



**ARTESIAN WASTEWATER MANAGEMENT, INC.
SUSSEX COUNTY, DELAWARE**

**PROJECT MANUAL
CHANDLER STREET PUMPING STATION
TOWN OF MILTON**

DRAFT

**DECEMBER 1, 2023
15737**

TABLE OF CONTENTS

<u>Section</u>	<u>Description</u>	<u>Page No.</u>
IN	Invitation to Bid	IN-1
IB	Instructions to Bidders	IB-1 thru IB-5
BLS	Bid for Lump Sum Contract	BLS-1 thru BLS-4
SV	Schedule of Values	SV-1
NCC	Non-Collusion Certification	NCC-1
CB	Artesian Contractor Background Data Sheet	CB-1 thru CB-5
RL	Release of Liens	RL-1 thru RL-2
GC	General Conditions	GC-1 thru GC-65
SC	Supplementary Conditions	SC-1 thru SC-8

<u>Description</u>	<u>Pages</u>
--------------------	--------------

Division 1 - General Requirements

01100 Summary	01100-1
01290 Payment Procedures	01290-1 to 01290-4
01330 Submittal Procedures	01330-1 to 01330-6
01420 References	01420-1 to 01420-5
01500 Temporary Facilities and Controls	01500-1 to 01500-4
01600 Product Requirements	01600-1 to 01600-4
01700 Execution Requirements	01700-1 to 01700-6
01770 Closeout Procedures	01770-1 to 01770-3

Division 2 – Site Construction

02230 Site Clearing	02230-1 to 02230-4
02240 Dewatering	02240-1 to 02240-2
02300 Earthwork	02300-1 to 02300-11
02530 Sanitary Sewerage	02530-1 to 02530-12
02920 Lawns and Grasses	02920-1 to 02920-9

Division 3 – Concrete

03300 Cast-In-Place Concrete	03300-1 to 03300-13
03400 Precast Structural Concrete	03400-1 to 03400-7

Division 4 – Masonry

04200 Unit Masonry	04200-1 to 04200-9
--------------------	--------------------

Division 5 - Metals

05120 Structural Steel	05120-1 to 05120-4
05310 Steel Deck	05310-1 to 05310-5

05500 Metal Fabrications 05500-1 to 05500-4

Division 6 – Wood

06100 Rough Carpentry 06100-1 to 06100-3

Division 7 – Thermal and Moisture Protection

07190 Water Repellents 07190-1 to 07190-2

07210 Building Insulation 07210-1 to 07210-6

07531 EPDM Membrane Roofing 07531-1 to 07531-6

Division 8 - Doors and Windows

08220 Fiberglass Doors, Frames and Hardware 08220-1 to 08220-3

08712 Door Hardware 08712-1 to 08712-9

Division 9 - Finishes

09912 Painting 09912-1 to 09912-6

Division 10 - Specialties

10520 Fire Protection Specialties 10520-1 to 10520-2

Division 11 - Equipment

11310 Spray Effluent Pumps 11310-1 to 11310-4

Division 15 - Mechanical

15050 Basic Mechanical Materials and Methods 15050-1 to 15050-6

15060 Hangers and Supports 15060-1 to 15060-5

15075 Mechanical Identification 15075-1 to 15075-2

15122 Meters and Gauges 15122-1 to 15122-4

15145 Plumbing 15145-1 to 15145-4

15441 Metering Pump Skid Package 15441-1 to 15441-6

15800 Air Distribution 15800-1 to 15800-3

Division 16 – Electrical

16010 General Provisions 16010-1 to 16010-4

16050 Basic Electrical Materials and Methods 16050-1 to 16050-9

16053 Identification for Electrical Systems 16053-1 to 16053-4

16055 Electrical Testing & Start-Up 16055-1 to 16055-4

16400 Service and Distribution 16400-1 to 16400-4

16426 Main Distribution Switchboard 16426-1 to 16426-5

16460 Electrical Power System Studies 16460-1 to 16460-5

16473	Surge Protection Devices	16473-1 to 16473-4
16482	Motor Control Centers	16482-1 to 16482-7
16483	Variable Frequency Drives	16483-1 to 16483-7
16484	Solid State Starters	16484-1 to 16484-5
16900	Electrical Controls and Instrumentation	16900-1 to 16900-9
16920	Plant Pump Control	16920-1 to 16920-2

APPENDICES

Appendix A - Geotechnical Report

INVITATION TO BID

Sealed bids will be received by Artesian Wastewater Management, Inc. of Newark, Delaware until 5:00 p.m. local time on **December 31, 2023**.

ARTESIAN WASTEWATER MANAGEMENT INC.
CHANDLER STREET PUMPING STATION
TOWN OF MILTON
SUSSEX COUNTY, DELAWARE

A mandatory prebid meeting will be held at southern office of Artesian Water Company, Inc., 664 Churchmans Road, Newark, DE 19702 at 1:00 p.m. local time on **December 12, 2023**.

Bids shall be provided via e-mail to bids@artesianwater.com. Once submitted, a confirmation message will be sent to the sender's e-mail address verifying that the bid was received. If no confirmation is received, it is the Contractor's responsibility to promptly contact Artesian for verification. Bids are **only to be sent** to bids@artesianwater.com. If bids are sent to a second party, the bid may be rejected. Questions may be directed to **Daniel Konstanski at 302-453-2396** and/or dkonstanski@artesianwater.com.

Artesian Wastewater Management, Inc. reserves the right to waive any informalities and to reject any or all bids. No bid may be withdrawn within sixty (60) days after the actual date of the bid opening.

IB - INSTRUCTIONS TO BIDDERS

ARTICLE 1 - DEFINED TERMS

- 1.1 The terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below which are applicable to both the singular and plural thereof:
 - A. Bidder – The individual or entity who submits a Bid directly to the Owner.
 - B. Issuing Office– The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.
 - C. Successful Bidder – The Bidder submitting a responsive bid to whom Owner (on the basis of Owner's evaluations as herein provided) makes an award.
- 1.2 Where appropriate, supplemental definitions of a specific or technical nature are stated in the Specifications or in other portions of the Contract Documents.

ARTICLE 2 - BIDDING DOCUMENTS

- 2.1 Complete sets of the Bidding Documents may be obtained from the Engineer for the non-refundable payment stated in the Invitation to Bid.
 - A. The Engineer is Verdantas LLC
 - B. The Engineer's address is 1060 S Governors Ave #101, Dover, DE 19904.
- 2.2 Complete sets of the Bidding Documents shall be used in preparing bids. Neither the Owner nor Engineer assumes any responsibility for errors or misinterpretation resulting from the use of incomplete sets of the Bidding Documents
- 2.3 Owner and Engineer, in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining bids for the Work and do not confer a license or grant for any other use.

ARTICLE 3 - EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA AND SITE

- 3.1 Before submitting a bid, each Bidder must thoroughly examine the Contract Documents and visit the site to become familiar with all local conditions that may in any way affect the performance of the work. Bidder must comply with all Federal, State, and local laws, ordinances, rules, and regulations affecting the performance of the work. Bidder must carefully correlate observations and determinations regarding the work to be performed with all of the requirements of the Contract Documents.
- 3.2 Before preparing and submitting a bid, each Bidder will, at Bidder's own expense, make such surveys, investigations, and evaluations as Bidder may deem necessary to determine Bidder's bid prices for performance of the work within the terms of the Contract Documents.
- 3.3 By the submission of a bid for the project work, the Bidder makes an incontrovertible representation that Bidder has complied fully with the requirements set forth above.
- 3.4 After bids have been submitted, the Bidder shall not assert that there was a misunderstanding concerning the quantities of work or the nature of the work to be done.

ARTICLE 4 - PRE-BID MEETING

- 4.1 A pre-bid meeting will be held to afford Bidders the opportunity to examine the site of the project work and to discuss with the Owner and Engineer any appropriate items pertaining to the Contract Documents or the project.
- 4.2 The date, time and place for the pre-bid meeting shall be as stated in the Invitation to Bid. Attendance at the pre-bid meeting is mandatory.
- 4.3 No statements or discussions offered at the pre-bid meeting will in any way revise, supplement, or otherwise affect the project requirements as presented in the Contract Documents unless questions raised during the pre-bid meeting are answered by formal written Addenda issued to all parties recorded by the Engineer as having received the Bidding Documents. Such Addenda will become a portion of the Contract Documents and will be binding.

ARTICLE 5 - SITE AND OTHER AREAS

- 5.1 The Site is identified in the Bidding Documents. All additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment to be incorporated in the Work are to be obtained and paid for by the Contractor.
- 5.2 Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by the Owner unless otherwise provided for in the Bidding Documents.

ARTICLE 6 - INTERPRETATIONS AND ADDENDA

- 6.1 All questions regarding the meaning or intent of the Contract Documents shall be submitted to the Owner in writing. Interpretations or clarifications considered necessary by the Owner in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by the Owner as having received the Bidding Documents.
- 6.2 Questions received less than five (5) days prior to the scheduled date of opening of bids may not be answered.
- 6.3 Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications are not a part of the Contract Documents and will be without legal effect.
- 6.4 The Contract Documents contain the provisions required for the construction of the project. Information obtained from an officer, agent, or employee of the Owner or any other person shall not affect the risks or obligations assumed by the Contractor or relieve the Contractor from fulfilling any of the conditions of the Contract.

ARTICLE 7 - CONTRACT TIMES AND LIQUIDATED DAMAGES

- 7.1 The number of days within which the Work is to be substantially completed and completed and ready for final payment will be set forth in the Agreement.

ARTICLE 8 - SUBSTITUTE AND "OR EQUAL" ITEMS

- 8.1 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents, or those substitute or "or-equal" materials and equipment approved by Engineer and identified by Addendum. The materials and equipment described in the Bidding Documents establish a standard of required type, function and quality to be met by any proposed substitute or "or-equal" item.
- 8.2 No item of material or equipment will be considered by Engineer as a substitute or "or-equal" unless written request for approval has been submitted by Bidder and has been received by Engineer at least 7 days prior to the date for receipt of bids. Each such request shall conform to the requirements of Article 7 of the General Conditions. The burden of proof of the merit of the proposed item is upon Bidder.

- 8.3 Engineer's decision of approval or disapproval of a proposed item will be final. If Engineer approves any proposed item, such approval will be set forth in an Addendum issued to all prospective Bidders. Bidders shall not rely upon approvals made in any other manner.

ARTICLE 9 - SUBCONTRACTORS, SUPPLIERS AND OTHERS

- 9.1 The Subcontractor and Supplier Lists on the Bid Form must be fully completed.
- A. Name only one subcontractor for each item.
 - B. As required by the Delaware Code, Title 29, Section 6962, the names and addresses of all Subcontractors who are to perform work and labor must be provided with the Bid Form. Only one (1) Subcontractor for each item shall be named. If a Subcontractor is not intended to be used for a listed item, the Bidder's name shall be inserted for that item. Bidder shall be able to document Bidder's capability to act as a subcontractor in a category that the Bidder's name is inserted. The work must be awarded to the Subcontractor listed, or any substitution must be done in compliance with the above noted Section 6962.
 - C. The work must be awarded to the subcontractor listed. Any substitution must be approved in writing by the Owner. Payment of an amount determined by the Owner up to but not in excess of twenty-five percent (25%) of the subcontract price for each violation will be required of the Contractor for failure to utilize any subcontractor listed in the Bidder's proposal, unless the Contractor substantiates to the satisfaction of the Owner valid conditions for substitution.
 - D. Name the equipment manufacturer on the Suppliers List, not the local or regional sales representative or distributor.
 - E. All subcontractors must be approved by Owner as per the process described in pages CB-1 through CB-5 herein, Artesian Contractor Background Data Sheet.

ARTICLE 10 - PREPARATION OF BID

- 10.1 Submit the separate Bidding Package, consisting of the Bid Form, required documents and attachments electronically. Bids shall be provided via e-mail to bids@artesianwater.com. Once submitted, a confirmation message will be sent to the sender's e-mail address verifying that the bid was received. If no confirmation is received, it is the Contractor's responsibility to promptly contact Artesian for verification. Bids are **only to be sent to bids@artesianwater.com**. If bids are sent to a second party, the bid may be rejected. Questions may be directed **to Daniel Konstanski at 302-453-2396 and/or dkonstanski@artesianwater.com**. The Contract Documents need not be returned with the Bidding Package.
- 10.2 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Bid Form.
- 10.3 The Bid shall contain the Schedule of Values form completed by the Bidder. The schedule of values shall serve as the Bidder's proposed basis for Application for Payment subsequent to Award of Contract and subject to approval by the Owner as described in Section 01290 – Payment Procedures.
- 10.4 A bid by a corporation must be executed in the corporate name by the president or other corporate officer having the necessary authority, and the corporate seal shall be affixed and attested to by the secretary or an assistant secretary of the corporation. The corporate address and state of incorporation shall be shown below the signature.
- 10.5 A bid by a partnership shall be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be shown below the signature.

- 10.6 A bid by a limited liability company shall be executed in the name of the firm by a member and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown below the signature.
- 10.7 A bid by an individual shall show the Bidder's name and official address.
- 10.8 A bid by a joint venture shall be executed by each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown below the signature.
- 10.9 All names shall be typed or printed in ink below the signatures.
- 10.10 The address and telephone number for communications regarding the bid shall be shown.
- 10.11 Each Bid submission shall include the following fully executed documents:
 - A. Bid Form
 - B. Non-Collusion Certification as prescribed in the Bidding Documents.
 - C. Schedule of Values Form

ARTICLE 11 - SUBMITTAL OF BID

- 11.1 Bids shall be submitted at the time and place indicated in the Invitation to Bid or as modified by any Addenda. Any bid received after the time and date specified shall not be considered.
- 11.2 No Bidder may withdraw a bid within sixty (60) days after the actual day of the bid opening. The Owner may, at Owner's sole discretion, release any bid prior to that date.

ARTICLE 12 - MODIFICATION AND WITHDRAWAL OF BID

- 12.1 A bid may be modified or withdrawn by an appropriate document duly executed in the manner that a bid must be executed and delivered electronically prior to the date and time for the opening of bids.
- 12.2 If within 24 hours after bids are opened, any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its bid, that Bidder may withdraw its bid. Thereafter, if the Work is rebid, that Bidder may be disqualified from further bidding on the Work.

ARTICLE 13 - AWARD OF CONTRACT

- 13.1 Owner reserves the right to reject any or all bids, including without limitation, nonconforming, non-responsive, unbalanced, or conditional bids. Owner further reserves the right to reject the bid of any Bidder whom it finds, after reasonable inquiry and evaluation, Owner further reserves the right to reject the lowest bid if the Owner deems the bid to be not responsible. Owner may also reject the bid of any Bidder if Owner believes that it would not be in the best interest of the Project to make an award to that Bidder. Owner also reserves the right to waive all informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder.
- 13.2 More than one bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one bid for the Work may be cause for disqualification of that Bidder and the rejection of all bids in which that Bidder has an interest.
- 13.3 In evaluating bids, Owner will consider whether or not the bids comply with the prescribed requirements, and such alternates, unit prices and other data, as may be requested in the Bid Form or prior to the Notice of Award.

- 13.4 If the Contract is to be awarded, the Owner will give the apparent successful Bidder a Notice of Award within sixty (60) days after the day of the bid opening. Should there be reasons why a contract cannot be awarded within the specified period, the time may be extended by mutual agreement between the Owner and the Bidder.

ARTICLE 14 - SIGNING OF AGREEMENT

- 15.1 When Owner gives a Notice of Award to the Successful Bidder, it shall be accompanied by the required number of unsigned counterparts of the Agreement with the other Contract Documents which are identified in the Agreement as attached thereto.
- 15.2 Within 15 days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner.
- 15.3 Within ten days thereafter, Owner shall deliver one fully signed counterpart to Successful Bidder with a complete set of the Drawings with appropriate identification.

END OF SECTION IB

BID FOR LUMP SUM CONTRACT

Project Identification: Artesian Wastewater Management, Inc. – Chandler Street Pumping Station
Town of Milton, Sussex County, Delaware

Bid submitted by _____, hereinafter referred to as

Bidder, organized and existing under the laws of the State of _____, doing business as (a corporation)(a partnership)(an individual)(a joint venture), to Artesian Wastewater Management, Inc., hereinafter referred to as Owner:

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

2. Bidder accepts all of the terms and conditions of the Invitation to Bid and Instructions to Bidders. This bid will remain subject to acceptance for a period as stated in the Invitation to Bid. Bidder will sign and deliver the required number of counterparts of the Agreement and other documents required by the bidding requirements within fifteen (15) days after the date of Owner's Notice of Award.

3. In submitting this bid, Bidder represents, as more fully set forth in the agreement, that:

- (a) Bidder has examined and carefully studied the Contract Documents and the following addenda receipt of all which is hereby acknowledged: (List Addenda by Addendum Number and Date)

- (b) Bidder has visited the site and become familiar with and is satisfied as to the general, local and site conditions that may affect cost, progress, performance and furnishing of the work;
- (c) Bidder is familiar with and is satisfied as to all federal, state and local laws and regulations that may affect cost, progress, performance and furnishing of the work.

4. The contractor shall begin the contract work as required by the Contract Documents or as directed by the Owner and shall complete the contract within the time schedule specified.

6. Bidder will complete the work in accordance with the Contract Documents for the total lump sum price of (complete the bid entry below for the applicable contract(s) being bid):

Chandler Street Pump Station

_____ (\$ _____)

SUBCONTRACTOR LIST

Bidder proposes to utilize the following subcontractors on this project (complete the entries below for the applicable contract(s) being bid):

Demolition Name: _____

Address: _____

Yard Piping/Force Main Name: _____

Address: _____

Mechanical Name: _____

Address: _____

Electrical Name: _____

Address: _____

Cast-In-Place Concrete Name: _____

Address: _____

Painting Name: _____

Address: _____

Concrete Unit Masonry Name: _____

Address: _____

SUPPLIERS LIST

Bidder proposes to use equipment supplied by the following manufacturers for this project (complete the entries below for the applicable contract(s) being bid):

Submersible Pumps

Name: _____

Address: _____

Yard Piping/Force Main

Name: _____

Address: _____

Precast Structures

Name: _____

Address: _____

Valves/Fittings

Name: _____

Address: _____

Flow Meter

Name: _____

Address: _____

Generator

Name: _____

Address: _____

Variable Frequency Drives

Name: _____

Address: _____

The Bidder understands that the Owner reserves the right to reject any or all bids and to waive any informalities in the bidding.

The Bidder agrees that this bid shall be good and may not be withdrawn for a period as stated in the Advertisement for Bids after the bids are actually received.

Upon receipt of written notice of the acceptance of this bid, Bidder will execute the formal Contract within 15 days as required by the Contract Documents.

Respectfully Submitted:

Bidder

BY: _____

Address

Telephone

Attest: _____
Secretary

SEAL - If Bidder is a Corporation

**ARTESIAN WASTE WATER MANAGEMENT
CHANDLER STREET PUMPING STATION
TOWN OF MILTON
SCHEDULE OF VALUES ⁽¹⁾**

No.	Description	Value
1	Mobilization	\$
2	Earthworks	\$
3	Precast Concrete	\$
4	Cast-In-Place Concrete	\$
5	Masonry	\$
6	Doors, Frames and Hardware	\$
7	Mechanical Piping	\$
8	Electrical Conduits and Wiring	\$
9	Painting	\$
10	Yard Piping/Force Main	\$
11	Electrical	\$
Total		\$

⁽¹⁾ Complete the entries in the schedule of values for the applicable contract(s) being bid.

NON-COLLUSION CERTIFICATION

Bidder's Name: _____

Address: _____

Project: _____

Project No.: _____

This is to certify that neither the above named Bidder, nor any of its officers, partners, owners, agents, representatives, employees or parties in interest, has in any way colluded, conspired, connived or agreed, directly or indirectly, with any other Bidder, firm or person to submit a collusive or sham Bid in connection with the Contract for which the attached Bid has been submitted or to refrain from bidding in connection with such Contract, or has in any manner, directly or indirectly, sought by agreement or collusion or communication or conference with any other Bidder, firm or person to fix the price or prices in the attached Bid or of any other bidder, or to fix any overhead, profit or cost element of the Bid price or the Bid price of any other Bidder, or to secure through any collusion, conspiracy, connivance or unlawful agreement any advantage against the Owner or any person interested in the proposed Contract; and the price or prices quoted in the attached Bid are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees, or parties in interest.

(Signed) _____

Title

Date

SEAL - If Bidder is a Corporation

ATTEST: _____

Secretary



100 YEARS OF SUPERIOR SERVICE

Artesian Water Company, Inc. ▲ Artesian Wastewater Management, Inc. ▲ Artesian Utility Development, Inc.

Dear Contractor:

Artesian would like to thank you for your interest in becoming an Approved Contractor. As an approved contractor, your company will be able to bid on projects. We require that all contractors performing work for Artesian, or on company owned property, go through the approval and renewal process annually.

To become an approved contractor, please fill out the attached documentation and return them to your Artesian contact. To summarize the documents attached, please include the following paperwork when submitting the package:

- Current insurance certificate (be sure to meet our minimum requirements)
- 3 years of an Experience Modification rating from your insurance provider
- 3 years of OSHA 300 and OSHA 300A logs
- Current Delaware Business License
- Current Maryland and/or Pennsylvania Business License if applicable

The Artesian contact will sponsor your company through our approval process. Please allow ten business days after submission of your credentials for the approval process to be completed.

In the future, your company contact, as listed on the first page of the document, will receive a letter annually based on the earliest insurance expiration on the certificate. Any contractor who does not renew the annual documentation within three years of expiration will have to go through the initial approval process again before bidding on any project.

