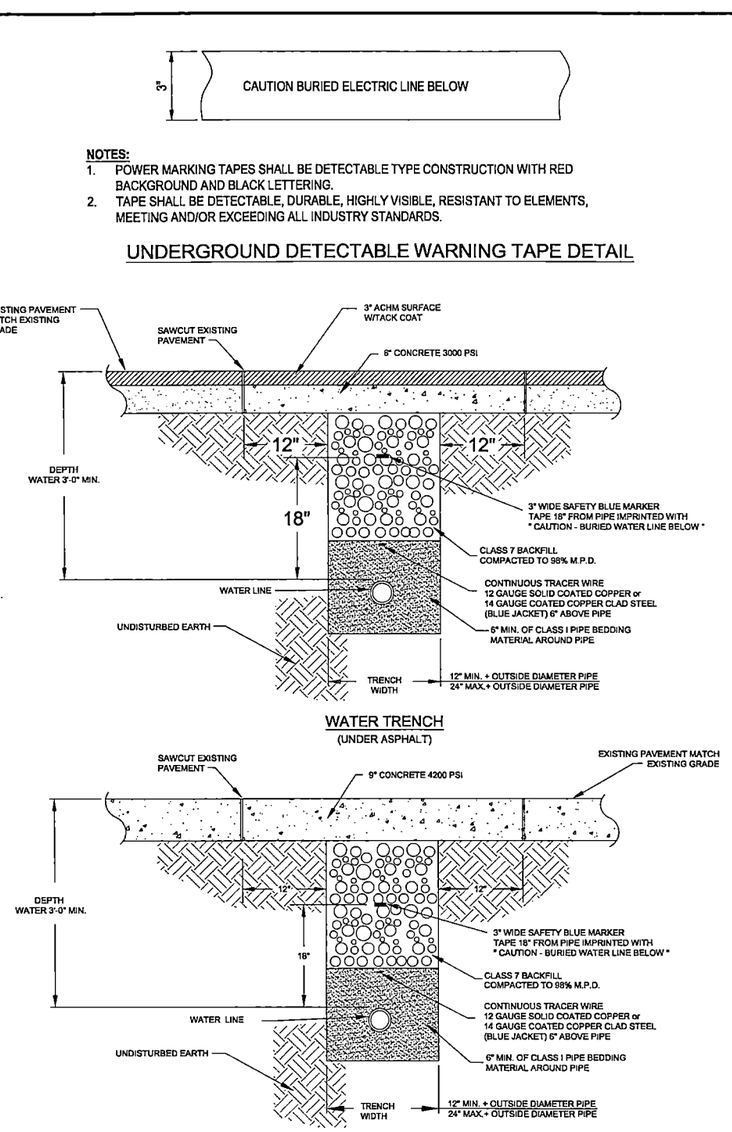
SHEET NUMBER **15**

File: I:\2015\15048100 - Siloam Springs Reuse\D\awings\SSWWTPREUSE-DOT.dwg Last Save: 3/25/2016 10:57 AM Last saved by: JTMartin
Last plotted by: Martin, Jerry T Plot Style: AECmono.ctb Plot Scale: 1:1 Plot Date: 3/25/2016 10:58 AM Plotter used: DWG To PDF.pc3

NOTES:
1. POWER MARKING TAPES SHALL BE DETECTABLE TYPE CONSTRUCTION WITH RED BACKGROUND AND BLACK LETTERING.
2. TAPE SHALL BE DETECTABLE, DURABLE, HIGHLY VISIBLE, RESISTANT TO ELEMENTS, MEETING AND/OR EXCEEDING ALL INDUSTRY STANDARDS.

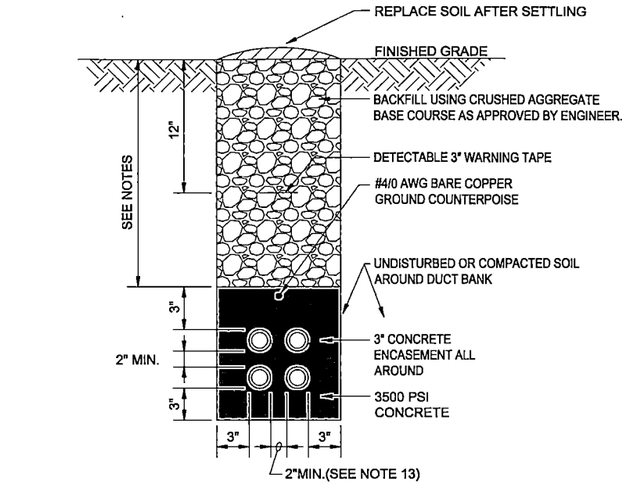
UNDERGROUND DETECTABLE WARNING TAPE DETAIL

WATER TRENCH
(UNDER ASPHALT)