Thank you,

Artesian Water Company



Artesian Contractor Background Data Sheet

(Attach additional pages as necessary)

1. Firm's legal name:
2. Office location(s):
3. Principal office address:
4. Primary contact name and phone number (including cell phone numbers and e-mail addresses):
5. Legal status: Corporation, Partnership, Individual, Join Venture, Other:
6. Type of work (trade) – complete Classification of Services form attached
7. Describe your Construction Capability Profile:
8. Number of years in business:
9. Number of Employees:
10. Jurisdictions your organization is licensed:
11. List key individuals in your organization and indicate who is authorized to sign contracts:
12. Related Parties: If any Owner, Partner, or Officer of your organization is related to ANY employee at Artesian, please list the name and title of that individual, the name of the Artesian employee and relationship:
13. List any judgments, claims arbitration proceedings or suits with regard to construction contracts against your organization or officers:



Artesian Contractor Background Data Sheet

(Attach additional pages as necessary)

14. Has your firm filed any law suits or requested arbitration with regard to construction contracts within the past five years:
15. Within the past five years has your firm failed to complete a construction contract:
16. List major projects that your firm has completed in the last five years
17. Provide three trade references:
18. Name of your insurance company, agent, and contact information:
19. Current Certificate of Insurance. Please meet our minimum requirements per the attached certificate sample. (Attach)
20. OSHA 300 and 300A logs for past three years, if applicable. If three years are not available, please provide explanation. (Attach)
21. Provide your firm's Experience Modification Rate (EMR) for past three years, if applicable. If EMR is greater than 1.0, please include an additional letter from your insurance carrier explaining what attributed to the rate. (Attach as letter from your Worker's Compensation Insurance Carrier)
22. Current Business License (Attach)

Name of Firm: _____

Contact Name: _____

Date Submitted: _____

Classification of Services

Please check the service your company provides:

- Concrete
- Design Build Projects
- Developer
- Electrical
- Engineering Services
- General Contractor
- Geotechnical Services
- Mechanical
- Pipeline
- Plumbing
- Roofing
- Well & Pump
- Other _____
(please describe)

Insurance Certificate Sample

ACORD CERTIFICATE OF LIABILITY INSURANCE		DATE (MM/DD/YYYY)				
PRODUCER		THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.				
INSURED						
		INSURERS AFFORDING COVERAGE				
		NAIC #				
		INSURER A:				
		INSURER B:				
		INSURER C:				
		INSURER D:				
		INSURER E:				
COVERAGES						
THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. AGGREGATE LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.						
INSR ADD'L LTR	INSRD	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS
		GENERAL LIABILITY <input checked="" type="checkbox"/> COMMERCIAL GENERAL LIABILITY <input type="checkbox"/> CLAIMS MADE <input checked="" type="checkbox"/> OCCUR GEN'L AGGREGATE LIMIT APPLIES PER: <input type="checkbox"/> POLICY <input type="checkbox"/> PRO-JECT <input type="checkbox"/> LOC				EACH OCCURRENCE \$ 1,000,000 DAMAGE TO RENTED PREMISES (Ea occurrence) \$ 500,000 MED EXP (Any one person) \$ 5,000 PERSONAL & ADV INJURY \$ 1,000,000 GENERAL AGGREGATE \$ 2,000,000 PRODUCTS - COMP/OP AGG \$ 2,000,000 Umbrella \$ 5,000,000
		AUTOMOBILE LIABILITY <input checked="" type="checkbox"/> ANY AUTO <input type="checkbox"/> ALL OWNED AUTOS <input type="checkbox"/> SCHEDULED AUTOS <input type="checkbox"/> HIRE/ RENTED AUTOS <input type="checkbox"/> NON-OWNED AUTOS <input checked="" type="checkbox"/> \$1,000 Collision Deductible <input checked="" type="checkbox"/> \$1,000 Comprehensive Ded.				COMBINED SINGLE LIMIT (Ea accident) \$ BODILY INJURY (Per person) \$ BODILY INJURY (Per accident) \$ PROPERTY DAMAGE (Per accident) \$ AUTO ONLY - EA ACCIDENT \$ OTHER THAN AUTO ONLY: EA ACC \$ AGG \$
		GARAGE LIABILITY <input type="checkbox"/> ANY AUTO				AUTO ONLY - EA ACCIDENT \$ OTHER THAN AUTO ONLY: EA ACC \$ AGG \$
		EXCESS/UMBRELLA LIABILITY <input checked="" type="checkbox"/> OCCUR <input type="checkbox"/> CLAIMS MADE DEDUCTIBLE \$ RETENTION \$				EACH OCCURRENCE \$ 1,000,000 AGGREGATE \$ 2,000,000 \$ \$ \$
		WORKERS COMPENSATION AND EMPLOYERS' LIABILITY ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUSION? If yes, describe under SPECIAL PROVISIONS below OTHER				<input checked="" type="checkbox"/> WC STATUS: <input type="checkbox"/> OTHER TORY LIMITS E.L. EACH ACCIDENT \$ 500,000 E.L. DISEASE - EA EMPLOYEE \$ 500,000 DISEASE - POLICY LIMIT \$ 500,000
DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES / EXCLUSIONS ADDED BY ENDORSEMENT / SPECIAL PROVISIONS						
CERTIFICATE HOLDER				CANCELLATION		
				SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING INSURER WILL ENDEAVOR TO MAIL _____ DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO DO SO SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE INSURER, ITS AGENTS OR REPRESENTATIVES.		
				AUTHORIZED REPRESENTATIVE		
ACORD 25 (2004/08)				© ACORD CORPORATION 1988		

RELEASE OF LIENS

The undersigned, having received payment in full for all labor, materials, supplies, or equipment supplied to _____ Contractor, or to any subcontractor, in the construction or repair of the improvements known as

_____ upon the property located at

and furnished in the execution and fulfillment of the Contract between said Contractor and

_____, Owner, dated _____, do (does) hereby release and waive any and all claims, liens, and lien rights, of any kind, nature, or description whatsoever, against said property and the Owner thereof, and against said Contractor.

Lienor or Claimant	Signature
	Name (type or print)
	Date

BE IT REMEMBERED That on this _____ day of 20 _____, personally came before me, the subscriber, a Notary Public for the State of Delaware,

who being first duly sworn according to law, did depose and say that the person, firm or corporation that has executed the above Release has furnished, or is contracted to

furnish services, labor or materials in the construction of improvements on the premises described in said Release.

SWORN to and subscribed before me the day and year first above written.

Notary Public

SEAL

This document has important legal consequences; consultation with an attorney is encouraged with respect to its use or modification. This document should be adapted to the particular circumstances of the contemplated Project and the controlling Laws and Regulations.

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by



Issued and Published Jointly by



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1420 King Street, Alexandria, VA 22314-2794

(703) 684-2882

www.nspe.org

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1015 15th Street N.W., Washington, DC 20005

(202) 347-7474

www.acec.org

American Society of Civil Engineers

1801 Alexander Bell Drive, Reston, VA 20191-4400

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

TABLE OF CONTENTS

	Page
Article 1 – Definitions and Terminology	1
1.01 Defined Terms	1
1.02 Terminology	5
Article 2 – Preliminary Matters	6
2.01 Delivery of Bonds and Evidence of Insurance	6
2.02 Copies of Documents	6
2.03 Before Starting Construction	6
2.04 Preconstruction Conference; Designation of Authorized Representatives	7
2.05 Initial Acceptance of Schedules	7
2.06 Electronic Transmittals	7
Article 3 – Documents: Intent, Requirements, Reuse	8
3.01 Intent	8
3.02 Reference Standards	8
3.03 Reporting and Resolving Discrepancies	8
3.04 Requirements of the Contract Documents	9
3.05 Reuse of Documents	10
Article 4 – Commencement and Progress of the Work	10
4.01 Commencement of Contract Times; Notice to Proceed	10
4.02 Starting the Work	10
4.03 Reference Points	10
4.04 Progress Schedule	10
4.05 Delays in Contractor’s Progress	11
Article 5 – Availability of Lands; Subsurface and Physical Conditions; Hazardous Environmental Conditions	12
5.01 Availability of Lands	12
5.02 Use of Site and Other Areas	12
5.03 Subsurface and Physical Conditions	13
5.04 Differing Subsurface or Physical Conditions	14
5.05 Underground Facilities	15

5.06	Hazardous Environmental Conditions at Site	17
Article 6 – Bonds and Insurance		19
6.01	Performance, Payment, and Other Bonds	19
6.02	Insurance—General Provisions	19
6.03	Contractor’s Insurance	20
6.04	Owner’s Liability Insurance	23
6.05	Property Insurance	23
6.06	Waiver of Rights	25
6.07	Receipt and Application of Property Insurance Proceeds	25
Article 7 – Contractor’s Responsibilities		26
7.01	Supervision and Superintendence	26
7.02	Labor; Working Hours	26
7.03	Services, Materials, and Equipment.....	26
7.04	“Or Equals”	27
7.05	Substitutes	28
7.06	Concerning Subcontractors, Suppliers, and Others	29
7.07	Patent Fees and Royalties	31
7.08	Permits	31
7.09	Taxes	32
7.10	Laws and Regulations.....	32
7.11	Record Documents	32
7.12	Safety and Protection.....	32
7.13	Safety Representative	33
7.14	Hazard Communication Programs	33
7.15	Emergencies	34
7.16	Shop Drawings, Samples, and Other Submittals.....	34
7.17	Contractor’s General Warranty and Guarantee.....	36
7.18	Indemnification	37
7.19	Delegation of Professional Design Services	37
Article 8 – Other Work at the Site		38
8.01	Other Work	38
8.02	Coordination	39
8.03	Legal Relationships.....	39

Article 9 – Owner’s Responsibilities.....	40
9.01 Communications to Contractor.....	40
9.02 Replacement of Engineer	40
9.03 Furnish Data	40
9.04 Pay When Due.....	40
9.05 Lands and Easements; Reports, Tests, and Drawings	40
9.06 Insurance	40
9.07 Change Orders.....	40
9.08 Inspections, Tests, and Approvals.....	41
9.09 Limitations on Owner’s Responsibilities	41
9.10 Undisclosed Hazardous Environmental Condition.....	41
9.11 Evidence of Financial Arrangements.....	41
9.12 Safety Programs	41
Article 10 – Engineer’s Status During Construction.....	41
10.01 Owner’s Representative.....	41
10.02 Visits to Site.....	41
10.03 Project Representative.....	42
10.04 Rejecting Defective Work.....	42
10.05 Shop Drawings, Change Orders and Payments.....	42
10.06 Determinations for Unit Price Work	42
10.07 Decisions on Requirements of Contract Documents and Acceptability of Work	42
10.08 Limitations on Engineer’s Authority and Responsibilities.....	42
10.09 Compliance with Safety Program.....	43
Article 11 – Amending the Contract Documents; Changes in the Work	43
11.01 Amending and Supplementing Contract Documents	43
11.02 Owner-Authorized Changes in the Work	44
11.03 Unauthorized Changes in the Work	44
11.04 Change of Contract Price	44
11.05 Change of Contract Times	45
11.06 Change Proposals	45
11.07 Execution of Change Orders.....	46
11.08 Notification to Surety.....	47
Article 12 – Claims.....	47

12.01	Claims	47
Article 13 –	Cost of the Work; Allowances; Unit Price Work.....	48
13.01	Cost of the Work	48
13.02	Allowances	50
13.03	Unit Price Work	51
Article 14 –	Tests and Inspections; Correction, Removal or Acceptance of Defective Work.....	52
14.01	Access to Work.....	52
14.02	Tests, Inspections, and Approvals.....	52
14.03	Defective Work.....	53
14.04	Acceptance of Defective Work.....	53
14.05	Uncovering Work	53
14.06	Owner May Stop the Work	54
14.07	Owner May Correct Defective Work.....	54
Article 15 –	Payments to Contractor; Set-Offs; Completion; Correction Period	55
15.01	Progress Payments.....	55
15.02	Contractor’s Warranty of Title	58
15.03	Substantial Completion.....	58
15.04	Partial Use or Occupancy	59
15.05	Final Inspection	59
15.06	Final Payment.....	59
15.07	Waiver of Claims	61
15.08	Correction Period	61
Article 16 –	Suspension of Work and Termination	62
16.01	Owner May Suspend Work	62
16.02	Owner May Terminate for Cause	62
16.03	Owner May Terminate For Convenience	63
16.04	Contractor May Stop Work or Terminate	63
Article 17 –	Final Resolution of Disputes	64
17.01	Methods and Procedures.....	64
Article 18 –	Miscellaneous	64
18.01	Giving Notice	64
18.02	Computation of Times.....	64
18.03	Cumulative Remedies	64

18.04	Limitation of Damages	65
18.05	No Waiver	65
18.06	Survival of Obligations	65
18.07	Controlling Law	65
18.08	Headings.....	65

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

- A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.
1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
 2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.
 3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
 4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
 5. *Bidder*—An individual or entity that submits a Bid to Owner.
 6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.
 7. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.
 8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued on or after the Effective Date of the Contract.
 9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
 10. *Claim*—(a) A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein: seeking an adjustment of Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract; or (b) a demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal; or seeking resolution of a contractual issue that Engineer

has declined to address. A demand for money or services by a third party is not a Claim.

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

24. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
25. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date or by a time prior to Substantial Completion of all the Work.
26. *Notice of Award*—The written notice by Owner to a Bidder of Owner’s acceptance of the Bid.
27. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.
28. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
29. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor’s plan to accomplish the Work within the Contract Times.
30. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.
31. *Project Manual*—The written documents prepared for, or made available for, procuring and constructing the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.
32. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or “RPR” includes any assistants or field staff of Resident Project Representative.
33. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.
34. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer’s review of the submittals and the performance of related construction activities.
35. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.
36. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.

37. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands furnished by Owner which are designated for the use of Contractor.
38. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
39. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.
40. *Substantial Completion*—The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms “substantially complete” and “substantially completed” as applied to all or part of the Work refer to Substantial Completion thereof.
41. *Successful Bidder*—The Bidder whose Bid the Owner accepts, and to which the Owner makes an award of contract, subject to stated conditions.
42. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
43. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.
44. *Technical Data*—Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (a) subsurface conditions at the Site, or physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) or (b) Hazardous Environmental Conditions at the Site. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then the data contained in boring logs, recorded measurements of subsurface water levels, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical or environmental report prepared for the Project and made available to Contractor are hereby defined as Technical Data with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06.
45. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including but not limited to those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, fiber optic transmissions, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.
46. *Unit Price Work*—Work to be paid for on the basis of unit prices.
47. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.

48. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 Terminology

- A. The words and terms discussed in the following paragraphs are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.
- B. *Intent of Certain Terms or Adjectives:*
 1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.
- C. *Day:*
 1. The word “day” means a calendar day of 24 hours measured from midnight to the next midnight.
- D. *Defective:*
 1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - a. does not conform to the Contract Documents; or
 - b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 - c. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or 15.04).
- E. *Furnish, Install, Perform, Provide:*
 1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.
 2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
 4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words “furnish,” “install,” “perform,” or “provide,” then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.
- F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

- A. *Bonds*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.
- B. *Evidence of Contractor’s Insurance*: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract), the certificates and other evidence of insurance required to be provided by Contractor in accordance with Article 6.
- C. *Evidence of Owner’s Insurance*: After receipt of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or otherwise), the certificates and other evidence of insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

- A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.
- B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

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

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

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.03.A, procedures for handling Shop Drawings, Samples, and other submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.
- B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.05 *Initial Acceptance of Schedules*

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

2.06 *Electronic Transmittals*

- A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may transmit, and shall accept, Project-related correspondence, text, data, documents, drawings, information, and graphics, including but not limited to Shop Drawings and other submittals, in electronic media or digital format, either directly, or through access to a secure Project website.
- B. If the Contract does not establish protocols for electronic or digital transmittals, then Owner, Engineer, and Contractor shall jointly develop such protocols.
- C. When transmitting items in electronic media or digital format, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items resulting from the recipient's use of software application packages, operating systems, or

computer hardware differing from those used in the drafting or transmittal of the items, or from those established in applicable transmittal protocols.

ARTICLE 3 – DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

- A. The Contract Documents are complementary; what is required by one is as binding as if required by all.
- B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents.
- C. Unless otherwise stated in the Contract Documents, if there is a discrepancy between the electronic or digital versions of the Contract Documents (including any printed copies derived from such electronic or digital versions) and the printed record version, the printed record version shall govern.
- D. The Contract supersedes prior negotiations, representations, and agreements, whether written or oral.
- E. Engineer will issue clarifications and interpretations of the Contract Documents as provided herein.

3.02 *Reference Standards*

- A. Standards Specifications, Codes, Laws and Regulations
 - 1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard specification, manual, reference standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.
 - 2. No provision of any such standard specification, manual, reference standard, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

- A. *Reporting Discrepancies:*
 - 1. *Contractor's Verification of Figures and Field Measurements:* Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict,

error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.

2. *Contractor's Review of Contract Documents:* If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.
3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies:*

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

3.04 *Requirements of the Contract Documents*

- A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work thereunder.
- B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.
- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Owner and Contractor that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

- A. Contractor and its Subcontractors and Suppliers shall not:
 - 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or
 - 2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.
- B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

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

4.02 *Starting the Work*

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

4.03 *Reference Points*

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

4.04 *Progress Schedule*

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

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 11.
- B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

- A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Times and Contract Price. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
- B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.
- C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:
1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
 2. abnormal weather conditions;
 3. acts or failures to act of utility owners (other than those performing other work at or adjacent to the Site by arrangement with the Owner, as contemplated in Article 8); and
 4. acts of war or terrorism.
- D. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5.
- E. Paragraph 8.03 governs delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.
- F. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor.

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

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

5.01 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.
- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.
- C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

5.02 *Use of Site and Other Areas*

A. *Limitation on Use of Site and Other Areas:*

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

by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

- B. *Removal of Debris During Performance of the Work:* During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.
- C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.
- D. *Loading of Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

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

5.04 *Differing Subsurface or Physical Conditions*

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

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

- B. *Engineer's Review:* After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine the necessity of Owner's obtaining additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A above; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.
- C. *Owner's Statement to Contractor Regarding Site Condition:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.
- D. *Possible Price and Times Adjustments:*
1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, or both, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. such condition must fall within any one or more of the categories described in Paragraph 5.04.A;
 - b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03; and,

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

5.05 *Underground Facilities*

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

becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.

- C. *Engineer's Review:* Engineer will promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the Underground Facility in question; determine the extent, if any, to which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and advise Owner in writing of Engineer's findings, conclusions, and recommendations. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.
- D. *Owner's Statement to Contractor Regarding Underground Facility:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question, addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.
- E. *Possible Price and Times Adjustments:*
 - 1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, or both, to the extent that any existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Underground Facility in question;
 - b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
 - c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times; and
 - d. Contractor gave the notice required in Paragraph 5.05.B.
 - 2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.
 - 3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

5.06 *Hazardous Environmental Conditions at Site*

- A. *Reports and Drawings*: The Supplementary Conditions identify:
1. those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
 2. Technical Data contained in such reports and drawings.
- B. *Reliance by Contractor on Technical Data Authorized*: Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:
1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or
 2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or
 3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.
- D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.
- E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.

- F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.
- G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off.
- H. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.
- I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.H shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6 – BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

- A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of Contractor's obligations under the Contract. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the Supplementary Conditions, or other specific provisions of the Contract. Contractor shall also furnish such other bonds as are required by the Supplementary Conditions or other specific provisions of the Contract.
- B. All bonds shall be in the form prescribed by the Contract except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (as amended and supplemented) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. A bond signed by an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed the accompanying bond.
- C. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds in the required amounts.
- D. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state or jurisdiction where any part of the Project is located, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements above.
- E. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.
- F. Upon request, Owner shall provide a copy of the payment bond to any Subcontractor, Supplier, or other person or entity claiming to have furnished labor or materials used in the performance of the Work.

6.02 *Insurance—General Provisions*

- A. Owner and Contractor shall obtain and maintain insurance as required in this Article and in the Supplementary Conditions.
- B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.
- C. Contractor shall deliver to Owner, with copies to each named insured and additional insured (as identified in this Article, in the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Contractor has obtained and is

maintaining the policies, coverages, and endorsements required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

- D. Owner shall deliver to Contractor, with copies to each named insured and additional insured (as identified in this Article, the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Owner has obtained and is maintaining the policies, coverages, and endorsements required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.
- E. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, shall not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.
- F. If either party does not purchase or maintain all of the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.
- G. If Contractor has failed to obtain and maintain required insurance, Owner may exclude the Contractor from the Site, impose an appropriate set-off against payment, and exercise Owner's termination rights under Article 16.
- H. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect to obtain equivalent insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and the Contract Price shall be adjusted accordingly.
- I. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests.
- J. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner and other individuals and entities in the Contract.

6.03 *Contractor's Insurance*

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

4. Foreign voluntary worker compensation (if applicable).
- B. *Commercial General Liability—Claims Covered:* Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against:
1. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees.
 2. claims for damages insured by reasonably available personal injury liability coverage.
 3. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.
- C. *Commercial General Liability—Form and Content:* Contractor's commercial liability policy shall be written on a 1996 (or later) ISO commercial general liability form (occurrence form) and include the following coverages and endorsements:
1. Products and completed operations coverage:
 - a. Such insurance shall be maintained for three years after final payment.
 - b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.
 2. Blanket contractual liability coverage, to the extent permitted by law, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
 3. Broad form property damage coverage.
 4. Severability of interest.
 5. Underground, explosion, and collapse coverage.
 6. Personal injury coverage.
 7. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.
 8. For design professional additional insureds, ISO Endorsement CG 20 32 07 04, "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.
- D. *Automobile liability:* Contractor shall purchase and maintain automobile liability insurance against claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy shall be written on an occurrence basis.
- E. *Umbrella or excess liability:* Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the paragraphs above. Subject to industry-standard exclusions, the coverage afforded shall follow form as to each and every one of the underlying policies.
- F. *Contractor's pollution liability insurance:* Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result

of pollution conditions arising from Contractor's operations and completed operations. This insurance shall be maintained for no less than three years after final completion.

- G. *Additional insureds*: The Contractor's commercial general liability, automobile liability, umbrella or excess, and pollution liability policies shall include and list as additional insureds Owner and Engineer, and any individuals or entities identified in the Supplementary Conditions; include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds; and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Contractor shall obtain all necessary endorsements to support these requirements.
- H. *Contractor's professional liability insurance*: If Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance shall provide protection against claims arising out of performance of professional design or related services, and caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by Contractor itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.
- I. *General provisions*: The policies of insurance required by this Paragraph 6.03 shall:
 - 1. include at least the specific coverages provided in this Article.
 - 2. be written for not less than the limits of liability provided in this Article and in the Supplementary Conditions, or required by Laws or Regulations, whichever is greater.
 - 3. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 10 days prior written notice has been given to Contractor. Within three days of receipt of any such written notice, Contractor shall provide a copy of the notice to Owner, Engineer, and each other insured under the policy.
 - 4. remain in effect at least until final payment (and longer if expressly required in this Article) and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract Documents.
 - 5. be appropriate for the Work being performed and provide protection from claims that may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable.
- J. The coverage requirements for specific policies of insurance must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

6.04 *Owner's Liability Insurance*

- A. In addition to the insurance required to be provided by Contractor under Paragraph 6.03, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.
- B. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

6.05 *Property Insurance*

- A. *Builder's Risk*: Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the full insurable replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:
 - 1. include the Owner and Contractor as named insureds, and all Subcontractors, and any individuals or entities required by the Supplementary Conditions to be insured under such builder's risk policy, as insureds or named insureds. For purposes of the remainder of this Paragraph 6.05, Paragraphs 6.06 and 6.07, and any corresponding Supplementary Conditions, the parties required to be insured shall collectively be referred to as "insureds."
 - 2. be written on a builder's risk "all risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire; lightning; windstorm; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; flood; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; water damage (other than that caused by flood); and such other perils or causes of loss as may be specifically required by the Supplementary Conditions. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise, such insurance may be provided through other insurance policies acceptable to Owner and Contractor.
 - 3. cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.
 - 4. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects).

5. extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier).
 6. extend to cover damage or loss to insured property while in transit.
 7. allow for partial occupation or use of the Work by Owner, such that those portions of the Work that are not yet occupied or used by Owner shall remain covered by the builder's risk insurance.
 8. allow for the waiver of the insurer's subrogation rights, as set forth below.
 9. provide primary coverage for all losses and damages caused by the perils or causes of loss covered.
 10. not include a co-insurance clause.
 11. include an exception for ensuing losses from physical damage or loss with respect to any defective workmanship, design, or materials exclusions.
 12. include performance/hot testing and start-up.
 13. be maintained in effect, subject to the provisions herein regarding Substantial Completion and partial occupancy or use of the Work by Owner, until the Work is complete.
- B. *Notice of Cancellation or Change:* All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 6.05 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured.
- C. *Deductibles:* The purchaser of any required builder's risk or property insurance shall pay for costs not covered because of the application of a policy deductible.
- D. *Partial Occupancy or Use by Owner:* If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide notice of such occupancy or use to the builder's risk insurer. The builder's risk insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy; rather, those portions of the Work that are occupied or used by Owner may come off the builder's risk policy, while those portions of the Work not yet occupied or used by Owner shall remain covered by the builder's risk insurance.
- E. *Additional Insurance:* If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.05, it may do so at Contractor's expense.
- F. *Insurance of Other Property:* If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, such as tools, construction equipment, or other personal property owned by Contractor, a Subcontractor, or an employee of Contractor or a Subcontractor, then the entity or individual owning such property item will be responsible for deciding whether to insure it, and if so in what amount.

6.06 *Waiver of Rights*

- A. All policies purchased in accordance with Paragraph 6.05, expressly including the builder's risk policy, shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all Subcontractors, all individuals or entities identified in the Supplementary Conditions as insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.
- B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for:
 - 1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and
 - 2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06.
- C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 6.06.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them.
- D. Contractor shall be responsible for assuring that the agreement under which a Subcontractor performs a portion of the Work contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by builder's risk insurance and any other property insurance applicable to the Work.

6.07 *Receipt and Application of Property Insurance Proceeds*

- A. Any insured loss under the builder's risk and other policies of insurance required by Paragraph 6.05 will be adjusted and settled with the named insured that purchased the

policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.

- B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.05 shall distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.
- C. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the money so received applied on account thereof, and the Work and the cost thereof covered by Change Order, if needed.

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

7.01 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.02 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.
- B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner's written consent, which will not be unreasonably withheld.

7.03 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or not such items are specifically called for in the Contract Documents.
- B. All materials and equipment incorporated into the Work shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and

guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

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

7.04 "Or Equals"

- A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or equal" item is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment, or items from other proposed suppliers under the circumstances described below.
 - 1. If Engineer in its sole discretion determines that an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer shall deem it an "or equal" item. For the purposes of this paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that:
 - 1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;
 - 2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
 - 3) it has a proven record of performance and availability of responsive service; and
 - 4) it is not objectionable to Owner.
 - b. Contractor certifies that, if approved and incorporated into the Work:
 - 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.
- B. *Contractor's Expense:* Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.
- C. *Engineer's Evaluation and Determination:* Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal", which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.

- D. *Effect of Engineer's Determination:* Neither approval nor denial of an "or-equal" request shall result in any change in Contract Price. The Engineer's denial of an "or-equal" request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents.
- E. *Treatment as a Substitution Request:* If Engineer determines that an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item, Contractor may request that Engineer consider the proposed item as a substitute pursuant to Paragraph 7.05.

7.05 *Substitutes*

- A. Unless the specification or description of an item of material or equipment required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment under the circumstances described below. To the extent possible such requests shall be made before commencement of related construction at the Site.
 - 1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of material or equipment from anyone other than Contractor.
 - 2. The requirements for review by Engineer will be as set forth in Paragraph 7.05.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.
 - 3. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:
 - a. shall certify that the proposed substitute item will:
 - 1) perform adequately the functions and achieve the results called for by the general design,
 - 2) be similar in substance to that specified, and
 - 3) be suited to the same use as that specified.
 - b. will state:
 - 1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times,
 - 2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and
 - 3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.
 - c. will identify:
 - 1) all variations of the proposed substitute item from that specified, and

- 2) available engineering, sales, maintenance, repair, and replacement services.
 - d. shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.
- B. *Engineer's Evaluation and Determination:* Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.
 - C. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
 - D. *Reimbursement of Engineer's Cost:* Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.
 - E. *Contractor's Expense:* Contractor shall provide all data in support of any proposed substitute at Contractor's expense.
 - F. *Effect of Engineer's Determination:* If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.05.D, by timely submittal of a Change Proposal.

7.06 *Concerning Subcontractors, Suppliers, and Others*

- A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner.
- B. Contractor shall retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of designated parts of the Work if required by the Contract to do so.
- C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against which Contractor has reasonable objection.
- D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable, during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed acceptable to Owner unless Owner raises a substantive, reasonable objection within five days.

- E. Owner may require the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors, Suppliers, or other individuals or entities for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor, Supplier, or other individual or entity so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity.
- F. If Owner requires the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, or both, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.
- G. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.
- H. On a monthly basis Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.
- I. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions.
- J. Contractor shall be solely responsible for scheduling and coordinating the work of Subcontractors, Suppliers, and all other individuals or entities performing or furnishing any of the Work.
- K. Contractor shall restrict all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed herein.
- L. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.
- M. All Work performed for Contractor by a Subcontractor or Supplier shall be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer.
- N. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor on account of Work performed for Contractor by the particular Subcontractor or Supplier.

O. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier, or other individual or entity; nor
2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

7.07 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.
- B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.
- C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device not specified in the Contract Documents.

7.08 *Permits*

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

7.09 *Taxes*

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

7.10 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It shall not be Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.
- C. Owner or Contractor may give notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of such notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.11 *Record Documents*

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

7.12 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:
 - 1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site, when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property or work in progress.
 - C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.
 - D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.
 - E. All damage, injury, or loss to any property referred to in Paragraph 7.12.A.2 or 7.12.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
 - F. Contractor's duties and responsibilities for safety and protection shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 15.06.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).
 - G. Contractor's duties and responsibilities for safety and protection shall resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.13 *Safety Representative*

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

7.14 *Hazard Communication Programs*

- A. Contractor shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or

exchanged between or among employers at the Site in accordance with Laws or Regulations.

7.15 *Emergencies*

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

7.16 *Shop Drawings, Samples, and Other Submittals*

A. *Shop Drawing and Sample Submittal Requirements:*

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

- B. *Submittal Procedures for Shop Drawings and Samples:* Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals. Each submittal will be identified as Engineer may require.

1. *Shop Drawings:*

- a. Contractor shall submit the number of copies required in the Specifications.
- b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to

provide and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.D.

2. *Samples:*
 - a. Contractor shall submit the number of Samples required in the Specifications.
 - b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 7.16.D.
3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.
- C. *Other Submittals:* Contractor shall submit other submittals to Engineer in accordance with the accepted Schedule of Submittals, and pursuant to the applicable terms of the Specifications.
- D. *Engineer's Review:*
 1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
 2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.
 3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
 4. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the requirements of the Contract Documents in a Field Order.
 5. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 7.16.A and B.
 6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, shall not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.
 7. Neither Engineer's receipt, review, acceptance or approval of a Shop Drawing, Sample, or other submittal shall result in such item becoming a Contract Document.

8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.D.4.

E. *Resubmittal Procedures:*

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

7.17 *Contractor's General Warranty and Guarantee*

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on Contractor's warranty and guarantee.
- B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
 1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 2. normal wear and tear under normal usage.
- C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:
 1. observations by Engineer;
 2. recommendation by Engineer or payment by Owner of any progress or final payment;
 3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
 4. use or occupancy of the Work or any part thereof by Owner;
 5. any review and approval of a Shop Drawing or Sample submittal;
 6. the issuance of a notice of acceptability by Engineer;
 7. any inspection, test, or approval by others; or
 8. any correction of defective Work by Owner.

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

7.18 *Indemnification*

- A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.
- B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.
- C. The indemnification obligations of Contractor under Paragraph 7.18.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:
 - 1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or
 - 2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

7.19 *Delegation of Professional Design Services*

- A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable Laws and Regulations.
- B. If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other submittals prepared by such professional. Shop

Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

- C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.
- D. Pursuant to this paragraph, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 7.16.D.1.
- E. Contractor shall not be responsible for the adequacy of the performance or design criteria specified by Owner or Engineer.

ARTICLE 8 – OTHER WORK AT THE SITE

8.01 *Other Work*

- A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.
- B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any utility work at or adjacent to the Site, Owner shall provide such information to Contractor.
- C. Contractor shall afford each other contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.
- D. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 8, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

8.02 *Coordination*

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

8.03 *Legal Relationships*

- A. If, in the course of performing other work at or adjacent to the Site for Owner, the Owner's employees, any other contractor working for Owner, or any utility owner causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment shall take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract. When applicable, any such equitable adjustment in Contract Price shall be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
- B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due to Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this paragraph.
- C. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due to Contractor.

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

ARTICLE 9 – OWNER'S RESPONSIBILITIES

9.01 *Communications to Contractor*

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

9.02 *Replacement of Engineer*

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

9.03 *Furnish Data*

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

9.04 *Pay When Due*

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

9.05 *Lands and Easements; Reports, Tests, and Drawings*

- A. Owner's duties with respect to providing lands and easements are set forth in Paragraph 5.01.
- B. Owner's duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.
- C. Article 5 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

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

9.07 *Change Orders*

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

9.08 *Inspections, Tests, and Approvals*

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

9.09 *Limitations on Owner's Responsibilities*

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

9.10 *Undisclosed Hazardous Environmental Condition*

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

9.11 *Evidence of Financial Arrangements*

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

9.12 *Safety Programs*

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

ARTICLE 10 – ENGINEER'S STATUS DURING CONSTRUCTION

10.01 *Owner's Representative*

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

10.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.
- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.08. Particularly, but without limitation, during

or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Project Representative*

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

10.04 *Rejecting Defective Work*

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

10.05 *Shop Drawings, Change Orders and Payments*

- A. Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, are set forth in Paragraph 7.16.
- B. Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, are set forth in Paragraph 7.19.
- C. Engineer's authority as to Change Orders is set forth in Article 11.
- D. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.06 *Determinations for Unit Price Work*

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

10.07 *Decisions on Requirements of Contract Documents and Acceptability of Work*

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

10.08 *Limitations on Engineer's Authority and Responsibilities*

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

- B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.
- D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 15.06.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.
- E. The limitations upon authority and responsibility set forth in this Paragraph 10.08 shall also apply to the Resident Project Representative, if any.

10.09 *Compliance with Safety Program*

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

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

11.01 *Amending and Supplementing Contract Documents*

- A. The Contract Documents may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
 - 1. *Change Orders:*
 - a. If an amendment or supplement to the Contract Documents includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order. A Change Order also may be used to establish amendments and supplements of the Contract Documents that do not affect the Contract Price or Contract Times.
 - b. Owner and Contractor may amend those terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, without the recommendation of the Engineer. Such an amendment shall be set forth in a Change Order.
 - 2. *Work Change Directives:* A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.04 regarding change of Contract Price. Contractor must submit any Change Proposal seeking an

adjustment of the Contract Price or the Contract Times, or both, no later than 30 days after the completion of the Work set out in the Work Change Directive. Owner must submit any Claim seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 60 days after issuance of the Work Change Directive.

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

11.02 *Owner-Authorized Changes in the Work*

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

11.03 *Unauthorized Changes in the Work*

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

11.04 *Change of Contract Price*

- A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment of Contract Price shall comply with the provisions of Article 12.
- B. An adjustment in the Contract Price will be determined as follows:
 1. where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03); or
 2. where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.04.C.2); or
 3. where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on

the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.04.C).

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

11.05 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of Article 12.
- B. An adjustment of the Contract Times shall be subject to the limitations set forth in Paragraph 4.05, concerning delays in Contractor's progress.

11.06 *Change Proposals*

- A. Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; appeal an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under

the Contract. The Change Proposal shall specify any proposed change in Contract Times or Contract Price, or both, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents.

1. *Procedures:* Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 30 days) after the start of the event giving rise thereto, or after such initial decision. The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal. The supporting data shall be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event. Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal.
 2. *Engineer's Action:* Engineer will review each Change Proposal and, within 30 days after receipt of the Contractor's supporting data, either deny the Change Proposal in whole, approve it in whole, or deny it in part and approve it in part. Such actions shall be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.
 3. *Binding Decision:* Engineer's decision will be final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.
- B. *Resolution of Certain Change Proposals:* If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice shall be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

11.07 Execution of Change Orders

- A. Owner and Contractor shall execute appropriate Change Orders covering:
1. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
 2. changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;
 3. changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.02, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters; and
 4. changes in the Contract Price or Contract Times, or other changes, which embody the substance of any final and binding results under Paragraph 11.06, or Article 12.

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

11.08 *Notification to Surety*

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

ARTICLE 12 – CLAIMS

12.01 *Claims*

- A. *Claims Process:* The following disputes between Owner and Contractor shall be submitted to the Claims process set forth in this Article:
 - 1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
 - 2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents; and
 - 3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters.
- B. *Submittal of Claim:* The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim shall rest with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, or both, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.
- C. *Review and Resolution:* The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim shall be stated in writing and submitted to the other party, with a copy to Engineer.
- D. *Mediation:*
 - 1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate shall stay the Claim submittal and response process.
 - 2. If Owner and Contractor agree to mediation, then after 60 days from such agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process shall resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim

submittal and decision process shall resume as of the date of the conclusion of the mediation, as determined by the mediator.

3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.
- E. *Partial Approval*: If the party receiving a Claim approves the Claim in part and denies it in part, such action shall be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.
- F. *Denial of Claim*: If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim shall be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.
- G. *Final and Binding Results*: If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim shall be incorporated in a Change Order to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

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

13.01 *Cost of the Work*

- A. *Purposes for Determination of Cost of the Work*: The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:
 1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or
 2. To determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.
- B. *Costs Included*: Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 13.01.C, and shall include only the following items:
 1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, and vacation and holiday pay applicable

thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case the cash discounts shall accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.
3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.
4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.
5. Supplemental costs including the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.
 - c. Rentals of all construction equipment and machinery, and the parts thereof, whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.
 - d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
 - e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
 - f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 6.05), provided such losses and damages have resulted from causes

other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

- g. The cost of utilities, fuel, and sanitary facilities at the Site.
- h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
- i. The costs of premiums for all bonds and insurance that Contractor is required by the Contract Documents to purchase and maintain.

C. *Costs Excluded:* The term Cost of the Work shall not include any of the following items:

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

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

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

13.02 Allowances

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

- B. *Cash Allowances*: Contractor agrees that:
 - 1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
 - 2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.
- C. *Contingency Allowance*: Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.
- D. Prior to final payment, an appropriate Change Order will be issued as recommended by Engineer to reflect actual amounts due Contractor on account of Work covered by allowances, and the Contract Price shall be correspondingly adjusted.

13.03 *Unit Price Work*

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
- D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of the following paragraph.
- E. Within 30 days of Engineer's written decision under the preceding paragraph, Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price if:
 - 1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement;
 - 2. there is no corresponding adjustment with respect to any other item of Work; and
 - 3. Contractor believes that it is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price, and the parties are unable to agree as to the amount of any such increase or decrease.

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

14.01 Access to Work

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

14.02 Tests, Inspections, and Approvals

- A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.
- B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work shall be governed by the provisions of Paragraph 14.05.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.
- D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:
 - 1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;
 - 2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;
 - 3. by manufacturers of equipment furnished under the Contract Documents;
 - 4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and
 - 5. for acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work.

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

- E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.
- F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering shall be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to

cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

- A. *Contractor's Obligation:* It is Contractor's obligation to assure that the Work is not defective.
- B. *Engineer's Authority:* Engineer has the authority to determine whether Work is defective, and to reject defective Work.
- C. *Notice of Defects:* Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.
- D. *Correction, or Removal and Replacement:* Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.
- E. *Preservation of Warranties:* When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.
- F. *Costs and Damages:* In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

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

14.05 *Uncovering Work*

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

- B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.
- C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.
 - 1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.
 - 2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

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

14.07 *Owner May Correct Defective Work*

- A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, then Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.
- B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.
- C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will

include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

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

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

15.01 Progress Payments

- A. *Basis for Progress Payments:* The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.
- B. *Applications for Payments:*
1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens, and evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.
 2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
 3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.
- C. *Review of Applications:*
1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
 2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

- a. the Work has progressed to the point indicated;
 - b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and
 - c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.
3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
- a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
 - b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.
4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
- a. to supervise, direct, or control the Work, or
 - b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
 - d. to make any examination to ascertain how or for what purposes Contractor has used the money paid on account of the Contract Price, or
 - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.
6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:
- a. the Work is defective, requiring correction or replacement;
 - b. the Contract Price has been reduced by Change Orders;
 - c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
 - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or

- e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.

D. *Payment Becomes Due:*

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

E. *Reductions in Payment by Owner:*

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

remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed shall be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.

3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 15.01.C.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

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

15.03 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.
- B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
- C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which shall fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.
- D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

- E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.
- F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

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

15.05 *Final Inspection*

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

15.06 *Final Payment*

- A. *Application for Payment:*
 - 1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of

inspection, annotated record documents (as provided in Paragraph 7.11), and other documents, Contractor may make application for final payment.

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

B. *Engineer's Review of Application and Acceptance:*

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

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

D. *Payment Becomes Due:* Thirty days after the presentation to Owner of the final Application for Payment and accompanying documentation, the amount recommended by Engineer (less any further sum Owner is entitled to set off against Engineer's recommendation,

including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions above with respect to progress payments) will become due and shall be paid by Owner to Contractor.

15.07 *Waiver of Claims*

- A. The making of final payment will not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 15.05, from Contractor's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, from outstanding Claims by Owner, or from Contractor's continuing obligations under the Contract Documents.
- B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted or appealed under the provisions of Article 17.

15.08 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents, or by any specific provision of the Contract Documents), any Work is found to be defective, or if the repair of any damages to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas used by Contractor as permitted by Laws and Regulations, is found to be defective, then Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:
 - 1. correct the defective repairs to the Site or such other adjacent areas;
 - 2. correct such defective Work;
 - 3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
 - 4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting therefrom.
- B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others).
- C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

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

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

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

16.02 *Owner May Terminate for Cause*

- A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:
 - 1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule);
 - 2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
 - 3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or
 - 4. Contractor's repeated disregard of the authority of Owner or Engineer.
- B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) ten days written notice that Owner is considering a declaration that Contractor is in default and termination of the contract, Owner may proceed to:
 - 1. declare Contractor to be in default, and give Contractor (and any surety) notice that the Contract is terminated; and
 - 2. enforce the rights available to Owner under any applicable performance bond.
- C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.
- D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within seven days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.
- E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses,

and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

- F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.
- G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond shall govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate For Convenience*

- A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
 - 1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
 - 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and
 - 3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.
- B. Contractor shall not be paid on account of loss of anticipated overhead, profits, or revenue, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

- A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.
- B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for

expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

- A. *Disputes Subject to Final Resolution:* The following disputed matters are subject to final resolution under the provisions of this Article:
 - 1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full; and
 - 2. Disputes between Owner and Contractor concerning the Work or obligations under the Contract Documents, and arising after final payment has been made.
- B. *Final Resolution of Disputes:* For any dispute subject to resolution under this Article, Owner or Contractor may:
 - 1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions; or
 - 2. agree with the other party to submit the dispute to another dispute resolution process; or
 - 3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18 – MISCELLANEOUS

18.01 *Giving Notice*

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

18.02 *Computation of Times*

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

18.03 *Cumulative Remedies*

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

18.04 *Limitation of Damages*

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

18.05 *No Waiver*

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

18.06 *Survival of Obligations*

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

18.07 *Controlling Law*

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

18.08 *Headings*

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

Artesian Water Company

SUPPLEMENTARY CONDITIONS

Supplementary Conditions

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract, EJCDC® C-700 (2018 Edition). All provisions that are not so amended or supplemented remain in full force and effect.

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

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

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

SC-1.01 *Defined Terms*

SC-1.01.20 Change the definition of Engineer to mean Artesian Water Company, Inc.'s Engineering Department or their designated representative.

ARTICLE 2 – PRELIMINARY MATTERS

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

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

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

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

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

- 1. Duffield Geotechnical Report

SC-5.06 Hazardous Environmental Conditions

SC 5.06 Delete Paragraphs 5.06.A and 5.06.B in their entirety and insert the following:

- A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner.
- B. Not Used.

ARTICLE 6 – BONDS AND INSURANCE

SC-6.02 Add the following paragraph immediately after Paragraph 6.02.B:

- 1. Contractor may obtain worker’s compensation insurance from an insurance company that has not been rated by A.M. Best, provided that such company (a) is domiciled in the state in which the project is located, (b) is certified or authorized as a worker’s compensation insurance provider by the appropriate state agency, and (c) has been accepted to provide worker’s compensation insurance for similar projects by the state within the last 12 months. Artesian Water Company must be named as “Additional Insured” under the policy coverage. Notice of Cancellation must be provided by written notice thirty (30) days prior to any termination of coverage.

SC-6.03 Contractor’s Liability Insurance

SC 6.03 Add the following new paragraph immediately after Paragraph 6.03.J:

- K. The limits of liability for the insurance required by Paragraph 6.03 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

- 1. Workers’ Compensation, and related coverages under Paragraphs 6.03.A.1 and A.2 of the General Conditions:

State:	<u>Statutory</u>
Federal, if applicable:	<u>Statutory</u>
Employer’s Liability:	
Bodily injury, each accident	\$ <u>500,000</u>
Bodily injury by disease, each employee	\$ <u>500,000</u>
Bodily injury/disease aggregate	\$ <u>500,000</u>

2. Contractor's Commercial General Liability under Paragraphs 6.03.B and 6.03.C of the General Conditions:

General Aggregate	\$ <u>2,000,000</u>
Products - Completed Operations Aggregate	\$ <u>2,000,000</u>
Personal and Advertising Injury	\$ <u>1,000,000</u>
Each Occurrence (Bodily Injury and Property Damage)	\$ <u>1,000,000</u>
Damage to rented premises	\$ <u>500,000</u>
Medical expense	\$ <u>5,000</u>

3. Automobile Liability under Paragraph 6.03.D. of the General Conditions:

Combined Single Limit of	\$ <u>1,000,000</u>
Collision deductible (max)	\$ <u>1,000</u>
Comprehensive deductible (max)	\$ <u>1,000</u>

4. Excess or Umbrella Liability:

Per Occurrence	\$ <u>5,000,000</u>
General Aggregate	\$ <u>5,000,000</u>

5. Contractor's Pollution Liability:

Each Occurrence	\$ <u>5,000,000</u>
General Aggregate	\$ <u>5,000,000</u>

If line is checked, Contractor is not required to provide Contractor's Pollution Liability insurance under this Contract

7. Contractor's Professional Liability:

Each Claim	\$ <u>1,000,000</u>
Deductible (Max)	\$ <u>25,000</u>

ARTICLE 7 – CONTRACTOR'S RESPONSIBILITIES

SC-7.02.B. Add the following new subparagraphs immediately after Paragraph 7.02.B:

1. Regular working hours will be 7:00 AM to 5:00 PM

2. Owner's legal holidays are:

NEW YEAR'S DAY

MARTIN LUTHER KING DAY

GOOD FRIDAY

MEMORIAL DAY

INDEPENDENCE DAY

LABOR DAY

Artesian Water Company

EJCDC® C-800, Guide to the Preparation of Supplementary Conditions.