NOTES:
1. ALL VALVES, BENDS, ETC. SHALL BE RESTRAINED.
2. THE CONTRACTOR SHALL PROVIDE ALL ITEMS NECESSARY TO CONNECT WITH ANY PART OF THE EXISTING WATER SYSTEM THAT WILL REMAIN IN ORDER TO ESTABLISH A SATISFACTORY AND ACCEPTABLE WATER SYSTEM.
3. CONTRACTOR TO CONSTRUCT ALL TRENCH EXCAVATION IN ACCORDANCE WITH ALL OSHA REGULATIONS (29 CFR CH.XVII, SUBPART B)
4. TRENCH SHALL BE EXCAVATED BELOW GRADE REQUIRED TO PROVIDE A MINIMUM 36" OF PIPE COVER.
5. MAXIMUM PIPE COVER SHALL BE 60" UNDER NORMAL CONDITIONS. COVER GREATER THAN 60" MAY BE ALLOWED FOR SHORT DISTANCES WHERE REQUIRED BY FIELD CONDITIONS. NO HYDRANT SHALL BE ALLOWED WHERE LINES ARE GREATER THAN 60" DEEP.

(UNDER CONCRETE)

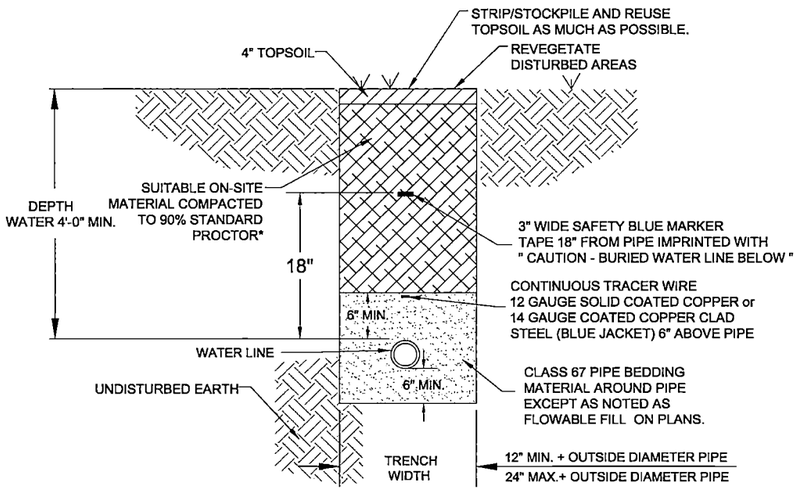


NOTES:
1. CONTRACTOR SHALL STAKE THE DUCT INSTALLATION IN PLAN AND ELEVATION FOR NEW ELECTRICAL DUCTS TO AVOID EXISTING UTILITIES, STAKING PLAN SHALL BE APPROVED BY OWNER AND ENGINEER PRIOR TO WORK.
2. CONTRACTOR SHALL ADJUST THE DEPTH OF THE ELECTRICAL DUCTS AS REQUIRED TO MAINTAIN THE MINIMUM COVER REQUIREMENT INDICATED AND AVOID EXISTING UTILITIES.
3. SIMILAR CONSTRUCTION FOR OTHER DUCT SIZES. SEE ELECTRICAL PLAN SHEETS FOR QUANTITY AND SIZES.
4. INSTALL DUCT CONDUIT SUPPORTS AT 5'-0" O.C. MAXIMUM SPACING. UTILIZE LOCKING COLLARS OR HOLD DOWN BARS WITH ANCHORS TO PREVENT DUCT FLOTATION. (TYPICAL ALL DUCTS).
5. OFFSETS AND BENDS OVER 10 DEGREES AND ELBOWS IN PVC CONDUIT RUNS SHALL BE GRSC.
6. NO PVC SHALL EMERGE FROM THE GROUND OR CONCRETE SLAB OR ENCASEMENT, PVC SHALL CONVERT TO PVC COATED GALVANIZED RIGID STEEL CONDUIT PRIOR TO ITS EMERGENCE UNLESS NOTED OTHERWISE.
7. SPARE PVC COATED GALVANIZED RIGID STEEL CONDUITS SHALL STUB UP 6" ABOVE FINISHED GRADE OR CONCRETE PAD SURFACE AND BE CAPPED WATERTIGHT.
8. INSTALL GROUND RODS AT ENDS OF ELECTRICAL DUCT AND CONNECT TO GROUND RING.
9. INSTALL CONDUCTORS AND CABLES AS NOTED ON DRAWINGS. INSTALL PULL ROPE IN ALL SPARE DUCTS.
10. MINIMUM COVER REQUIREMENT FOR DUCT BANKS UNDER ROADS, DRIVEWAYS AND PARKING LOTS SHALL BE 24".
11. MINIMUM COVER REQUIREMENTS FOR ELECTRICAL SECONDARY SERVICE DUCT BANKS SHALL BE 30".
12. MINIMUM COVER REQUIREMENTS FOR ELECTRICAL PRIMARY SERVICE DUCT BANKS SHALL BE 36".
13. VERTICAL AND HORIZONTAL DISTANCES BETWEEN CONDUITS SHALL BE 3" MINIMUM FOR DUCTS CONTAINING CIRCUITS OVER 600 VOLTS.
14. DUCT BANKS TO EXTEND BELOW FLOOR SLABS.