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VETERANS DAY
THANKSGIVING DAY
DAY AFTER THANKSGIVING
CHRISTMAS HOLIDAY
DAY AFTER or BEFORE CHRISTMAS
NEW YEAR'S EVE

SC-7.06.D. Add the following new subparagraphs immediately after Paragraph 7.06.D:

Any Subcontractor submitted must be registered with the Owner. It is the responsibility of the Contractor to determine whether the Subcontractor is already registered with the Owner and, if not, to register the Subcontractor with the Owner. The method of registration shall be determined by the Owner and supplied to the Contractor at the Contractor's request.

ARTICLE 8 – OTHER WORK AT THE SITE

SC-8.02 Coordination

SC-8.02 Delete Paragraph 8.02.A in its entirety and replace with the following:

- A. Owner intends to contract with others for the performance of other work at or adjacent to the Site.**
- 1. The Owner shall have authority and responsibility for coordination of the various contractors and work forces at the Site;**
 - 2. The following specific matters are to be covered by such authority and responsibility: coordination with Artesian on Start-up and SCADA Integrator;**

9 – OWNER'S RESPONSIBILITIES

SC-9.13 Add the following new paragraph immediately after Paragraph 9.12 of the General Conditions:

SC-9.13 Owner will furnish an "Owner's Site Representative" to represent Owner at the Site and assist Owner in observing the progress and quality of the Work. Owner's Site Representative will be a representative from Artesian Water Company Inc's Engineering Department. The authority and responsibilities of Owner's Site Representative will be the duties of the RPR as found below:

- A. The Resident Project Representative (RPR) will be Artesian Water's representative at the Site, will act as directed by and under the supervision of Artesian Water, and will confer with Engineer regarding RPR's actions.**
- 1. General: RPR's dealings in matters pertaining to the Work in general shall be with Artesian Water and Contractor. RPR's dealings with Subcontractors shall only be through or with the full knowledge and approval of Contractor.**
 - 2. Schedules: Review the progress schedule, schedule of Shop Drawing and Sample submittals, and Schedule of Values prepared by Contractor and consult with Engineer concerning acceptability.**

3. **Conferences and Meetings:** Attend meetings with Contractor, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings, and prepare and circulate copies of minutes thereof.
4. **Liaison:**
 - a. Serve as Artesian Water's liaison with Contractor. Working principally through Contractor's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.
 - b. Assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's on-Site operations.
 - c. Assist in obtaining from Owner additional details or information, when required for proper execution of the Work.
5. **Interpretation of Contract Documents:** Report to Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.
6. **Shop Drawings and Samples:**
 - a. Record date of receipt of Samples and Contractor-approved Shop Drawings.
 - b. Receive Samples which are furnished at the Site by Contractor, and notify Engineer of availability of Samples for examination.
 - c. Advise Engineer and Contractor of the commencement of any portion of the Work requiring a Shop Drawing or Sample submittal for which RPR believes that the submittal has not been approved by Engineer.
7. **Modifications:** Consider and evaluate Contractor's suggestions for modifications in Drawings or Specifications and report such suggestions, together with RPR's recommendations, if any, to Engineer. Transmit to Contractor in writing decisions as issued by Engineer.
8. **Review of Work and Rejection of Defective Work:**
 - a. Conduct on-Site observations of Contractor's work in progress to assist Engineer in determining if the Work is in general proceeding in accordance with the Contract Documents.
 - b. Report to Artesian Water whenever RPR believes that any part of Contractor's work in progress is defective, will not produce a completed Project that conforms generally to the Contract Documents, or will imperil the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made; and advise Engineer of that part of work in progress that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection or approval.

9. Inspections, Tests, and System Start-ups:

- a. Verify that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate Owner's personnel, and that Contractor maintains adequate records thereof.
- b. Observe, record, and report to Engineer appropriate details relative to the test procedures and systems start-ups.

10. Records:

- a. Prepare a daily report or keep a diary or log book, recording Contractor's hours on the Site, Subcontractors present at the Site, weather conditions, data relative to questions of Change Orders, Field Orders, Work Change Directives, or changed conditions, Site visitors, deliveries of equipment or materials, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures; and send copies to Engineer.
- b. Record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of all Contractors, Subcontractors, and major Suppliers of materials and equipment.
- c. Maintain records for use in preparing Project documentation.

11. Reports:

- a. Furnish to Artesian Water and Engineer periodic reports as required of progress of the Work and of Contractor's compliance with the Progress Schedule and schedule of Shop Drawing and Sample submittals.
- b. Draft and recommend to Artesian Water and Engineer proposed Change Orders, Work Change Directives, and Field Orders. Obtain backup material from Contractor.
- c. Immediately notify Artesian Water and Engineer of the occurrence of any Site accidents, emergencies, acts of God endangering the Work, force majeure or delay events, damage to property by fire or other causes, or the discovery of any Constituent of Concern or Hazardous Environmental Condition.

12. Payment Requests: Review applications for payment with Contractor for compliance with the established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.

Work Item	Limit as a Percentage of Contract Price
After shop drawing review and approval	20%

Substantial Completion (monthly draws)	70%
Final Completion	10%

13. Certificates, Operation and Maintenance Manuals: During the course of the Work, verify that materials and equipment certificates, operation and maintenance manuals and other data required by the Contract Documents to be assembled and furnished by Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have these documents delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

14. Completion:

- a. Participate in Engineer's visits to the Site to determine Substantial Completion, assist in the determination of Substantial Completion and the preparation of a punch list of items to be completed or corrected.
- b. Participate in Engineer's final visit to the Site to determine completion of the Work, in the company of Owner and Contractor, and prepare a final punch list of items to be completed and deficiencies to be remedied.
- c. Observe whether all items on the final list have been completed or corrected and make recommendations to Engineer concerning acceptance and issuance of the notice of acceptability of the work.

C. The RPR shall not:

1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).
2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.
3. Undertake any of the responsibilities of Contractor, Subcontractors, or Suppliers.
4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of Contractor's work.
5. Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor.
6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.
7. Accept Shop Drawing or Sample submittals from anyone other than Contractor.
8. Authorize Owner to occupy the Project in whole or in part.

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

SC 13.01.B.5.c Delete Paragraph 13.01.B.5.c in its entirety and insert the following in its place:

c. Construction Equipment and Machinery:

- 1) Rentals of all construction equipment and machinery, and the parts thereof, in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.**
- 2) Costs for equipment and machinery owned by Contractor will be paid at a rate shown for such equipment in the Rental Rate Bluebook. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs. Costs will include the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when directly attributable to the changed Work. The cost of any such equipment or machinery, or parts thereof, shall cease to accrue when the use thereof is no longer necessary for the changed Work. Equipment or machinery with a value of less than \$1,000 will be considered small tools.**

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

SC 15.03.B Add the following new subparagraph to Paragraph 15.03.B:

- 1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, shall be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.**

SPECIFICATIONS

SPECIFICATIONS

SECTION 01100 - SUMMARY

PART 1 - GENERAL

1.1 PROJECT INFORMATION

- A. Project Identification: Artesian Wastewater Management Inc. Chandler Street Pumping Station, Town of Milton, Sussex County, Delaware.
- B. Project Location: Chandler Street in the Town of Milton, Sussex County, Delaware. A location map is included on the cover sheet of the Drawings.
- C. Owner: Artesian Wastewater Management, Inc., 644 Churchmans Road, Newark, DE, 19702.
- D. Engineer Identification: The Technical Specifications, dated **November, 2023**, were prepared by Verdantas LLC., 1060 S Governors Ave Suite 101, Dover, Delaware 19904.
- E. The work consists of, but is not limited to, the construction of: a new valve vault and electrical control structure, two (2) new submersible pumps and associated valves and fittings, bypass pumping vault, new electrical controls, new generator and ATS, approximately 30 LF of 6-inch diameter force main, site work and restoration of all surfaces disturbed by construction.

1.2 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: The Specifications are organized into Divisions and Sections using the 16-division format and CSI/CSC's "MasterFormat" numbering system.
- B. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Abbreviated Language: Language used in the Specifications and other Contract Documents is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be inferred as the sense requires. Singular words shall be interpreted as plural, and plural words shall be interpreted as singular where applicable as the context of the Contract Documents indicates.
 - 2. Requirements expressed in the imperative mood are to be performed by Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by Contractor or by others when so noted.
 - a. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01100

SPECIFICATIONS

SECTION 01290 - PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies administrative and procedural requirements for preparation of Schedules of Values and for measurement and payment of unit price items.

1.2 SCHEDULE OF VALUES

- A. The Contractor shall submit six (6) copies of a proposed Schedule of Values at the preconstruction meeting.
- B. When approved by the Engineer, the Schedule of Values shall be incorporated into, and serve as the basis for, the Contractor's Applications for Payment.
- C. Format and Content:
 - 1. Identification: Include the following Project identification on the Schedule of Values:
 - a. Project name and location.
 - b. Name of Engineer.
 - c. Project number.
 - d. Contractor's name and address.
 - e. Date of submittal.
 - 2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of subcontractor.
 - d. Dollar value.
 - 3. Provide a breakdown of the Lump Sum Bid Item in enough detail to facilitate continued evaluation of Applications for Payment and progress reports.
 - 4. Round amounts to nearest whole dollar; total shall equal the Lump Sum Bid Amount.
 - 5. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
 - 6. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

D. The Schedule of Values shall specifically identify and include, but not be limited to, the following:

1	Mobilization
2	Earthworks
3	Precast Concrete
4	Cast-In-Place Concrete
5	Masonry
6	Doors, Frames and Hardware
7	Mechanical Piping
8	Electrical Conduits and Wiring
9	Painting
10	Yard Piping/Force Main
11	Electrical

SPECIFICATIONS

MEASUREMENT AND PAYMENT

E. General Provisions

1. All work shown on the Drawings and described in the Contract Documents is to be paid for under the bid items listed on the proposal forms. The absence from the proposal form of a bid item specifically describing work shown on or required by the Contract Documents means that the cost of any such work shall be included in the prices bid for adjacent, associated, or related items for which quantities have been established.
2. Payment for the materials furnished and the work performed under the Contract Documents will be made as stipulated in the Contract Documents for the amount of materials supplied and the work actually done under authorization of the Engineer and in accordance with the actual measurements.
3. The Contractor shall not proceed with any quantities of work beyond that specifically shown on or specifically described in the Contract Documents without the written authorization of the Engineer. Any such work undertaken without authorization shall be subject to exclusion from measurement for payment under the terms of these Contract Documents at the discretion of the Owner.
4. All work completed under the Contract shall be measured by the Engineer according to United States standard measure. The method of measurement and computations to be used in the determination of quantities of materials furnished and of work performed under the Contract will be those methods generally recognized as conforming to good engineering practices.
5. All material that is to be measured by weight shall have a weight ticket signed by an approved certified weigh master and shall be presented to the Engineer when received on the job site.
6. When requested by the Contractor and approved by the Engineer in writing, material specified to be measured by the cubic yard may be weighed and such weights will be converted to cubic yards for payment purposes. Factors for conversion from weight measurement to volume measurement will be determined by the Engineer and shall be agreed to by the Contractor before such method of measurement of pay quantities is used.
7. As described elsewhere in these Contract Documents, the Contractor is required to submit a parts list and printed instructions and diagrams covering the operation and maintenance of each item of equipment and controls supplied. The Owner reserves the right to withhold payment in part or in total for any delivered equipment for which the foregoing documents have not been provided to the Engineer in the number described.

F. Mobilization

1. Mobilization shall consist of initiating the Contract and may include such portions of the following as are required at the beginning of the project setting up the Contractor's general plant; project signs; shops; storage areas; sanitary and other facilities as required by the Contract Documents, by local or state law, or by regulation, providing access to the site; obtaining necessary permits and licenses, and payments of fees; protecting existing materials; and providing required insurance and bonds.
2. Payment for Mobilization will be made at the lump sum price bid for the item, which price shall include full payment for this item as described. The provisions for payment for this item supercede any provisions elsewhere in the Contract Documents for including the costs of these initial services and facilities in the various items scheduled in the bid.
3. The lump sum price bid for mobilization, less retainage, shall be payable to the Contractor in accordance with the following schedule:
 - a. Fifty percent (50%) of the lump sum price for the item "Mobilization" shall be payable to the Contractor upon his successful completion of five percent (5%) of the awarded contract work. For purposes of this item, five percent (5%) of the work shall be considered completed when the total of payments earned, exclusive of the amount done, shall exceed five percent (5%) of the total price bid for the awarded contract.
 - b. The remaining fifty percent (50%) of the lump sum price bid for the item "Mobilization" shall be payable to the Contractor in two (2) increments of twenty-five percent (25%) each. Each of the increments shall be payable to the Contractor upon his successful completion of forty percent (40%) and seventy percent (70%) of the awarded contract work. Percent completion of the awarded contract work shall be computed as defined previously.

SPECIFICATIONS

- c. The lump sum price bid for mobilization shall not exceed five percent (5%) of the total price bid for the awarded contract.

G. Chandler Street Pumping Station

1. The lump sum price for the project shall include all work except for items specifically identified elsewhere in the Contract Documents as being excluded from the lump sum bid. The Contractor shall furnish and install all labor and materials necessary to complete the work in accordance with the Contract Documents.
2. Payment for labor, equipment and materials required by these Contract Documents shall be based on a percent of completion of project elements defined in the approved Schedule of Values for Contract Payments.

D. Payments to Contractor

1. The Engineer shall, within ten (10) days after receipt of each Application for Payment with an invoice, either indicate in writing his recommendation of payment and present the Application to the Owner, or return the Application to the Contractor indicating in writing his reasons for refusing to recommend payment. In the latter case, the Contractor may make the necessary corrections and resubmit the Application. The Owner shall expedite payment to the Contractor in the amount approved by the Engineer.
2. Upon application of the Contractor, and subject to sole discretion of the Engineer, payments may be made on the basis of equipment and materials not incorporated in the work but paid for, delivered and suitably stored at the site or at another location acceptable to the Engineer.
3. The Owner shall retain five (5) percent of the amount of payment due the Contractor. When the progress of the work is satisfactory, the Owner may, at the Owner's sole discretion reduce the amount retained.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01290

SPECIFICATIONS

SECTION 01330 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.
- B. Related Sections include the following:
 - 1. Section 01770 "Closeout Procedures" for submitting warranties, Project Record Documents and operation and maintenance manuals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Engineer's responsive action.
- B. Informational Submittals: Written information that does not require Engineer's approval. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

- A. General: Electronic files of the Contract Drawings will not be provided by Engineer for Contractor's use in preparing submittals.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
 - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 - 2. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination. Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows.
 - 1. Time for review shall commence on Engineer's receipt of submittal.
 - 2. Initial Review: Allow 15 working days for initial review of each submittal. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
 - 3. Identification: Place a permanent label or title block on each submittal for identification.
 - 4. Indicate name of firm or entity that prepared each submittal on label or title block.
 - 5. Provide a space approximately 4 by 5 inches on label or beside title block to record Contractor's review and approval markings and action taken by Engineer.
- D. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.
- E. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer observes noncompliance with provisions of the Contract Documents, initial submittal may serve as final submittal. Additional copies submitted will be marked with action taken and will be returned.

SPECIFICATIONS

- F. Transmittal: Package each submittal individually and appropriately for shipping and handling. Transmit each submittal using a transmittal form. Submittals received from sources other than Contractor will be returned without Engineer's review.
1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
 2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents. The Engineer may approve the Contractor's use of a rubber stamp to place the contractor's certification on submittals.
 3. Transmittal Form: Provide locations on form for the following information:
 - a. Project name.
 - b. Date.
 - c. Destination (To:).
 - d. Source (From:).
 - e. Names of subcontractor, manufacturer, and supplier.
 - f. Category and type of submittal.
 - g. Submittal purpose and description.
 - h. Remarks.
 - i. Signature of transmitter.
 - j. Relevant specification section or Contract Drawing number.
- G. Use for Construction: Use only final approved submittals with mark indicating action taken by Engineer in connection with construction.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
1. Number of Copies: Submit a minimum of six (6) copies of each submittal, unless otherwise indicated. Engineer will distribute four (4) copies and return the remaining copies to the Contractor.
 2. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
 3. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 4. Mark each copy of each submittal to show which products and options are applicable.
 5. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Mill reports.
 - j. Standard product operating and maintenance manuals.
 - k. Compliance with recognized trade association standards.
 - l. Compliance with recognized testing agency standards.
 - m. Application of testing agency labels and seals.
 - n. Notation of coordination requirements.

SPECIFICATIONS

- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Preparation: Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
 - f. Shopwork manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
 3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 40 inches.
- C. Samples: Prepare physical units of materials or products, including the following:
1. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 2. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 3. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Engineer's sample where so indicated. Attach label on unexposed side that includes the following:
 - a. Generic description of Sample.
 - b. Product name or name of manufacturer.
 - c. Sample source.
 4. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
 - a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least three sets of paired units that show approximate limits of the variations.
 5. Number of Samples for Initial Selection: Submit one full set of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Engineer will return submittal with options selected.
 6. Number of Samples for Verification: Submit three sets of Samples. Engineer will retain two Sample sets; remainder will be returned.
 - a. Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.

SPECIFICATIONS

7. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
 - a. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 1. Number of Copies: Submit six (6) copies of each submittal, unless otherwise indicated. Engineer will not return copies.
 2. Certificates and Certifications: Provide a notarized statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.
 3. Test and Inspection Reports: Comply with requirements in Division 1 Section "Quality Requirements."
- B. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Engineers and owners, and other information specified.
- C. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that product complies with requirements.
- D. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- E. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.
- F. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
- G. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.
- H. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
- I. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- J. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.
- K. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

SPECIFICATIONS

- L. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 1 Section "Closeout Procedures."
- M. Design Data: Prepare written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- N. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
 - 1. Preparation of substrates.
 - 2. Required substrate tolerances.
 - 3. Sequence of installation or erection.
 - 4. Required installation tolerances.
 - 5. Required adjustments.
 - 6. Recommendations for cleaning and protection.
- O. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
 - 1. Name, address, and telephone number of factory-authorized service representative making report.
 - 2. Statement on condition of substrates and their acceptability for installation of product.
 - 3. Statement that products at Project site comply with requirements.
 - 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 - 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 - 6. Statement whether conditions, products, and installation will affect warranty.
 - 7. Other required items indicated in individual Specification Sections.
- P. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.
- Q. Material Safety Data Sheets: Submit information directly to Owner. If submitted to Engineer, Engineer will not review this information but will return it with no action taken.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.
- B. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Project name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.2 ENGINEER'S ACTION

- A. General: Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.

SPECIFICATIONS

- B. Action Submittals: Engineer will review each submittal to evaluate compliance with Contract Documents, make marks to indicate corrections or modifications required, and return it. The Engineer's review and notations with respect to shop drawings and other submittals do not relieve the Contractor of fully satisfying the Contract Documents in any way and all respects. Engineer will stamp each submittal with an action stamp to indicate action taken, and additional submittal requirements, if any, will be marked as follows:
1. If the returned item is marked "Rejected", the Engineer has determined that the submittal is not adequate to establish that there is compliance with the Contract Documents and a new submission is required.
 2. If the returned item is marked "Revise and Resubmit", it signifies that substantial changes in the shop drawing or other submittals are necessary and that the item must be resubmitted to the Engineer for further review.
 3. If the item is marked "Returned with Notations", it signifies that the Engineer has noted minor changes or additions to the item that are necessary to satisfy the Contract Documents and that a resubmittal is not necessary unless otherwise noted.
- C. Informational Submittals: Engineer will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Engineer will forward each submittal to appropriate party.
- D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 01330

SPECIFICATIONS

SECTION 01420 - REFERENCES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. General: Basic Contract definitions are included in the General Conditions.
- B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the General Conditions.
- C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "approved," "required," and "permitted" have the same meaning as "directed."
- D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."
- E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
- F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- H. "Provide": Furnish and install, complete and ready for the intended use.
- I. "Installer": Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
 - 1. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespeople of the corresponding generic name.
- J. "Experienced": When used with an entity, "experienced" means having successfully completed a minimum of five (5) previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- K. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

1.2 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

SPECIFICATIONS

- C. **Conflicting Requirements:** If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Engineer for a decision before proceeding.
1. **Minimum Quantity or Quality Levels:** The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.
- D. **Abbreviations and Acronyms for Standards and Regulations:** Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

ADAAG	Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-5434
CFR	Code of Federal Regulations Available from Government Printing Office www.access.gpo.gov/nara/cfr	(888) 293-6498 (302) 512-1530
DOD	Department of Defense Specifications and Standards Available from Defense Automated Printing Service www.astimage.daps.dia.mil/online	(215) 697-6257
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Defense Automated Printing Service www.astimage.daps.dia.mil/online Available from General Services Administration www.fss.gsa.gov/pub/fed-specs.cfm Available from National Institute of Building Sciences www.nibs.org	(215) 697-6257 (202) 619-8925 (202) 289-7800
MILSPEC	Military Specification and Standards Available from Defense Automated Printing Service www.astimage.daps.dia.mil/online	(215) 697-6257
UFAS	Uniform Federal Accessibility Standards Available from access Board www.access-board.gov	(800) 872-2253 (202) 272-5434

1.3 ABBREVIATIONS AND ACRONYMS

- A. **Industry Organizations:** Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

AASHTO	American Association of State Highway and Transportation Officials www.aashto.org	(202) 624-5800
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SPECIFICATIONS

ACI	American Concrete Institute/ACI International www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association www.concrete-pipe.org	(972) 506-7216
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASHRAE	American Society of Heating, Refrigeration and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (212) 591-7722
ASSE	American Society of Sanitary Engineers www.asse-plumbing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9585
AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337
BHMA	Builders Hardware Manufacturers Association www.buildershardware.com	(212) 297-2122
CLFMI	Chain Link Fence Manufacturers Institute www.chainlinkinfo.org	(301) 596-2583
CPPA	Corrugated Polyethylene Pipe Association www.cppa-info.org	(800) 510-2772 (202) 462-9607
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSA	CSA International (Formerly: IAS – International Approval Services) www.csa-international.org	(800) 463-6727 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
HI	Hydraulic Institute www.pumps.org	(888)786-7744 (973) 267-9700

SPECIFICATIONS

HMMA	Hollow Metal Manufacturers Association (See NAAMM)	
IEEE	Institute of Electrical and Electronics Engineers, Inc.) www.ieee.org	(212) 419-7900
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NFPA	National Fire Protection Association www.nfpa.org	(800) 344-3555 (617-770-3000)
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
SDI	Steel Door Institute www.steeldoor.org	(440) 899-0010
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
UL	Underwriters Laboratories Inc. www.ul.com	(800) 704-4050 (847) 272-8800
UNI	Uni-bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700

- B. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

CE	Army Corps of Engineers www.usace.army.mil	
EPA	Environmental Protection Agency www.epa.gov	(202) 260-2090
GSA	General Services Administration www.gsa.gov	(202) 708-5082
HUD	Department of Housing and Urban Development www.hud.gov	(202) 708-1112
NIST	National Institute of Standards and Technology www.nist.gov	(301) 975-6478
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742 (202) 693-1999

SPECIFICATIONS

RUS	Rural Utilities Service (See USDA)	(202) 720-9540
USDA	Department of Agriculture www.usda.gov	(202) 720-2791

- C. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Names, telephone numbers, and Web-site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

DeIDOT	Delaware Department of Transportation www.deldot.gov	(302) 760-2080
DNREC	Delaware Department of Natural Resources And Environmental Control www.dnrec.state.de.us	(302) 739-4506

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01420

SPECIFICATIONS

SECTION 01500 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, field offices and security and protection facilities.
- B. Temporary utilities include, but are not limited to, the following:
 - 1. Sanitary facilities, including toilets, wash facilities, and drinking-water facilities.
 - 2. Electric power service.
- C. Support facilities include, but are not limited to, the following:
 - 1. Storage and fabrication sheds.
- D. Security and protection facilities include, but are not limited to, the following:
 - 1. Environmental protection.
 - 2. Storm water control.
 - 3. Tree and plant protection.
 - 4. Security enclosure and lockup.
 - 5. Barricades, warning signs, and lights.
- E. Related Sections include the following:
 - 1. Section 01330 "Submittal Procedures" for procedures for submitting copies of implementation and termination schedule and utility reports.
 - 2. Section 01700 "Execution Requirements" for progress cleaning requirements.
 - 3. Section 02240 "Dewatering" for disposal of ground water at Project site.

1.2 QUALITY ASSURANCE

- A. Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.
 - 1. Trade Jurisdictions: Assigned responsibilities for installation and operation of temporary utilities are not intended to interfere with trade regulations and union jurisdictions.
 - 2. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if acceptable to Engineer. Provide materials suitable for use intended.
- B. Portable Chain-Link Fencing: Minimum 2-inch 9-gage, galvanized steel, chain-link fence fabric; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch OD line posts and 2-7/8-inch OD corner and pull posts, with 1-5/8-inch OD top and bottom rails. Provide concrete bases for supporting posts.

2.2 EQUIPMENT

SPECIFICATIONS

- A. General: Provide new equipment. Undamaged, previously used equipment in serviceable condition may be used if acceptable to Engineer. Provide equipment suitable for use intended.
- B. Fire Extinguishers: Hand carried, portable, UL rated. Provide class and extinguishing agent as indicated or a combination of extinguishers of NFPA-recommended classes for exposures.
 - 1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.
- C. Self-Contained Toilet Units: Single-occupant units of chemical, aerated recirculation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- D. Drinking-Water Fixtures: Containerized, tap-dispenser, bottled-water drinking-water units, including paper cup supply.
- E. Electrical Outlets: Properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-V plugs into higher-voltage outlets; equipped with ground-fault circuit interrupters, reset button, and pilot light.
- F. Power Distribution System Circuits: Where permitted and overhead and exposed for surveillance, wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic sheathed cable.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Secure portable or mobile buildings when used. Relocate and modify facilities as required.
- B. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

- A. General: Engage appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company recommendations.
 - 1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking-water fixtures. Comply with regulations and health codes for type, number, location, operation, and maintenance of fixtures and facilities.
 - 1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
 - 2. Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.
- C. Drinking-Water Facilities: Provide drinking water, water containers and paper cups for use by all workmen employed on the project.
- D. Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include

SPECIFICATIONS

meters, transformers, overload-protected disconnecting means, automatic ground-fault interrupters, and main distribution switchgear.

1. Install electric power service underground, unless overhead service must be used.
 2. Install power distribution wiring overhead and rise vertically where least exposed to damage.
- E. Electric Distribution: Provide receptacle outlets adequate for connection of power tools and equipment.
1. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.
 2. Provide warning signs at power outlets other than 110 to 120 V.

3.3 SUPPORT FACILITIES INSTALLATION

- A. General: Locate field offices, storage sheds, sanitary facilities, and other temporary construction and support facilities within the project area as approved by the Owner.
- B. Field Offices: Place temporary field offices on proper foundations adequate for normal loading. Provide the following:
1. Connections for utility service.
 2. Steps and landings at entrance doors.
 3. High wind tie-downs.
- C. Dewatering Facilities and Drains: Comply with requirements in applicable Division 2 Sections for temporary drainage and dewatering facilities and operations not directly associated with construction activities included in individual Sections. Where feasible, use same facilities. Maintain Project site, excavations, and construction free of water.
1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining property nor endanger permanent Work or temporary facilities.
 2. Remove snow and ice as required to minimize accumulations.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near Project site.
- B. Storm Water Control: Provide earthen embankments and similar barriers in and around excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rains.
- C. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from construction damage. Protect tree root systems from damage, flooding, and erosion.
- D. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights.

3.4 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

SPECIFICATIONS

- B. Pay all installation, maintenance and operation costs for the Engineer's field offices, including but not limited to telephone service (local and long distance calls), electrical service, sanitary facilities, drinking water, heating fuel, etc.
- C. Maintenance: Maintain and clean temporary facilities, furnishings, equipment, and services weekly until removal. Protect from damage caused by freezing temperatures and similar elements.
- D. Termination and Removal: Remove temporary facilities, contents, and services when no longer needed, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are the property of Contractor.
 - 2. Remove foundations and debris from temporary facilities. Clean site and grade to required elevations.
 - 3. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

END OF SECTION 01500

SPECIFICATIONS

SECTION 01700 - EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
1. Construction layout.
 2. Field engineering and surveying.
 3. General installation of products.
 4. Progress cleaning.
 5. Starting and adjusting.
 6. Protection of installed construction.
 7. Correction of the Work.
 8. Maintenance of Traffic
 9. Preconstruction and progress meetings.
 10. Progress schedules.
 11. Construction phasing and operation of existing facilities.
- B. Related Sections include the following:
1. Division 1 Section 01330 "Submittal Procedures" for submitting surveys.
 2. Division 1 Section 01770 "Closeout Procedures" for submitting Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.

1.2 QUALITY ASSURANCE

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

SPECIFICATIONS

1. Notify Engineer not less than two (2) days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Engineer's written permission.
- C. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- D. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- E. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

3.3 UTILITIES

- A. The Contractor shall plan for and implement all necessary requirements to prevent damage to any existing underground utility including, but not limited to, the following:
1. To request from the office of each operator having a utility in the area, the location and other pertinent information regarding these utilities not less than two (2) working days but no more than ten (10) working days prior to the day of commencement of work in the area.
 2. To inform each person employed by the Contractor at the site of such work of the information obtained regarding the location of utilities and other pertinent information.
 3. To report any break, leak, dent, gouge, groove, or other damage to the operator immediately.
 4. To alert immediately the occupants of the premises as to any emergency that the Contractor may create or discover.
- B. The Contractor's attention is directed to the fact that the locations of existing utilities and other structures shown on the Drawings are approximate only. Prior to any construction activities, the Contractor shall have the utility company locate them or determine the location of the utilities. The Contractor shall take all necessary measures to protect utilities or arrange for relocation during construction. Any damage to utilities shall be repaired by the Contractor at his expense according to the requirements of the utility specifications. The following utilities are located in or adjacent to the construction site.
1. Electric Service – Delaware Power
 2. Storm Drainage - DelDOT / Town of Milton
 3. Water Service – Town of Milton
 4. Sewer Service – Artesian Wastewater Management Inc.

SPECIFICATIONS

3.4 CONSTRUCTION LAYOUT

- A. General: Construction layout services will be provided by the Owner. The Contractor shall coordinate the work and schedule with the Owner's representative for construction layout services. The Owner's construction layout services may include the following:
1. Verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Engineer promptly.
 2. Establish benchmark and control points to set lines and levels as needed to locate each element of project.
 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
 4. Inform installers of lines and levels to which they must comply.
 5. Check the location, level and plumb, of every major elements the work progresses.
 6. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
 7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

Any discrepancy or errors, real or perceived, that are observed by the Contractor in the construction layout shall be notified to the Owner immediately.

- B. Site Improvements: The Owner will locate and lay out the site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.
- C. Building Lines and Levels: The Owner will locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.
- D. Record Log: The Owner will maintain a log of layout control work including deviations from required lines and levels, beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used.

3.5 FIELD ENGINEERING

- A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer before proceeding.
 2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

3.6 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
1. Make vertical work plumb and make horizontal work level.
 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated..
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

SPECIFICATIONS

- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.
- F. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
 - 2. Allow for building movement, including thermal expansion and contraction.
- G. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.7 PROGRESS CLEANING

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
 - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 - 2. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
 - 1. Remove liquid spills promptly.
 - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
 - 1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
- H. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

SPECIFICATIONS

- I. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- J. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- K. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

3.11 MAINTENANCE OF TRAFFIC

- A. The Contractor shall indicate on the proposed schedule for construction any significant disruptions to the normal flow of traffic. The streets affected and the duration of the disruptions shall be indicated. The overall schedule for such disruptions, and any revisions, shall be approved in writing by the Engineer. The Contractor shall notify the Engineer at least 48 hours prior to any proposed disruption of traffic.
- B. Any disruption of the traffic shall be fully indicated by signs, barriers, and flagmen as approved by the Engineer.

SPECIFICATIONS

- C. The Contractor shall provide for and maintain ingress and egress to and from the properties abutting the construction project after working hours. Construction activities, which may temporarily interfere with property access, shall be coordinated in advance with the property owners.
- D. All work within the right-of-way of State maintained roadways shall be done in full conformance with the specifications and requirements of the Delaware Department of Transportation.

3.12 PRECONSTRUCTION CONFERENCE

- A. Before any work at the site is started, a conference attended by the Contractor, Engineer, Owner and others as appropriate will be held to establish a working understanding among the parties as to the Work, procedures for handling shop Drawings and other submittals, processing Applications for payment and maintaining other records.
- B. The Contractor shall submit a proposed progress schedule for the work at the Preconstruction Conference. No work shall commence until the progress schedule has been reviewed and accepted by the Engineer.
- C. The Contractor shall submit a preliminary schedule of Shop Drawing and Sample submittals at the Preconstruction Conference. The schedule shall list each required submittal and the times for submitting, reviewing, and processing each submittal.

3.13 PROGRESS MEETINGS

- A. Progress meetings shall be held monthly unless otherwise required by the Owner or Engineer.
- B. The Contractor shall provide a revised progress schedule at each progress meeting which reflects actual work completed and any proposed adjustments for future work.

END OF SECTION 01700

SPECIFICATIONS

SECTION 01770 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Project Record Documents.
 - 3. Operation and Maintenance Manuals.
 - 4. Warranties.
 - 5. Manufacturer's Field Reports.
- B. Related Sections include the following:
 - 1. Division 1 Section 01330 "Submittal Procedures".
 - 2. Division 1 Section 01700 "Execution Requirements" for progress cleaning of Project site.
 - 3. Divisions 2 through 16 Sections for specific closeout and special cleaning requirements for products of those Sections.

1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of conditional acceptance, complete the following. List items below that are incomplete in request.
 - 1. Prepare a list of items to be completed and corrected (punch list) and reasons why the Work is not complete.
 - 2. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 - 3. Complete startup testing of systems.
 - 4. Submit test/adjust/balance records.
 - 5. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 - 6. Touch up and repair and restore marred exposed finishes to eliminate visual defects.
- B. Inspection: Submit a written request for inspection for conditional acceptance. On receipt of request, Owner and Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Conditional Acceptance after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by, that must be completed or corrected before certificate will be issued.
 - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
 - 2. Results of completed inspection will form the basis of requirements for Final Acceptance.

1.3 FINAL COMPLETION

- A. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Owner and Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
- B. The date of Final acceptance of the total project, or partial acceptance of individual systems shall be determined by the Engineer.

SPECIFICATIONS

1.4 PROJECT RECORD DOCUMENTS

- A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.
- B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.
 - 1. Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 - d. Mark Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. Where Shop Drawings are marked, show cross-reference on Contract Drawings.
 - 2. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
 - 3. Mark important additional information that was either shown schematically or omitted from original Drawings.
 - 4. Note Construction Change Directive numbers, Change Order numbers, alternate numbers, and similar identification where applicable.
 - 5. Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location. Organize into manageable sets; bind each set with durable paper cover sheets. Include identification on cover sheets.
- C. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.5 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall provide to the Engineer, six (6) copies of Operation and Maintenance Manual for the items listed below, and for any other items as directed in writing by the Engineer. Manuals shall include spare parts list, printed instructions and diagrams required for service, repair or replacement, and name, address and phone number of agency that will make repair or replacement during warranty period and/or where spare parts may be obtained:
 - 1. Submersible Pumps
 - 2. Flow Meter
 - 3. Level Transducer
 - 4. Variable Frequency Drives
 - 5. Generator
- B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

SPECIFICATIONS

1.6 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- C. The Contractor shall warrant that all workmanship, material, and equipment furnished and installed under the Contract Documents shall be free of defects for a period of one (1) year after the date of Final Acceptance by the Owner. In the event there is more than one certificate of Final Acceptance issued, the warranty shall be for one (1) year after each acceptance date. Should such defects appear, the Contractor shall repair or replace such defects at no cost to the Owner.

1.7 MANUFACTURER'S FIELD REPORTS

- A. The Contractor shall obtain and deliver to the Engineer prior to the initiation of start up operations, Manufacturer's Field Reports for the following equipment:
 - 1. Submersible Pumps
 - 2. Flow Meter
 - 3. Variable Frequency Drives
 - 4. Generator

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 DEMONSTRATION AND TRAINING

- A. Instruction: Instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Provide instructors experienced in operation and maintenance procedures.
 - 2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
 - 3. Schedule training with Owner, through Engineer, with at least seven days' advance notice.
 - 4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.
- B. The manufacturer's representative shall issue a Manufacturer's Field Report attesting to conformance of the operation of the facilities to the Contract Documents.

END OF SECTION 01770

SPECIFICATIONS

SECTION 02221 - DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Demolition and removal of buildings and structures.
2. Demolition and removal of site improvements adjacent to a building or structure to be demolished.
3. Abandoning in place below-grade construction.
4. Disconnecting, capping or sealing, and abandoning site utilities in place.

B. Related Sections include the following:

1. Division 1 Section 01500 "Temporary Facilities and Controls" for temporary construction, protection facilities, and environmental-protection measures for demolition operations.
2. Division 2 Section 02230 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of demolition.

1.2 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or recycled.
- B. Remove and Salvage: Detach items from existing construction and deliver them to Owner.
- C. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or recycled.

1.3 PROJECT CONDITIONS

- A. Owner will occupy parts of the Project site immediately adjacent to demolition area and continue to operate the facility. Arrange demolition schedule so as not to interfere with Owner's on-site operations.
- B. Provide not less than three (3) working days notice to Owner of activities that will affect Owner's operations. Conduct demolition so Owner's operations will not be disrupted. Maintain access to existing walkways, exits, and other adjacent occupied or used facilities.
- C. Equipment and structures to be demolished will be vacated and their use discontinued before start of demolition work.
- D. Owner assumes no responsibility for condition of structures to be demolished. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- E. Before demolition, Owner will remove the following items:**
1. All liquid contents of existing Chandler Street Pump Station.

SPECIFICATIONS

- F. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.
- G. Storage or sale of removed items or materials on-site is not permitted.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Survey existing conditions and correlate with requirements indicated to determine extent of demolition required.
- B. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are the same as those indicated in Project Record Documents.
- C. When unanticipated mechanical, electrical, or structural elements are encountered, investigate and measure the nature and extent of the element. Promptly submit a written report to Engineer.
- D. Survey the condition of structures to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.

3.2 PREPARATION

- A. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
 - 1. Provide at least three (3) working days' notice to Owner if shutdown of service is required during changeover. Owner will arrange to shut off indicated utilities when requested by Contractor.
 - 2. If utility services are required to be removed, relocated, or abandoned, before proceeding with demolition, provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
 - 3. Cut off pipe or conduit a minimum of 12 inches below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
 - 4. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
 - 5. Strengthen or add new supports when required during progress of demolition.
- B. Removed and Salvaged Items: Comply with the following:
 - 1. Clean salvaged items of dirt and demolition debris.
 - 2. Store items in a secure area until delivery to Owner.
 - 3. Protect items from damage during transport and storage.

3.3 PROTECTION

SPECIFICATIONS

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations.
- B. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during demolition. When permitted by Engineer, items may be removed to a suitable, protected storage location during demolition and reinstalled in their original locations after demolition operations are complete.
- C. Existing Utilities: Maintain utility services indicated to remain and protect them against damage during demolition operations.
 - 1. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
 - 2. Provide temporary services during interruptions to existing utilities, as acceptable to Owner.
- D. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated.
 - 1. Protect existing site improvements, appurtenances, and landscaping to remain.
 - 2. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
 - 3. Provide protection to ensure safe passage of people around demolition area and to and from occupied portions of adjacent buildings and structures.
 - 4. Protect adjacent exterior construction that is to remain and that is exposed to demolition operations.

3.4 DEMOLITION, GENERAL

- A. General: Demolish indicated existing equipment, structures and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
 - 1. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
 - 2. Maintain adequate ventilation when using cutting torches.
 - 3. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- B. Engineering Surveys: Perform surveys as the Work progresses to detect hazards that may result from building demolition activities.
- C. Site Access and Temporary Controls: Conduct demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walkways, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
- D. Explosives: Use of explosives is not permitted.

3.5 MECHANICAL DEMOLITION

SPECIFICATIONS

- A. Proceed with demolition of structural framing members systematically, from higher to lower level.
- B. Remove debris from elevated portions by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- C. Concrete: Cut concrete full depth at junctures with construction indicated to remain, using power-driven saw, then remove concrete between saw cuts.
- D. Masonry: Cut masonry at junctures with construction indicated to remain, using power-driven saw, then remove masonry between saw cuts.
- E. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished at junctures with construction indicated to remain, then break up and remove.
- F. Structural Steel: Dismantle field connections without bending or damaging steel members. Do not use flame-cutting torches unless otherwise authorized by Engineer. Remove structural framing members and lower to ground by method suitable to minimize ground impact or dust generation.
- G. Equipment: Disconnect equipment at nearest fitting connection to services, complete with service valves. Remove as whole units, complete with controls.
- H. Below-Grade Construction: Demolish foundation walls and other below-grade construction that is within 5 feet outside of footprint indicated for new construction. Abandon below-grade construction outside this area.
 - 1. Remove below-grade construction, including foundation walls, and footings to the depths indicated.
- I. Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet outside of footprint indicated for new construction. Abandon utilities outside this area.
 - 1. Piping: Disconnect piping at unions, flanges, valves, or fittings.
 - 2. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

3.6 SITE RESTORATION

- A. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Division 2 Section 02300 "Earthwork."
- B. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.
- C. Return adjacent areas to condition existing before building demolition operations began.

3.7 REPAIRS

- A. General: Promptly repair damage to adjacent construction caused by building demolition operations.

SPECIFICATIONS

- B. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.
- C. Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

3.8 DISPOSAL OF DEMOLISHED MATERIALS

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.
 - 1. Do not allow demolished materials to accumulate on-site.
 - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- B. Burning: Do not burn demolished materials.

END OF SECTION 02221

SPECIFICATIONS

SECTION 02230 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, ground covers, plants and grass to remain.
2. Removing existing trees, shrubs, ground covers, plants and grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 1 Section 01500 "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and temporary erosion and sedimentation control procedures.
2. Division 1 Section 01700 "Execution Requirements" for verifying utility locations and for recording field measurements.
3. Division 2 Section 02300 "Earthwork" for soil materials, excavating, backfilling, and site grading.
4. Division 2 Section 02920 "Lawns and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.2 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.3 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

SPECIFICATIONS

- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 2 Section 02300 "Earthwork."
- B. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
- D. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. The Contractor shall, in accordance with the Delaware Erosion and Sediment Control Handbook, plan and implement all necessary requirements under the Delaware Sediment and Storm Water Regulations. The Contractor shall minimize erosion of the disturbed construction areas and shall prevent sediment from entering water courses or areas beyond the project site. The Contractor shall comply with all applicable Federal, State, and local regulations pertaining to sediment and erosion control.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within fenced area.
 - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
 - 3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.

SPECIFICATIONS

2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 3. Coat cut faces of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Engineer.
1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
 2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Engineer.

3.4 TRANSPLANTING

- A. Transplant small trees and shrubs located either within construction lines or which may be damaged during construction to a new location on the same property.
1. New locations for transplanting shall be determined in the field by the Engineer.
 2. Perform the necessary excavation to remove and transplant the various designated small trees and bushes as shown and required by the Contract Documents.
- B. Take all precautions customary in good trade practice in preparing plants for transplanting. Plants transplanted with workmanship that fail to meet the highest standards will be rejected. All plants shall have firm, natural balls of earth of ample proportions and diameter not less than as specified in the "USA Standard for Nursery Stock". Plants with cracked, broken, or crushed balls which occur either before or during planting operations, will be rejected and shall be removed from the site immediately. Bare root plants shall be dug with sufficient spread and depth of roots as to insure full and prompt recovery and development of the plants. All plants shall be handled so that roots are adequately protected and moist at all times. Material that cannot be planted immediately after delivery shall be adequately protected by covering with canvas, wet straw, burlap, moss, or other suitable material and kept covered until ready to be planted. Trees shall not be planted with frozen earth balls.
- C. Where specified the plants shall be located as indicated on the Drawings, but may be shifted to avoid utilities subject to the approval of the Engineer. In all mass plant areas, the plants shall be evenly spaced to give uniform cover in the planting bed area. No excavation shall commence until all locations are approved.
- D. Plant all trees and shrubs in pits excavated with vertical sides as detailed on the Drawings. They shall be of such a depth that when planted and settled, the crown of the plant shall bear the same relation to finished grade as it did to soil surface in its place of growth. All backfill topsoil shall be covered with waterproof material after mixing. Pits shall be backfilled with specified soil mix and compacted firmly, especially under ball of roots to establish a firm foundation. Plants shall be set in the center of pits in a vertical position so that the crown of the plant is level with the finished grade after allowing for watering and settling of soil. The soil mixture shall be carefully and firmly worked and tamped under and around the base of the ball to fill all voids. When partially backfilled and compacted, the burlap shall be removed from the sides and tops of the balls and cut away to prevent air pockets, but no burlap shall be pulled from under the balls. A ring of earth shall be formed around the plant to produce a dish for watering. All plants shall be thoroughly watered immediately after planting. This shall mean complete saturation of all backfill in the pits and beds during the same day of planting. Care shall be taken during all planting operations to insure that no excavated material is dumped on any grassed area unless a suitable type of matting or protective underlay is used. The Contractor will be responsible for all damage to any grassed, planted, or other landscape area caused by these operations and shall repair any damage so caused in a manner satisfactory to the Engineer at the Contractor's own expense.