CONCRETE ENCASED ELECTRICAL DUCT BANK DETAIL

NOTES:
1. ALL VALVES, BENDS, ETC. SHALL BE RESTRAINED.
2. THE CONTRACTOR SHALL PROVIDE ALL ITEMS NECESSARY TO CONNECT WITH ANY PART OF THE EXISTING WATER SYSTEM THAT WILL REMAIN IN ORDER TO ESTABLISH A SATISFACTORY AND ACCEPTABLE WATER SYSTEM.
3. CONTRACTOR TO CONSTRUCT ALL TRENCH EXCAVATION IN ACCORDANCE WITH ALL OSHA REGULATIONS (29 CFR CH.XVII, SUBPART B)
4. TRENCH SHALL BE EXCAVATED BELOW GRADE REQUIRED TO PROVIDE A MINIMUM 36" OF PIPE COVER.
5. MAXIMUM PIPE COVER SHALL BE 60" UNDER NORMAL CONDITIONS. COVER GREATER THAN 60" MAY BE ALLOWED FOR SHORT DISTANCES WHERE REQUIRED BY FIELD CONDITIONS. NO HYDRANT SHALL BE ALLOWED WHERE LINES ARE GREATER THAN 60" DEEP.

WATER MAIN INSTALLATION
PRIOR TO ROADWAY CONSTRUCTION



NOTES:
1. ALL VALVES, BENDS, ETC. SHALL BE RESTRAINED.
2. THE CONTRACTOR SHALL PROVIDE ALL ITEMS NECESSARY TO CONNECT WITH ANY PART OF THE EXISTING WATER SYSTEM THAT WILL REMAIN IN ORDER TO ESTABLISH A SATISFACTORY AND ACCEPTABLE WATER SYSTEM.
3. CONTRACTOR TO CONSTRUCT ALL TRENCH EXCAVATION IN ACCORDANCE WITH ALL OSHA REGULATIONS (29 CFR CH.XVII, SUBPART B)
4. TRENCH SHALL BE EXCAVATED BELOW GRADE REQUIRED TO PROVIDE A MINIMUM 48" OF PIPE COVER.
5. MAXIMUM PIPE COVER SHALL BE 60" UNDER NORMAL CONDITIONS. COVER GREATER THAN 60" MAY BE ALLOWED FOR SHORT DISTANCES WHERE REQUIRED BY FIELD CONDITIONS. NO HYDRANT SHALL BE ALLOWED WHERE LINES ARE GREATER THAN 60" DEEP.
*6. BACKFILL AS SHOWN ON PLANS AT EXISTING AND FUTURE TRAFFIC LOCATIONS SHALL BE COMPACTED CLASS 7 AGGREGATE BASE COMPACTED TO 98% MODIFIED PROCTOR DENSITY.

TRENCHING AND BACKFILL DETAILS

GARVER

CERTIFICATE OF AUTHORIZATION
GARVER LLC
No. 766
ARKANSAS ENGINEER

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 12716
CHRISTOPHER E. BUNTIN
Digitally Signed 3/24/16

REV.	DATE	DESCRIPTION	BY

Siloam Springs

SILOAM SPRINGS WWTP
SILOAM SPRINGS, AR
SILOAM SPRINGS WASTEWATER ON-SITE REUSE

CIVIL DETAILS 5

JOB NO.: 15048100
DATE: MARCH 2106
DESIGNED BY: JTM
DRAWN BY: JTM

BAR IS ONE INCH ON ORIGINAL DRAWING
0 1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

DRAWING NUMBER
CD-105

SHEET NUMBER **16**

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Last plotted by: Martin, Jerry T.: Plot Styles: AEConroso.ctb Plot Scale: 1:1 Plot Date: 3/24/2016 10:57 AM Plotter used: DWG To PDF.pc3

ARKANSAS DEPT ENVIRONMENTAL QUALITY
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NORTH LITTLE ROCK AR 72118-5317
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SHOR - 2100
S:3MR
8716
1:517
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Page 1 of 1

JERRY T MARTIN
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GARVER FAYETTEVILLE, AR
2049 E JOYCE BLVD STE 400
FAYETTEVILLE AR 72703

7 LBS

1 OF 1

DWT: 15,12,3

SHIP TO:
ALAN ANDERSON, ENFORCEMENT ANALYST
5016820635
ARKANSAS DEPT ENVIRONMENTAL QUALITY
5301 NORTHSHORE DRIVE
NORTH LITTLE ROCK AR 72118

AR 722 9-21

UPS GROUND

TRACKING #: 1Z 187 2EW 03 9682 8716

BILLING: P/P

Reference No.1: 15048100
Reference No.2: 050 Final Phase

XOL 16.03.08

NV45 72.0A 01/2016

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(15" x 11" x 3")

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