SPECIFICATIONS

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction. Blasting shall not be permitted as a method of removal. Backfill the excavated area with select granular material specified in Section 02300.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches (450 mm) below exposed subgrade.
 - 4. Use only hand methods for grubbing within tree protection zone.
 - 5. Chip removed tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
 - 2. Do not stockpile topsoil within tree protection zones.
 - 3. Dispose of excess topsoil as specified for waste material disposal.
 - 4. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
 - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 02230

SPECIFICATIONS

SECTION 02240 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes construction dewatering.
- B. Related Sections include the following:
 - 1. Division 1 Section 01500 "Temporary Facilities and Controls" for temporary utilities and support facilities.
 - 2. Division 2 Section 02300 "Earthwork" for excavating, backfilling, site grading and for site utilities.
 - 3. Division 2 Section 02241 "Excavation Support and Shoring" for design and installation of temporary shoring required to prepare the bulk grading plan.

1.2 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
 - 4. Remove dewatering system if no longer needed.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with installer licensing, permitting, construction, and water disposal requirements of authorities having jurisdiction.

1.4 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner and Engineer will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
- C. Survey adjacent structures and improvements, employing a qualified professional engineer or land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

SPECIFICATIONS

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

- A. Prepare and submit permit applications in accordance with applicable state regulations.
- B. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- C. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- D. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
- E. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.
- F. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- G. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
 - 1. Remove dewatering system from Project site on completion of dewatering in accordance with applicable state regulations.
- H. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 02240

SPECIFICATIONS

SECTION 02241 - EXCAVATION SUPPORT AND SHORING

PART 1 – GENERAL

1.1 SUMMARY

- A. This work shall consist of the design and installation of temporary shoring required at the pumping station site to install subgrade improvements including the wet well and upstream sanitary system improvements including, but not limited to, the encasement and carrier pipe crossing Iron Branch. The shoring system may be temporary or permanent depending on the system provided by the Contractor
- B. A geotechnical evaluation report for the project titled "Geotechnical Evaluation, M&T Bank Pump Station Replacement, Millsboro, Delaware" prepared by Duffield Associates dated January 23, 2019 and amendments thereto are included as Appendix A. The Owner is making this information available for review by prospective contractors. Contractors are responsible for interpreting the available data and drawing their own conclusions.
- C. Related Sections include the following:
 - 1. Division 1 Section 01500 "Temporary Facilities and Controls" for temporary utilities and support facilities.
 - 2. Division 2 Section 02300 "Earthwork" for excavating, backfilling, site grading and for site utilities.
 - 3. Division 2 Section 02240 "Dewatering and Treatment" for construction dewatering and treatment of groundwater discharge for dewatering operations.

1.2 SUBMITTALS

- A. Design Submittals. The shoring system shall be designed by the Contractor to meet the specified loading conditions, as shown on the contract plans and approved working drawings. At least 21 calendar days before the planned start of shoring structure construction, submit complete design calculations and working drawings to the Engineer for review and approval. Include all details, dimensions, quantities, ground profiles, and cross-sections necessary to construct the shoring structure. The drawings and calculations shall be signed and sealed by the Contractor's Professional Engineer or by the Consultant designer's Professional Engineer. If the Contractor uses a consultant designer to prepare the design, the Contractor shall still have overall contract responsibility for both the design and the construction.
- B. Design Calculations. Design calculations shall include, but not be limited to, the following items:
 - 1 A written summary report which describes the overall shoring design.
 - 2 Applicable code requirements and design references.
 - 3 Structure critical design cross-section(s) geometry
 - 4 Safety factors/strength factors (for Service Load Design) used in the design of, steel, grout, and concrete materials.
 - 5 Design calculation sheets with the project number, structure location, designation of preparation, initials of designer and checker, and page number at the top of each page. Provide an index page with the design calculations.
 - 6 Design criteria including, soil strengths (friction angle and cohesion), unit weights, and ground-grout bond values and anchor drillhole diameter (if used) assumptions for each soil strata.
- C. Working Drawings. The working drawings shall include all information required for the construction and quality control of the shoring. Working drawings shall include, but not be limited to, the following items unless provided in the contract plans:
 - 1. A plan view of the shoring structure(s) identifying:

SPECIFICATIONS

- a. A reference baseline and elevation datum.
 - b. The offset from the construction centerline or baseline to the face of the shoring wall at all changes in horizontal alignment.
2. An elevation view of the shoring structure(s) identifying:
- a. Elevation view showing soil anchor locations and elevations; vertical and horizontal spacing.
 - b. Existing and finish grade profiles both behind and in front of the shoring structure.
 - c. Design parameters and applicable codes.
 - d. General notes for constructing the shoring structure including construction sequencing or other special construction requirements.
 - e. Soil Anchor typical sections including anchor spacing and inclination; minimum drillhole diameter; pipe casing and reinforcing bar sizes and details; splice types and locations; centralizers and spacers; grout bond zone and casing plunge lengths (if used); and connection details to the substructure footing, anchorage, plates, etc.
 - f. A typical detail of verification and production proof test anchors defining the anchor length, minimum drillhole diameter, inclination, and load test bonded and unbonded test lengths.
 - g. Details, dimensions, and schedules for all anchors, casing and reinforcing steel, including reinforcing bar bending details.
- Provide revised design calculations signed by the approved Registered Professional Engineer for all design changes made during the construction of the shoring structure.
3. Shoring Construction Submittal. The Contractor shall prepare and submit to the Engineer, for review the following for the shoring system or systems to be constructed:
- a. Detailed step-by-step description of the proposed shoring construction procedure, including personnel, testing and equipment to assure quality control. This step-by-step procedure shall be shown on the working drawings in sufficient detail to allow the Engineer to monitor the construction and quality of the shoring.
 - b. Proposed start date and time schedule and shoring installation schedule providing the following:
 - i. Sheet Pile Numbers
 - ii. Sheet Pile Minimum Embedment
 - iii. Bracing Information
 - iv. Soil Anchor Information
 - c. If welding of casing is proposed, submit the proposed welding procedure, certified by a qualified welding specialist.
 - d. Plan describing how surface water, drill flush, and excess waste grout will be controlled and disposed.
 - e. Proposed Grouting Plan (if included) The grouting plan shall include complete descriptions, details, and supporting calculations for the following
4. Proposed Sequencing Plan. The sequencing plan shall include complete descriptions, details, and supporting calculations for stage depth demonstrating the pre shoring excavation depths, the maximum depths that the shoring can support prior to the installation of the anchors.

Work other than test pile installation shall not begin until the construction submittals have been received, reviewed, and accepted in writing by the Engineer.

SPECIFICATIONS

- D. Design Requirements. The shoring system shall, at a minimum, be designed considering the following loads:
1. The excavation shoring shall be designed to resist the influence of any surcharge loads from adjacent existing structures, roadways and ponds shown on the Contract Drawings, and shall be designed to prevent damage to the adjacent existing structures and roadways.
 2. Temporary shoring components shall be removed to a minimum of 5 feet below final design grade when no longer needed. Notify the Owner and the Owner's Engineer prior to removing shoring.
 3. Temporary Shoring Components should be designed based on the following soil parameters:
 - a. Sand Stratum: a total unit weight of 115 cubic feet per cubic foot (effective unit weight of 53 pounds per cubic foot) and a design friction angle of 30 degrees. And a design cohesion of 0 pounds per square foot.
 - b. Silt Stratum: a total unit weight of 110 cubic feet per cubic foot (effective unit weight of 48 pounds per cubic foot) and a design friction angle of 0 degrees. And a design cohesion of 1000 pounds per square foot.

Stratum elevations should be determined based on the available soils information.

 - c. Steel sheeting should be installed to a minimum elevation of -35 feet, or a minimum of 20 feet below the excavation depth within the wet well, whichever is lower.
 - d. A minimum surcharge load of 250 pounds per square foot to the roadway and slope above the shored system, in addition to construction loads proposed by the contractor.
 - e. A design maximum groundwater elevation exterior to the shoring shall be elevation 10.0 .

PART 2 – PRODUCTS

- 2.1 Furnish materials new and without defects. Remove defective materials from the jobsite at no additional cost. Materials for shoring shall consist of the following:
- A. Steel Sheet Piles. Steel sheet piling shall be hot-rolled sections, as called out, conforming to ASTM A572, Grade 50. The interlocks of the sheet piling shall be free-sliding, providing a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintain continuous interlocking when installed. Provide manufacturer's installed interlock sealant on all interlocks.
 - B. Plates and Shapes: Structural steel plates and shapes for anchor top attachments shall conform to ASTM A 36/AASHTO M183, or ASTM A 572/AASHTO M223, Grade 350.

PART 3 – EXECUTION

- 3.1 Examination
- A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Contractor shall remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.
 - B. Coordinate work with other contractors, building operator and owner, to prevent conflict with ongoing operations.

SPECIFICATIONS

3.2 Protection of Existing Structures and Utilities

- A. Protect existing structure. Equipment and installation methods shall not cause damage to existing buildings or underground utilities.
- B. Document and locate existing underground structures and utilities. Notify Engineer of any conflicts prior to work.

3.3 Shoring Installation

- A. Site Drainage Control. The Contractor shall control and properly dispose of drill flush and construction related waste, including excess grout, in accord with the applicable engineering practices and all applicable local codes and regulations. Provide positive control and discharge of all surface water that will affect construction of the shoring and tieback anchor installation. Maintain all pipes or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost. Upon substantial completion of the Work shoring, and installation of the design surface water controls in the pad, remove temporary surface water control pipes or conduits from the site. Immediately contact the Engineer if unanticipated existing subsurface drainage structures are discovered during excavation or drilling. Suspend work in these areas until remedial measures meeting the Engineer's approval are implemented.
- B. Excavation. Coordinate the work and the excavation so the shoring structures are safely constructed. Perform the shoring construction and related excavation in accordance with the Plans and approved submittals. No excavations steeper than those specified herein or shown on the Plans will be made above or below the shoring structure locations without written approval of the Engineer.
- C. Shoring Installation. The shoring Contractor shall select the sheet installation method, anchor drilling method, the grouting procedure, and the grouting pressure used for the installation of the shoring. The Contractor shall also determine the anchor, final drillhole diameter and bond length, and central tendon reinforcement steel sizing necessary to develop the specified load capacities and load testing requirements developed by the Contractor's engineer. The Contractor is also responsible for estimating the grout take. There will be no extra payment for grout overruns.

1. Drilling.

- a. The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, without causing damage to any overlying or adjacent structures or services. The drillhole must be open along its full length to at least the design minimum drillhole diameter prior to placing grout and reinforcement.
- b. Temporary casing or other approved method of pile drillhole support will be required in caving or unstable ground to permit the pile shaft to be formed to the minimum design drillhole diameter. The Contractor's proposed method(s) to provide drillhole support and to prevent detrimental ground movements shall be reviewed by the Engineer. Detrimental ground movement is defined as movement which requires remedial repair measures. *Use of drilling fluid containing bentonite is not allowed.*

2. Pipe Casing and Reinforcing Bars Placement and Splicing.

- a. Reinforcement may be placed either prior to grouting or placed into the grout - filled drillhole before temporary casing (if used) is withdrawn. Reinforcement surface shall be free of deleterious substances such as soil, mud, grease or oil that might contaminate the grout or coat the reinforcement and impair bond. Pile cages and reinforcement arming if used shall be sufficiently robust to withstand the installation and grouting process and the withdrawal of the drill casings without damage or disturbance. The Contractor shall check pile top elevations and adjust all installed anchors to the planned elevations.

SPECIFICATIONS

- b. Centralizers and spacers (if used) shall be provided at 10 feet centers maximum spacing. The upper and lower most centralizer shall be located a maximum of 5 feet from the top and bottom of the anchor. Centralizers and spacers shall permit the free flow of grout without misalignment of the reinforcing bar(s).
 - 3. Grouting.
 - a. Tieback anchors shall be primary grouted the same day the load transfer bond length is drilled. Tiebacks not grouted within 24 hours of the bond length drill date should be redrilled to an additional depth at no additional cost to Owner.
- 3.4 Construction Monitoring. The contractor shall be responsible to perform a minimum of 3 readings a week during construction and weekly monitoring for a period of not less than 3 months post construction.
 - A. Survey-Work Monitor: Install a minimum of 5 survey points along the top of the wall to monitor for displacement or soil movement. Resurvey benchmarks three times a week during installation of excavation support and protection systems, excavation progress, and weekly thereafter. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Owners' engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
 - B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.
 - C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.
- 3.5 The contractor shall be responsible for performing quality control of the shoring system and shall provide the test results to the Owner upon completion. At a minimum, testing records should include tieback grout testing and load test results and vibration monitoring reports.
- 3.6 Clean-up. The contractor shall remove all material excavated and discarded by shoring and anchor drilling and grouting operations from project site to approved disposal areas.

SPECIFICATIONS

SECTION 02300 - EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete pavements.
5. Subbase and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling for utility trenches.

B. Related Sections include the following:

1. Division 1 Section 01500 "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities.
2. Division 2 Section 02300 "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
3. Division 2 Section 02240 "Dewatering" for lowering and disposing of ground water during construction.
4. Division 2 Section 02920 "Lawns and Grasses" for finish grading, including preparing and placing topsoil and planting soil for lawns.
5. Division 2 Sections for installing underground utilities.
Department of Natural Resources and Environmental Control,
Soil/Material Re-Use Policy at HSCA Regulated Sites
6. Department of Natural Resources and Environmental Control, Soil/Material Re-Use Policy at HSCA Regulated Sites

1.2 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

SPECIFICATIONS

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that cannot be efficiently removed by normal job equipment such as power shovels (e.g. Caterpillar 235C) or bulldozers (e.g. Caterpillar D9N with ripper attachment).
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- J. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 SUBMITTALS

- A. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 1. Classification according to ASTM D 2487 of each borrow soil material proposed for fill and backfill.
 2. Laboratory compaction curve according to ASTM D 1557 for each borrow soil material proposed for fill and backfill.

1.4 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Engineer and then only after arranging to provide temporary utility services according to requirements indicated.
 1. Notify Engineer not less than two days in advance of proposed utility interruptions.
 2. Do not proceed with utility interruptions without Engineer's written permission.
 3. Contact utility-locator service for area where Project is located not less than two (2) days and not more than ten (10) days before excavating. The phone number for Miss Utility is 1-800-257-7777.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

SPECIFICATIONS

C. Topsoil: Original surface, friable loam topsoil of uniform quality, free from heavy clay, coarse sand, stones over two (2) inch, lumps, frozen clods, plants, roots, sticks, and foreign materials harmful to plant growth.

1. Topsoil shall be reasonably free from two (2) inch or larger fragments of hot-mix, concrete pavement and surface treatment and shall not contain objectionable plant materials, or vegetable debris undesirable or harmful to plant life.
2. Topsoil shall be reasonably free of noxious perennial weeds or woody vegetation and completely void of Johnson grass (*Sorghum halapense*).
3. The topsoil shall have an acidity range of pH 6.0 to pH 7.5.
4. Topsoil shall contain not less than 2 percent nor more than 30 percent organic matter as determined in accordance with AASHTO T267 test method.
5. The method of testing topsoil shall be in accordance with the requirements of AASHTO T88, Modified, AASHTO T89, Method B; AASHTO T90 and meet the following specified grading:

<u>Sieve Size</u>	<u>Minimum Percent Passing</u>
2 inch	100
No. 4	90
No.10	80

6. Topsoil sand, silt and clay contents shall be as follows:

	<u>Minimum Percent</u>	<u>Maximum Percent</u>
Sand	15	65
Silt	10	60
Clay	5	40

7. Topsoil shall not be delivered until samples have been reviewed by the Engineer.
8. Topsoil shall be secured from areas from which topsoil has not been previously removed either by erosion or mechanical methods, and it shall not be removed to a depth in excess of the depth approved.
9. The area or areas from which topsoil is secured shall possess such uniformity of material depth, color, texture, drainage, and other characteristics as to offer assurance that when removed in commercial quantities, the product will be homogeneous in nature and will conform to the requirements of these specifications.

D. Borrow for Embankments and Subgrades: The uses, classification, characteristics, and definitions of terms for borrow materials obtained shall be in accordance with the requirements of AASHTO M 57, Modified; M145, Modified, M146; and M147, Modified. Materials having a dry weight less than 90 pounds per cubic foot, materials with liquid limits in excess of 50 and materials containing detrimental quantities of frozen material, rubbish, boulders in excess of 6" or organic matter such as leaves, roots, grass or sewage shall be excluded from use. The method of testing materials shall be in accordance with the requirements of AASHTO T 88, modified; T 89, modified; T 90, modified; and T 99, Method C, modified. In addition to the above requirements, which will be applicable for use in all types of embankment construction, the following borrow types will be subject to the additional requirements noted:

1. Borrow Type A shall be bank-run gravel slag, quarry waste, stone screenings or other acceptable granular material which has between 95 to 100% inclusive by dry weight passing a 3" sieve and a maximum of 35% by dry weight passing the No. 200 sieve.
2. Special Fill, Borrow Type B, material shall have 100% by dry weight passing a 3" sieve and a maximum of 10% by dry weight passing the No. 200 sieve.
3. Backfill, Borrow Type C, material shall have between 85 and 100% inclusive by dry weight passing a 1" sieve and a maximum of 25% by dry weight passing the No. 200 sieve.
4. Borrow Type D, material for concrete stabilization shall have 100% dry weight passing a 3" sieve and between 8 to 30% inclusive by dry weight passing the No. 200 sieve.
5. Borrow Type E, material for asphalt stabilization shall have 100% by dry weight passing a 3" sieve and between 6 to 20% inclusive by dry weight passing the No. 200 sieve. This material shall be non-plastic.
6. Common Borrow, Borrow Type F, material shall meet general requirements as specified under Section M.10.

SPECIFICATIONS

7. Select Borrow, Borrow Type G, shall meet any of the grading requirements listed in the following table:

Sieve Size	TYPE G (SELECT BORROW)					
	Percentage By Weight Passing Square Mesh Sieves					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
2"	100	100	95-100	95-100	95-100	95-100
1"	-	75-95	85-100	85-100	85-100	85-100
3/8"	30-65	40-75	50-85	60-100	-	-
No. 4	25-55	30-60	35-65	50-85	55-100	70-100
No. 10	15-40	20-45	25-50	40-70	40-100	55-100
No. 40	8-20	15-30	15-30	25-45	20-50	30-70
No. 200	2-8	5-20	5-15	5-20	6-20	8-25

Note: The fraction passing the No. 200 sieve shall not be greater than two-thirds of the fraction passing the No. 40 sieve. The fraction passing No. 40 sieve shall have a liquid limit not greater than 25 and a plasticity index not greater than 6, when tested according to AASHTO T 89, modified, and T 90.

- E. Graded Aggregate Base Courses: Coarse crushed stone, crushed slag fragments, or portland cement concrete fragments blended with crushed particles of the same origin.
1. Gradation Requirements as follows in accordance with AASHTO T2 , T27 and T96:

Sieve Size	Percent Passing TYPE A (CR-1)	Percent Passing TYPE B (Crusher Run)
2-1/2"	—	—
1-1/2"	100	—
1"	—	100
3/4"	50 - 80	—
No. 4	—	50 - 95
No. 10	20 - 50	20 - 50
No. 20	—	15 - 40
No. 100	10 - 30	—
	2 - 20	2 - 20

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 2 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 2 Section "Site Clearing," during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

SPECIFICATIONS

- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
 - 2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

- A. Explosives shall not be used on this project.

3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs on grade.
 - f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
 - 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.

SPECIFICATIONS

Excavate trenches to uniform widths to provide clearance on each side of pipe or conduit as indicated on Drawings. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.

Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade. Bell holes shall be provided at each joint to permit proper joint assembly and alignment. Any part of the trench bottom excavated below subgrade shall be backfilled to subgrade and shall be compacted as required to provide firm pipe support.

3.8 SUBGRADE INSPECTION

- A. Notify Engineer when excavations have reached required subgrade.
- B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
 - 2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.
- B. Fill unauthorized excavations under other construction or utility pipe as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
- B. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

SPECIFICATIONS

2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of standing water, mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of standing water, mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

D. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit.

2. Coordinate backfilling with utilities testing.

E. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

SPECIFICATIONS

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
 - 3. Under lawn or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
 - 4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus 1 inch.
 - 3. Pavements: Plus or minus ½ inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of ½ inch when tested with a 10-foot straightedge.

3.17 BASE COURSE

- A. Place base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place base course under pavements and walks as follows:
 - 1. Place base course 6 inches or less in compacted thickness in a single layer.
 - 2. Place base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 3. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
- C. The subgrade shall be properly shaped and uniformly and thoroughly compacted in conformity with the lines and grades as shown on the Drawings and/or as established in the field before any subbase, base, or surfacing material is placed. The subgrade shall be free from boulders, large rocks, muck, vegetation, or other materials that would prove detrimental to the road. Depressions that develop during the rolling shall be filled with suitable material and the subgrade shall be rolled until no depressions develop.

SPECIFICATIONS

- D. Where excavation to the finished graded section results in a subgrade of unsuitable soil, the Engineer may require the Contractor to remove the unsuitable materials and backfill to the finished graded section with approved material. The Contractor shall conduct his operations in such a way that the Engineer can take the necessary cross-sectional measurements before the backfill is placed.
- E. When directed by the Engineer, test roll the prepared subgrade prior to the placement of any base or subbase material.
- F. Test roll with self-propelled equipment of adequate size, type, and weight to reveal any soft, yielding, or spongy areas.
- G. If the test rolling shows the subgrade to be unstable, scarify, disc, aerate, or add moisture and recompact the subgrade to the extent that when retested by the above methods it will be stable, the cost of which will be at the Contractor's expense.
- H. If, in the opinion of the Engineer, there are areas to be removed or undercut, they may be ordered excavated and replaced; however, as determined by the Engineer, areas which become soft, or spongy due to the Contractor's methods of operation shall be removed and/or repaired at the Contractor's expense.
- I. The subgrade must be maintained in such condition that it will drain. Prior to the formation of the final subgrade or of the cutting of any box section in which the subbase or base will be placed, all side ditches parallel to the center line of the project shall be cut to their plan gradient. Temporary ditches permitting drainage from box sections to side ditches shall be provided at intervals as required. All facilities necessary for complete drainage of the construction areas shall be provided and maintained by the Contractor.
- J. In no case shall vehicles be allowed to travel in a single track and form ruts in the subgrade, and if any sharp irregularities are formed the subgrade shall be scarified and recompact.
- K. The graded aggregate base course as spread shall be well graded, have no pockets of fine material, and be so handled that there will be no segregation of fine or coarse particles. No base course material shall be spread more than 1,000 feet in advance of rolling and filling, except by written permission by the Engineer. No materials shall be placed adjacent to structures until they have been set to the required grade and alignment.
- L. The graded aggregate base course shall be rolled with a self-propelled roller weighing not less than ten (10) tons or approved vibratory equipment may be used. The rolling shall begin at the edges of the courses and on the final course the outside wheel of the roller shall cover equal parts of the material and the shoulder. The roller shall run forward and backward along the edge until the shoulder and course material are bound together firmly. When the sides have been firmly rolled, the rolling shall progress gradually toward the center, parallel with the center line of roadway, uniformly lapping each preceding track and covering thoroughly the entire surface with the rear wheel, and continuing until the entire surface does not creep nor wave ahead of the roller.
- M. The development of a spongy condition in the rolling process will justify either a discontinuance of the rolling for a period of time sufficient to permit the drying of the subgrade, or the complete removal of the base course and a treatment of the subgrade, all of which will be done under the direction of the Engineer.
- N. After the premixed material has been thoroughly rolled, it may be necessary to apply screenings gradually over the surface in such amounts as will completely fill the interstices of the rolled material.
- O. Immediately after the voids of each course have been filled with screenings, the premixed material shall be sprinkled with an approved sprinkling device. The sprinkling and rolling shall be continued and additional screenings applied where necessary until the course material is well bonded and firmly set. The quantity of screenings and water necessary for each course shall be determined by the Engineer. In no event shall the screenings remaining on the final surface be of such thickness as to be picked up by truck wheels or the finisher after the base course has been tack-coated. At all times the rolling shall begin at the sides, overlapping the shoulders and progressing toward the center, thoroughly covering the entire surface with the rear wheels.

SPECIFICATIONS

- P. Should the subgrade become soft and mixed through the premixed base course material, the Contractor shall, without additional compensation, remove the mixture, reshape and compact the subgrade, and replace the materials removed with clean aggregate which shall be rolled, broomed, and filled until compacted satisfactorily and uniformly with the surrounding surface.
- Q. The finished surface of the base course shall not vary from that required on the plans by more than 1/2" when tested with a 10' straightedge applied to the surface parallel to the center line of the pavement and with a template cut to the cross-section of the roadway and applied to a transverse direction. Such portions of completed base course which are defective, or which do not comply in all respects with the requirements of the Contract Documents, shall be taken up, removed, and replaced with a suitable material, properly laid in accordance with the Contract Documents. The transverse template shall be equal in length to the full width of the roadway, except the template lengths may be limited to a 24' maximum. The Contractor shall designate one employee whose duty it will be to perform the checking operation as required.

3.18 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the locations and frequencies directed by the Engineer.
- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.19 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
 - 1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 02300

SPECIFICATIONS

SECTION 02510 - WATER DISTRIBUTION

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water main systems with the following components:

1. Piping Materials.
2. Restrained mechanical joint fittings.
3. Gate valves.
4. Valve boxes.
5. Service Connections.
6. Fire Hydrants.
7. Disinfection.
8. Concrete.
9. Miscellaneous materials.

1.2 DEFINITIONS

- A. DI: Ductile Iron.
- B. PE: Polyethylene.
- C. PVC: Polyvinyl chloride plastic.
- D. SDR or DR: Ratio of pipe diameter to wall thickness.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Pipe
2. Fittings
3. Valves & Boxes
4. Fire Hydrants
5. Hydrant harnessing or restraining
6. Service connection clamps
7. Corporation Stops
8. Curb Stops
9. Water service lines
10. Disinfection

1.4 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe, pipe fittings, and seals from dirt and damage.

PRODUCTS

1.5 PIPING MATERIALS

A. The following piping systems shall be used on this Project:

SPECIFICATIONS

1. Service Connections:
 - a. Encasement Pipe: Galvanized steel.
 - b. Carrier Pipe: PVC SDR 9 pressure pipe and gasketed joints.
- B. Pipe Identification
 1. Each length of pipe shall be marked at intervals of five (5) feet to include the following when applicable to that type of pipe:
 - a. Nominal size and/or O.D. base
 - b. Material code designation or cell classification
 - c. Schedule or dimension ratio number
 - d. AWWA pressure class
 - e. AWWA and/or ASTM designation number
 - f. Manufacturer's name or trademark
 - g. Seal of testing agency verifying potable water service
- C. Ductile Iron Pressure Pipe and Fittings
 1. Pipe: AWWA C151, Class 52 unless noted otherwise.
 2. Joints: AWWA C111
 - a. Use push-on or mechanical joints below grade unless otherwise specified
 - b. Use flanged joints and stainless steel hardware above grade unless otherwise specified
 3. Standard Fittings: AWWA C110, ductile or gray iron.
 4. Compact Fittings: AWWA C153.
 5. Gaskets: AWWA C111, rubber.
 6. Coatings: Cement lined and bituminous coated inside and out with AWWA C104.
- D. Polyethylene (PE) Pipe and Fittings
 1. Pipe: high molecular weight high density polyethylene pipe in accordance with AWWA C 901, fabricated from material having a classification of ASTM D 1248. The pipe shall be iron pipe I.D., SDR 9, Class 160 in accordance with ASTM D-2239.
- E. PVC Pressure Pipe and Fittings
 1. Pipe: AWWA C900, Class 100, DR25 for gasketed joints and using ASTM F 477 elastomeric seals.
 2. PVC Fittings: AWWA C907, for gasketed joints and using ASTM F 477 elastomeric seals.
 3. Standard Ductile Iron Fittings: AWWA C110, ductile or gray iron.
 4. Compact Ductile Iron Fittings: AWWA C153.
- F. Steel Pipe and Fittings
 1. Pipe: shall be continuous pipe fabricated from steel plate in accordance with AWWA C 201.
 2. Joints: Joints shall be welded or flanged as shown on the Drawings except at equipment and valves where flange joints shall be required. Welded flanges may be socket type or of the butt type. Encasement pipe joints shall be fully welded.
- G. Galvanized Steel Pipe and Fittings
 1. Pipe: Schedule 40, hot-dipped in accordance with ASTM A 53 unless otherwise noted.
 2. Fittings: ASTM A 53
 - a. Pipe having a diameter of 3 inches or less shall have galvanized malleable iron threaded fittings and screwed, malleable iron, ground joint, brass seat, 150 psi unions shall be used to connect piping to valves and equipment to facilitate their removal and replacement.

SPECIFICATIONS

- b. Pipe having a diameter greater than 3 inches shall be joined with galvanized welded fittings shall have flanges when attached to valves or equipment. Elbows shall be long radius, whenever possible.

1.6 RESTRAINED MECHANICAL JOINT FITTINGS

- A. Gland body and restraint components: minimum ASTM A536, 60-42-10 ductile iron. Restraint shall be incorporated into the design of the follower gland.
- B. Available Product: MEGALUG manufactured by EBAA Iron, Inc.

1.7 GATE VALVES

- A. Conform to AWWA C509, Standard for Resilient Seated Gate Valves for Water Supply Service. Valve wedge shall be constructed of ductile iron, encapsulated in resilient rubber. Wedge rubber shall be molded in place and bonded to the ductile iron wedge, not mechanically attached with screws or rivets. Waterway shall be smooth and shall have no depressions or cavities in the seat area. Valve body and bonnet shall be epoxy coated, inside and out with fusion bonded epoxy conforming to AWWA C550.
 - 1. Buried gate valves shall be fitted with 2" square wrench nuts.
 - 2. Operators for other installations shall be handwheel, chain wheel, or mechanical operators as shown on and as required by the Contract Documents.
 - 3. Manufacturers:
 - a. U.S. Pipe
 - b. American Flow Control
 - c. Mueller

1.8 VALVE BOXES

- A. Valve boxes for buried valves shall be 3-piece adjustable screw type, 5 1/4" shaft diameter with "WATER" cast in cover.
 - 1. Manufacturers:
 - a. Tyler
 - b. Mueller
 - c. Clow
 - d. Kennedy
 - e. M&H

1.9 SERVICE CONNECTIONS

- A. All water service pipe shall size as shown on drawings, seamless, polyethylene tubing SDR 9 with schedule 40 galvanized steel encasement pipe at road crossings.
- B. Corporation Stops: Include the corporation stop, coupling nuts and insert stiffeners and shall be Mueller H-15026 or equal.
- C. Curb Stops: the curb stop, coupling nuts and insert stiffeners shall be Mueller H-1505-2, H-15191, or equal.
- D. Curb Stop Boxes: shall be adjustable screw type with "WATER" cast in the cover. Boxes for curb stops larger than 1" size shall be provided with an adapter curb box base. Curb stop boxes shall be Mueller Arch Base or equal.
- E. Service Saddles: shall conform to AWWA C800. Shall have a ductile iron body, 304L stainless steel straps and nitrile rubber gaskets. Threads shall be compatible with the corporation stop threads. Saddles for PVC pipe shall be preformed at the factory to the exact outside diameter of the pipe. Saddles shall be Mueller DN1S or equal.

SPECIFICATIONS

1.10 FIRE HYDRANTS

- A. Dry-Barrel Fire Hydrants: Shall conform to AWWA C502 as applicable to dry-barrel, compression type main valve, break flange hydrants. The hydrant shall be so designed that when it is in place, no excavation will be required to remove the main valve and the movable parts of the drain valve. Nominal main valve opening shall be 5 1/4 inches. Inlet connection shall be six (6) inches unless otherwise required by the Drawings. Pumper nozzle shall be 4 1/2 inches and the two (2) hose nozzles shall be 2 1/2 inches with threads to suit local fire department.
 - 1. Fire hydrants shall be B-62-B as manufactured by American Darling.
 - 2. Operating and Cap Nuts: Size and shape of operating nut shall be to suit local fire department.
 - 3. Direction of Opening: Hydrant shall open left or counterclockwise. The word "OPEN" and an arrow indicating the direction to open shall be cast in the hydrant cover.
 - 4. Exterior Finish: Color of fire hydrant shall be selected by Owner.

1.11 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 - 1. Cement: ASTM C 150, Type I or IA.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Buttresses, Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

1.12 MISCELLANEOUS MATERIALS

- A. Polyethylene Sheeting: ASTM D 4397, with at least 8-mil thickness
- B. Casing chocks: Metal components shall be stainless steel, type 304, liner shall be PVC and skids shall be fiberglass reinforced nylon. Manufacturer: PowerSeal Pipeline Products Corporation
- C. Detectable Pipeline Wire: Insulated (green color) solid copper, #14 AWG, 600 volt, of not less than 90% conductivity, conforming to ASTM Designation B.58. Splicing of wires shall be by a solderless, split-bolt lug connector, Type IK-8, by ILSCO or equal.
- D. Detectable Pipeline Warning Tape: Metallic type with metal foil running the full length and width of the tape. Foil shall be encased in a high visibility, color coded, insert plastic jacket with continuous, clearly imprinted identification legends.
 - 1. Manufacturer:
 - a. Allen Systems
 - b. Terra-Tape
 - 2. Colors and legends shall be in accordance with the American Public Works Association's recommended color code and the following:

Utility	Color	Legend
Electric	Safety Red	Caution - Buried electric line below

SPECIFICATIONS

Gas, oil, flammable materials	High Visibility Yellow	Caution - Buried gas line below
Communication	Safety Alert systems	Caution - Buried telephone line below Orange
Water systems	Safety/Precaution Blue	Caution - Buried water line below
Sewer systems	Safety Green	Caution - Buried sewer line below

PART - 2 EXECUTION

2.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

2.2 OPEN TRENCH WATER MAIN INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground water main piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Conform to the latest edition in effect at time of bid opening of ASTM D2774, AWWA C-600, the manufacturer's recommendations, and the Contract Documents.
- C. Install piping with 42-inch minimum cover.
- D. The trench bottom shall be constructed to provide a firm, stable and uniform support for the full length of the pipe. Bell holes shall be provided at each joint to permit proper joint assembly and alignment. Any part of the trench bottom excavated below grade shall be backfilled to grade and shall be compacted as required to provide firm pipe support. When an unstable subgrade condition is encountered, which will provide inadequate pipe support, additional trench depth shall be excavated and refilled with suitable foundation material.
- E. Keep interiors of pipes and fittings clean before installation and until final acceptance. Pipe delivered for construction shall be stored so as to minimize entrance of foreign material. When pipe laying is not in progress, all openings in the pipeline shall be closed by watertight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.
- F. Pipe and fittings shall be carefully handled and placed in the trench. Special care shall be taken to insure that each length of pipe abuts against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the bottom half of the pipe.
- G. Concrete thrust blocking or anchors shall be provided on all buried lines at bends, tees, capped or valved ends, fittings, and where directed by the Engineer. Blocking or anchors shall be poured against undisturbed earth and shall be in accordance with these Contract Documents. Mechanical joint restraints shall be provided at bends, tees, capped or valved ends, and fittings in addition to concrete thrust blocking or anchors at locations shown on the Drawings.
- H. The greatest of care shall be used to secure water tightness and to prevent damage to or disturbing of the joints during the backfilling process or at any time. After pipes have been laid and the joints have been made walking on or working over the pipe shall be limited to such as may be necessary in tamping until there is a covering of at least 2 feet in depth over the top of the pipe.

SPECIFICATIONS

- I. Install valves of the sizes and at the locations shown on the Drawings in accordance with these Contract Documents. Place bedding uniformly and provide support masonry as needed to maintain the valve stem plumb. Set the valve box plumb, centered over the operating nut, and uniformly bedded. Set the valve box cover flush with finished grade. In non-paved areas provide a concrete collar around the top of the valve box.
- J. Place pipeline detectable tape between 18 inches and 24 inches above the water main. At no time shall detectable tape be placed at a depth less than 6 inches.
- K. Place pipeline detectable wire along the full length of the installed pipe including encased road crossings. Remove the insulation at the splices, so a metal to metal connection is made. Place the wire in the bottom of the trench prior to any backfilling such that it and the water main are separated by not more than 3 inches distance. Bring the wire up to the surface of the ground at the beginning and termination of the pipe, and at any in-line valving (interior of the valve box or manhole) and any other appropriate location, or as directed by the Engineer.

2.3 JACK-BORED, ENCASED PIPING INSTALLATION

- A. Install steel pipe encasement conduit by the jack boring method. Joints shall be welded around the entire pipe circumference.
- B. The boring shall consist of pushing the pipe into the fill with the boring auger rotating within the pipe to remove the spoil. When augers or similar devices are used for pipe emplacement, the front of the pipe shall be provided with mechanical arrangement or devices that will positively prevent the auger and cutting head from leading the pipe so that there will be no unsupported excavation ahead of the pipe. The auger and cutting head arrangement shall be removed from within the pipe in the event an obstruction is encountered.
- C. The overcut by the cutting head shall not exceed the outside diameter of the pipe by more than $\frac{1}{2}$ inch. The face of the cutting head shall be arranged to provide reasonable obstruction of the free-flow of the soft material. The use of water or other fluids to facilitate carrier pipe emplacement and spoil removal is prohibited.
- D. If an obstruction is encountered during installation that stops the forward movement of the pipe, and it becomes evident that it is impossible to advance the pipe, cease operations, abandon the pipe in-place and fill completely with grout.
- E. Bore hole shall be essentially the same diameter as the outside of the pipe plus a thickness of the protective coating. If voids should develop or if the bored hole diameter is greater than the outside diameter of the pipe plus coating by more than approximately one inch, fill the voids with grout or by other methods, reviewed and approved by the Engineer.
- F. Pressure grout or freeze the soils before jacking or boring, if necessary, to stabilize the soils, control water, prevent loss of material, and prevent sediment or displacement of embankments. Grout shall be cement, chemical, or other special injection material selected to accomplish the necessary stabilization.
- G. The material to be used in the method of injection shall be prepared by a registered professional soils engineer or by an experienced and qualified company specializing in this work and submitted for review by the Engineer before the start of work. Proof of experience and competency shall accompany the submission.
- H. When water is known and expected to be encountered, operate and maintain pumps of sufficient capacity to handle the flow of water. Attended the pumps on a 24-hour basis until the operation can be safely halted. When dewatering, maintain close observation to detect any settlement or displacement of highways, embankments and facilities.
- I. At all times when the work is in progress, a field supervisor for the work, having no less than twelve (12) months, experience in the preparation of the equipment being used shall be present. If boring, drilling or similar machines are being used, the machine operator shall have no less than twelve (12) months experience in the operation of the equipment being used.

SPECIFICATIONS

- J. After the encasement conduit has been installed and accepted in writing by the Engineer, install the carrier pipe by one of the methods as follows:
 - 1. Strap salt treated 4-inch by 4-inch timber skids, 24-inches shorter than the pipe length to the carrier pipe. Install at least two (2) stainless steel straps on each length of pipe. Notch the wood skids one inch deep to prevent the strap from being in contact with the encasement conduit. Push the pipe into the encasement conduit with care being taken to ensure the joints are not displaced. Secure the pipe against movement with rods and turnbuckles, with struts or with additional skids.
 - 2. Attach casing chocks to the carrier pipe at not more than 2 feet from each the end of the casing and on 5-foot centers in between. Push the pipe into the encasement conduit with care being taken to ensure the joints are not displaced.
- K. Test the carrier pipe for leakage prior to backfilling with stabilized sand. Mix stabilized sand in proportions of at least three (3) sacks of portland cement to each cubic yard of sand. Thoroughly mix the cement, sand and water in a mechanical mixer using only enough water to provide a mixture which will fill all voids. Place the stabilized sand mixture pneumatically or by other means approved by the Engineer.
- L. Plug each end of the casing with Elastoseal and stainless steel clamps by PowerSeal, Link Seal fittings, or other methods approved by the Engineer.

2.4 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318/318R.

2.5 BURIED VALVE INSTALLATION

- A. Support valves with masonry as needed and bed uniformly to maintain the stem plumb.
- B. Set the valve box plumb, centered over the operating nut, and bed uniformly. Set the valve box cover flush with finished grade.
- C. Provide a concrete collar around the top of the valve box in non-paved areas.

2.6 TESTING AND ACCEPTANCE - WATER MAIN

- A. Test all new water mains before connecting them to the existing system. The Engineer shall determine the amount of main to be tested at any one time and reserves the right to separate the installation into several sections, in the event of long extensions, installations of pipe designed for different head conditions, or for other reasons.
- B. Hydrostatically test the pipe at a pressure 1.5 times the normal working pressure with a minimum pressure of 100 psi. Hold the test pressure for a period of at least two (2) hours during which time the test pressure shall not vary more than +/- 5 psi.
- C. Fill each valved section of pipe with water slowly and apply the specified test pressure, based on the elevation of the lowest point of the line or section under test, corrected to the elevation of the test gauge, by means of a pump connected to the pipe in a manner satisfactory to the Engineer.
- D. Expel air completely from the pipe and valves before applying the specified test pressure. If permanent air vents are not located at all high points, install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, close the corporation cocks and apply the test pressure. At the conclusion of the pressure test, remove the corporation cocks and plug the openings, or leave in place at the discretion of the Engineer.
- E. Conduct a leakage test concurrently with the pressure test. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain the pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

SPECIFICATIONS

- F. The test pressure shall not exceed twice the rated pressure of the valves or hydrants when the pressure boundary of the test section includes said valves or hydrants.

ALLOWABLE LEAKAGE PER 1000 FT. OF PIPELINE - gph

Avg. Test Pressure psi	Nominal Pipe Diameter - In.							
	2	3	4	6	8	10	12	14
250	0.24	0.36	0.47	0.71	0.95	1.19	1.42	1.66
225	0.23	0.34	0.45	0.68	0.90	1.13	1.35	1.58
200	0.21	0.32	0.43	0.64	0.85	1.06	1.28	1.48
175	0.20	0.30	0.40	0.59	0.80	0.99	1.19	1.39
150	0.19	0.28	0.37	0.55	0.74	0.92	1.10	1.29
125	0.17	0.25	0.34	0.50	0.67	0.84	1.01	1.18
100	0.15	0.23	0.30	0.45	0.60	0.75	0.90	1.05

- G. Acceptance shall be determined on the basis of allowable leakage as specified above. If any test of pipe laid discloses leakage greater than specified, the Contractor shall, at his own expense, locate and repair the defective material until the leakage is within the specified allowance. Repair all visible leaks regardless of the amount of leakage.

2.7 SERVICE CONNECTIONS

- A. Except where indicated on the Drawings or directed by the Engineer, service connections to existing users are not to be disturbed by the installation of the new water lines. Services damaged by the Contractor shall be repaired to the satisfaction of the Engineer at the Contractor's cost. Existing service connections are to remain in use until all new service connections have been completed, tested, accepted by the Engineer, and placed into service.
- B. Where existing small water lines are to be replaced by a new water main, new service connections from the new main to the existing curb box are to be provided by the Contractor. Existing curb stops and boxes shall be replaced.
- C. Where PVC water main is installed, a service clamp shall be used for connection of the corporation stop. For ductile iron water main, direct tapping shall be permitted.
- D. The corporation stop shall be placed in the upper half of the water main. Service tubing shall be loosely laid at the indicated depth without kinking. Curb stops shall be set at the proper depth as detailed by the Drawings. Curb boxes shall be set plumb, adequately braced, and set to existing grade. The outlet service connection from the curb stop for future services shall be fitted with a screw plug to restrict dirt from entering the curb stop.
- E. All water service crossing under the road shall be bored or jacked. The use of water or other fluids to facilitate carrier pipe placement and spoil removal is prohibited.
- F. After the encasement conduit has been installed, the water service pipe shall be installed and the ends of the encasement conduit plugged.
- G. All service connections shall be tested for visible leakage. After the service connection has been installed and prior to backfilling, both the corporation stop and curb stop shall be fully opened and the service shall be inspected for leaks around all fittings and connections.
- H. All visible leaks shall be corrected immediately by the Contractor and the test performed again at no additional expense to the Owner.
- I. Service connections shall not be accepted until all testing has been approved by the Engineer.

2.8 FIRE HYDRANTS

SPECIFICATIONS

- A. All hydrants shall stand plumb and shall have their nozzles parallel with, or at right angles to, the curb or centerline of roadway, with the pumper nozzle facing the curb or roadway.
- B. Each hydrant shall be connected to the water main with a 6-inch ductile iron pipe branch controlled by an independent 6-inch valve as shown on the Drawings.
- C. When a dry-barrel hydrant is set in soil that is pervious, drainage shall be provided at the base of the hydrant by placing coarse gravel or crushed stone mixed with coarse sand, from the bottom of the trench to at least 6 inches above the waste opening in the hydrant and to a distance of 1 foot around the elbow. Where groundwater rises above the drain port or when the hydrant is located within 8 feet of a sewer, the drain port shall be plugged and water pumped from the hydrant when freezing may occur.
- D. When a dry-barrel hydrant with an open drain is set in clay or other impervious soil, a drainage pit 2 ft. x 2 ft. x 2 ft. shall be excavated below each hydrant and filled with coarse gravel or crushed stone mixed with coarse sand, under and around the elbow of the hydrant and to a level of 6-inches above the drain port.
- E. All hydrants shall be well braced with thrust blocking and shall be restrained by means of retainer glands as shown on the Drawings or as approved by the Engineer.
- F. Fire hydrants shall be covered with a plastic bag until that portion of the water main has been tested and placed in service in accordance with the Contract Documents or as directed by the Engineer.
- G. After water mains have been tested and accepted, each hydrant shall be opened with all discharge nozzles fully closed and inspected for leaks. All visible leaks shall be corrected immediately by the Contractor and the test performed again at no additional expense to the Owner.
- H. After testing for leaks all hydrants shall be painted with color to be selected by Owner. Hydrant bonnets shall be color classified in accordance with the hydrants rated capacity. Color shall be as follows:

<u>CLASS</u>	<u>CAPACITY</u>	<u>COLOR</u>
AA	1500 GPM or greater	Light blue
A	1000 - 1499 GPM	Green
B	500 - 999 GPM	Orange
C	250 - 499 GPM	Red
D	Less than 250 GPM	Black

- I. Hydrants shall not be accepted until all testing has been approved by the Engineer.

2.9 DISINFECTION

- A. Precautions shall be taken to protect interior of pipes, fittings, hydrants, and valves against contamination. Pipe delivered for construction shall be stored so as to minimize entrance of foreign material. When pipe laying is not in progress, all openings in the pipeline shall be closed by watertight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.
- B. Calcium hypochlorite tablets shall be placed in each section of pipe and also in hydrants, hydrant branches, and other appurtenances. They shall be attached by an adhesive, except for the tablets placed in hydrants and in the joints between the pipe sections. All tablets within the main shall be placed at the top of the main. If the tablets are fastened before the pipe section is placed in the trench, their position shall be marked on the section to assure that there will be no rotation.
- C. Tablets shall be attached using food grade adhesive. The adhesive may be Permtex Form-A-Gasket No. 2 by Loctite Corporation or equal. There shall be no adhesive on the tablet except on the broad side next to the surface to which the tablet is attached.

SPECIFICATIONS

- D. The following table gives the number of hypochlorite tablets required for pipe of various section lengths and diameter.

NUMBER OF HYPOCHLORITE TABLETS OF 5-g
REQUIRED FOR DOSE OF 25 mg/l*

Length of Section Ft.	Diameter of Pipe Inches					
	2	4	6	8	10	12
13 or less	1	1	1	1	2	3
18	1	1	1	2	3	4
20	1	1	1	2	3	4
30	1	1	2	3	4	6
40	1	1	2	4	5	7

*Based on 3 3/4 g available chlorine per tablet.

- E. When installation has been completed, the main shall be filled with water at a velocity of less than 1-ft/sec. This water shall remain in the pipe for a minimum of 24 hours. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water.
- F. After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/l. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline.
- G. After final flushing, and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriologic quality and shall show the absence of coliform organisms. At least one sample shall be collected from chlorinated supplies where a chlorine residual is maintained throughout the new main. In the case of extremely long mains, samples shall be collected along the length of the line as well as at its end.
- H. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples have been obtained. The tablet method cannot be used in these subsequent disinfections. When the samples are satisfactory, the main may be placed in service.
- I. The procedures outlined below apply primarily when mains are wholly or partially dewatered as a result of cutting into or repairing existing water mains. Leaks or breaks that are repaired with clamping devices while the mains remain full of water under pressure shall require no disinfection.
- J. When existing water mains are excavated for repair work, the trench will likely be wet and badly contaminated from nearby sewers. Liberal quantities of hypochlorite applied to open trench areas will lessen the danger from such contamination. Tablets have the advantage in such a situation because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation.
- K. The following procedure shall be considered as the minimum procedure used to disinfect water mains during repair work. The interior of all pipe and fittings used in making the repair, particularly couplings and tapping sleeves, shall be swabbed with a 1 percent hypochlorite solution before they are installed.
- L. Thorough flushing shall be the means of removing contamination introduced during repairs. If valving and hydrant locations permit, flushing from both directions shall be provided. Flushing shall be started as soon as the repairs are completed and continued until discolored water is eliminated.
- M. All disinfection procedures, requirements for bacteriologic tests, and determination of acceptability shall be subject to the requirements of the Delaware Division of Environmental Health.

SPECIFICATIONS

2.10 SITE RESTORATION

- A. Restore all areas, structures, plants, pavements, facilities, and features to not less than the pre-existing conditions.
- B. Relocate all structures removed for the construction as shown and required by the Contract Documents.
 - 1. Relocate to a location to be determined in the field by the Engineer.
 - 2. New locations shall be within ten (10) feet of the original locations.
 - 3. Structures to be relocated shall include, but not be limited to, road signs, mailboxes, and fences.
- C. Restore areas outside of pavement at a uniform rate closely following installation of the pipeline. Neatly dress the area within one week following backfilling operations. Dress again or permanently restore when the soil has consolidated. Restoration of surfaces shall be completed within fifteen (15) days after the installation of the pipeline.
- D. Replace small trees and shrubs in kind at no additional cost to the Owner in the event that existing plants which are to remain are destroyed beyond use.
- E. Water all trees and shrubs as necessary to maintain the plantings until established.
- F. Mulch trees, shrubs, and ground cover with at least a 2" cover of mulch. Place mulch on the same day of planting. Wrap all trees with the wrapping material overlapping 1-1/2" from the lowest main branches to the base of the tree. Tie the wrapping at the top and bottom, and at 1' intervals along the trunk with twine.
- G. Topsoil, seed, and mulch non-paved areas in accordance with Division 2 Section "Lawns and Grasses."
- H. Restore paved areas in accordance with Division 2 Section "Hot-Mix Asphalt Paving."
- I. Upon completion of the surface restoration, perform a final clean-up within the limits of the project consisting of completely removing unused materials which will mar the appearance of the project, and sweeping dirt from pavements and structures.
- J. Maintain the restoration work for a period of 12-months after final acceptance of the Project at no additional cost to the Owner. The maintenance of the restoration shall include all labor, equipment, material, and supplies necessary, including trench refill and additional topsoil, seeding, mulching, watering, and erosion protection.

END OF SECTION 02510

SPECIFICATIONS

SECTION 02530 - SANITARY SEWERAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes gravity sanitary sewerage systems and force-main pressure sanitary sewerage systems with the following components:
 - 1. Piping.
 - 2. Pressure-type pipe couplings.
 - 3. Pipe expansion joints.
 - 4. Restrained mechanical joint fittings.
 - 5. Resilient seated gate valves.
 - 6. Eccentric plug valves
 - 7. Valve boxes.
 - 8. Check valves.
 - 9. Gravity sewer manholes.
 - 10. Concrete.
 - 11. Miscellaneous materials.

1.2 DEFINITIONS

- A. HDPE: High Density Polyethylene plastic.
- B. PP: Polypropylene
- C. PVC: Polyvinyl chloride plastic.
- D. SDR or DR: Ratio of pipe diameter to wall thickness.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Pipe
 - 2. Fittings
 - 3. Valves & Boxes
 - 4. Manholes

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect pipe, pipe fittings, and seals from dirt and damage.
- B. Handle manholes according to manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Pipe Identification
 - 1. Each length of pipe shall be marked at intervals of five (5) feet to include the following when applicable to that type of pipe:

SPECIFICATIONS

- a. Nominal size and/or O.D. base
- b. Material code designation or cell classification
- c. Schedule or dimension ratio number
- d. AWWA pressure class
- e. AWWA and/or ASTM designation number
- f. Manufacturer's name or trademark
- g. Seal of testing agency verifying potable water service Use push-on or mechanical joints below grade unless otherwise specified
- h. Use flanged joints above grade unless otherwise specified

B. Ductile Iron Pressure Pipe and Fittings

1. Pipe: ASTM A 746 unless noted otherwise.
2. Joints: AWWA C111
 - a. Use push-on or mechanical joints below grade unless otherwise specified
 - b. Use flanged joints and stainless steel hardware above grade unless otherwise specified
3. Standard Fittings: AWWA C110, ductile or gray iron.
4. Compact Fittings: AWWA C153.
5. Gaskets: AWWA C111, rubber.
6. Coatings: Lining shall be Clow Protecto 401, American Polybond Plus, Griffin Sewercoat or approved equal.

C. PVC Non-Pressure Pipe and Fittings

1. Pipe: ASTM, D 3034, SDR 35.
2. Joints: Push-on type using ASTM D 3212 and ASTM F 477 elastomeric seals.
3. Fittings: Fittings shall be manufactured in accordance with the same specifications, and have the same thickness, depth of socket and annular space as the pipe.
 - a. Wyes shall be complete pipe sections. Saddles shall not be permitted.

D. PVC Pressure Pipe and Fittings

1. Pipe: AWWA C 900 for SDR 14, 18 and 25 having outside diameter dimensions of cast iron pipe and ASTM D 2241 for DR 13, 5, 17, 21, and 26 having outside diameter dimensions of steel pipe.
2. PVC Fittings: Fittings shall be fabricated or molded from the same material as the pipe, or ductile iron fittings may be used
3. Standard Ductile Iron Fittings: AWWA C110, ductile iron.
4. Compact Ductile Iron Fittings: AWWA C153.

E. HDPE Pressure Pipe and Fittings

1. Pipe: Materials used for the manufacturing of polyethylene pipe and fittings shall be PE 4710 High Density Polyethylene meeting the ASTM D 3350 cell classification of 445474C. The material shall have a minimum hydrostatic design basis (HDB) of 1600 psi at 73 degrees F when tested in accordance with PPI TR-3, and shall be listed in the name of the pipe and fitting manufacturer in PPI TR-4. HDPE pipe shall be manufactured in accordance with ASTM F 714, AWWA C 906 and NSF 61.
2. Joints: Heat fused butt joints according to ASTM D3261
3. Fittings: Molded fittings according to ASTM D3261.
4. Mechanical fittings used with HDPE pipe shall be specifically designed for, or tested and found to be acceptable for use with polyethylene pipe by the fitting manufacturer. Mechanical fittings designed other materials shall not be used unless authorized by the mechanical fitting manufacturer.

2.2 PRESSURE-TYPE PIPE COUPLINGS

SPECIFICATIONS

- A. Reducing or transition couplings: Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig minimum pressure rating and ends of same sizes as piping to be joined.
- B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg.
 - b. Dresser, Inc.; DMD Div.
 - c. Ford Meter Box Company, Inc.
 - d. JCM Industries.
 - 2. Center-Sleeve Material: Manufacturer's standard.
 - 3. Gasket Material: Natural or synthetic rubber.
 - 4. Metal Component Finish: Corrosion-resistant coating or material

2.3 RUBBER PIPE EXPANSION JOINTS

- A. Manufacturers:
 - 1. Mercer Rubber Company.
 - 2. General Rubber Corporation.
- B. Joint Use:
 - 1. For pressure service - Mercer Style NO. 500N.
 - 2. For aeration blowers - Mercer Style No. 400N Lightweight.
- C. Rubber Expansion Joints: Constructed of the highest grade woven cotton or synthetic fiber and neoprene with integral duck and rubber flanges. Joints shall be of pipeline size to meet test pressures, conditions, and face-to-face measurements as designated. They shall be of a single arch construction unless otherwise designated. All joints located at concrete structural expansion joints shall be of the three-arch type. Arches shall be unfilled except where joints are used on sludge lines. In this case, arches shall be filled with soft rubber. Rubber expansion joints shall be of such design as to withstand the test pressures required without deformation, damage, or leakage. Galvanized split retaining rings and control units shall be furnished and installed as required to withstand the test pressures applied to the lines. Supplied with permanent galvanized steel control rods to prevent excessive expansion.
 - 1. Included Accessories: Temporary wire mesh. This wire mesh shall be 17-gauge stainless steel with 1/4-inch opening with a minimum net open area of 70 percent.

2.4 RESTRAINED MECHANICAL JOINT FITTINGS

- A. Gland body and restraint components: minimum ASTM A536, 60-42-10 ductile iron. Restraint shall be incorporated into the design of the follower gland.
- B. Available Product: MEGALUG manufactured by EBAA Iron, Inc.

2.5 CHECK VALVES

- A. Horizontal swing check valves shall be flanged, iron body, bronze mounted, swing gate, with outside lever and adjustable weight type, rated for the same pressure as the pipe in which installed. Bonnet shall be sufficiently large to permit cleaning and maintenance of the inner works without removing the valve body from the line.
 - 1. Manufacturers:
 - a. ITT Kennedy
 - b. Mueller

2.6 RESILIENT SEATED GATE VALVES

SPECIFICATIONS

- A. Conform to AWWA C509, Standard for Resilient Seated Gate Valves for Water Supply Service. Valve wedge shall be constructed of ductile iron, encapsulated in resilient rubber. Wedge rubber shall be molded in place and bonded to the ductile iron wedge, not mechanically attached with screws or rivets. Waterway shall be smooth and shall have no depressions or cavities in the seat area. Valve body and bonnet shall be epoxy coated, inside and out with fusion bonded epoxy conforming to AWWA C550.
1. Buried gate valves shall be fitted with 2" square wrench nuts.
 2. Operators for other installations shall be handwheel, chain wheel, or mechanical operators as shown on and as required by the Contract Documents.
 3. Manufacturers:
 - a. U.S. Pipe
 - b. American Flow Control
 - c. Mueller

2.7 ECCENTRIC PLUG VALVES

- A. Eccentric plug valves shall be of the non-lubricated, resilient seated eccentric type and shall be designed for a working pressure of 175 psi for valves 12" and smaller, 150 psi for valves 14" and larger. Port area shall be a minimum of 80% of the corresponding pipe area for sizes 3"-20" and a minimum of 70% for sizes 24" and larger. Valves shall provide tight shut-off at rated pressure.
1. The valve body shall be cast iron with a welded-in overlay of 90% nickel alloy content on all surfaces contacting the plug face.
 2. Furnish with replaceable permanently lubricated sleeve type 316 stainless steel bearings in the upper and lower journals.
 3. Shaft seals shall be multiple U-cup or V-type, replaceable without removing the valve bonnet.
 4. Valves shall be tested in accordance with AWWA C504.
 5. Manual gear operators shall be totally enclosed worm and gear type, permanently lubricated. Gear segment shall be of ductile iron, supported on bronze bearings.
 - a. Aboveground valves 8" and larger shall be provided with gear operators and hand wheel or chain wheel as shown on the Drawings.
 - b. Aboveground valves less than 8" shall be furnished with 2" nut and removable lever.
 - c. Buried valves shall be provided a 2" nut.
 - d. Buried valves 6" and larger shall be provided with a 2" nut and gear operator.
 6. Manufacturers:
 - a. DeZurik
 - b. Val-Matic

2.8 SEWAGE AIR VALVES

- A. Sewage air release valves shall have a short body and concave float designed to operate while pressurized, allowing entrained air in a sewage force main line, sewage pump, or waste water system to escape through the air release orifice. After entrained air escapes through the air release orifice, the valve orifice shall be closed by a needle mounted on compound lever mechanism, and prevent sewage from escaping. The air release orifice will then remain closed until more air accumulates and the opening cycle repeats automatically. The internal mechanism shall be constructed so as to positively prevent galvanic action. The float must withstand a minimum pressure of 500 psi. Valve shall be fitted with blow off valves, quick disconnect couplings, and minimum 6' of hose, to permit backflushing after installation without dismantling valve. The valve inlet shall be 2" N.P.T., the outlet ½" N.P.T.
1. Available Products:
 - a. APCO Model 400, manufactured by Valve and Primer Corporation.
 - b. Crispin Model S-20, manufactured by Multiplex Mfg. Co.
- B. Sewage combination air valve shall be single body, double orifice and designed to allow large volumes of air to escape or enter through the larger diameter air and vacuum orifice when filling or draining a pipeline. When the pipeline is filled and under pressure the large air and vacuum

SPECIFICATIONS

orifice shall stay closed, but the smaller diameter air release orifice shall remain operative and open to allow small pockets of air accumulating, to escape automatically and independently of the large orifice. The large air and vacuum orifice shall shut-off when the free acting center guide is raised, into the orifice, by the lifting force of the bottom float. The large orifice shut-off shall be without spilling. The float shall be heavily constructed stainless steel, hermetically sealed, and having a bottom impact area to provide immediate resistance to flow and instant upwards movement to shut off the large orifice without spilling. The Buna-N seat must be fastened to the valve cover, without distortion for drop tight shut-off. Valve shall be fitted with blow off valves, quick disconnect couplings, and minimum 6' of hose, to permit backflushing after installation without dismantling valve. Valve exterior to be painted Phenolic Primer Red Oxide for high resistance to corrosion. The valve inlet shall be 2" NPT, and the outlet 2" NPT.

1. Available Products:
 - a. APCO Model 440, manufactured by Valve and Primer Corporation.
 - b. Crispin Model US20B, manufactured by Multiplex Mfg. Co.

- C. Sewage air and vacuum valves shall allow unrestricted venting or re-entry of air through it, during filling or draining of the force main, to prevent water column separation or pipeline collapse due to vacuum. The sewage air vacuum valve shall incorporate one upper and one lower stainless steel float, connected by a common stainless steel float guide, thereby maintaining an air gap between the bottom float and top shut-off float. The internal baffle shall be fitted with a guide bushing and act to protect the shut-off float from direct air flow. All internals shall be easily removed through the top cover without removing the main valve from the lines. Both floats shall withstand 1000 psi or more. Valve shall be fitted with the top cover with blow off valves, quick disconnect couplings and minimum 6' of hose, to permit backflushing after installation without dismantling valve. The valve inlet shall be 2" N.P.T. and the outlet 2" N.P.T.

1. Available Products:
 - a. APCO Model 402, manufactured by Valve and Primer Corporation.
 - b. Crispin Model S-20A, manufactured by Multiplex Mfg. Co.

2.9 VALVE BOXES

- A. Valve boxes for buried valves shall be 3-piece adjustable screw type, 5 1/4" shaft diameter with "SEWER" cast in cover.

1. Manufacturers:
 - a. Tyler
 - b. Mueller
 - c. Clow
 - d. Kennedy
 - e. M&H

2.10 GRAVITY SEWER MANHOLES

- A. Precast Concrete Manholes: ASTM C 478 precast, reinforced concrete bases, risers and eccentric cone sections as indicated in the Drawings:
 1. Diameter:
 - a. 4'-0" for standard sewer manhole
 - b. 5'-0" for drop manholes
 2. Pipe Connections: Utilize A-Lok watertight rubber gaskets, or equal, cast integrally in the wall and located as required for sewer pipe connections.
 3. Top Section: Eccentric cone, unless otherwise indicated on the Drawings.
 4. Joint Sealant: ASTM C 443 and C 361, O-ring rubber gasket
 5. Steps: 3/8 inch diameter deformed steel reinforcing bar encased in polypropylene plastic with a notched tread ridge and retainer lug on each side, as manufactured by M.A. Industries, Inc., or equal. Steps shall be OSHA approved and cast or anchored into sidewalls at 12-inch intervals.
 6. Grade Rings: Reinforced-concrete per ASTM C 478, compressive strength of 4000 psi, 6 to 9-inch total thickness, to match diameter of manhole frame and cover.
 7. Exterior Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 16-mil minimum thickness.

SPECIFICATIONS

8. Manufacturers: Atlantic Pre-Cast Concrete, Inc.
- B. Manhole Frames and Covers: Grey iron of uniform quality; free from blow holes, porosity, hard spots and well cleaned by shot blasting. Frames and covers shall be cast in the U.S.A.
 1. Material: ASTM A 48, Class 30 unless otherwise indicated.
 2. Heavy Duty Rating
 3. Frame Opening Diameter: 24 inches.
 4. Frame height: 7 inches
 5. Self sealing, gasketed cover
 6. Cover Lettering: 1" flush lettering to read "Town of Millsboro Sanitary Sewer"
 7. Available Products: Neenah Foundry Company, Model R-1683

2.11 AIR RELEASE VALVE MANHOLES

- A. Precast Concrete Manholes: ASTM C 478 precast, reinforced concrete bases, risers and flat top sections as indicated in the Drawings:
 1. Diameter: 60 inches minimum, unless otherwise indicated.
 2. Base Section: Open bottom with "doghouse" type pipe openings.
 3. Top Section: Flat-slab type for shallow manholes.
 4. Joint Sealant: ASTM C 443 and C 361, O-ring rubber gasket.
 5. Steps: 3/8 inch diameter deformed steel reinforcing bar encased in polypropylene plastic with a notched tread ridge and retainer lug on each side, as manufactured by M.A. Industries, Inc., or equal. Steps shall be OSHA approved and cast or anchored into sidewalls at 12-inch intervals.
 6. Grade Rings: Reinforced-concrete per ASTM C 478, compressive strength of 4000 psi, 6-inch to 9-inch total thickness, to match diameter of manhole frame and cover.
 7. Exterior Protective Coating: Plant-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 16-mil minimum thickness.
 8. Manufacturers: Atlantic Pre-Cast Concrete, Inc.
- B. Manhole Frames and Covers: Grey iron of uniform quality; free from blow holes, porosity, hard spots and well cleaned by shot blasting. Frames and covers shall be cast in the U.S.A.
 1. Material: ASTM A 48, Class 30.
 2. Heavy Duty Rating
 3. Frame Opening Diameter: 34 inches.
 4. Frame height: 8-5/8 inches
 5. Vented Cover
 6. Cover Lettering: 1" flush lettering to read "Sussex County Sanitary Sewer"
 7. Available Products: Neenah Foundry Company, Model R-1752.

2.11 FLOW METER

- A. Flow meter
 1. The measurement range shall to $v = 0.033$ to 33 ft/s
 2. The manufacturer shall provide an application performance guarantee with submittals.
 3. The manufacturer shall review the application for each flow meter installation for process piping and fluid and recommend if grounding rods or rings are required for the operation of the flowmeter.
- B. Flow Tube Functionality and operation
 1. The meter shall incorporate magnetic field focusing plates to optimize the magnetic field around the sensing tube. The focusing plates shall ensure the meter maintains an accuracy of 0.5% of flow, or better, when the meter is mounted less than one upstream pipe diameter from bends in pipes, valves or other obstacles that cause flow errors.

SPECIFICATIONS

2. The meter shall be supplied with PFA Teflon liner material.
3. The EPDM rubber liner in sizes 3" through 12" shall be molded into place using a mechanically retained steel mesh that is permanently attached to the flow tube to ensure durability and longevity in slurry applications and for use on high vacuum services. Both the measuring tube and connection flanges shall be supplied in stainless steel in sizes ½" to 8".
4. The electrodes shall be high corrosion resistant 316-L (low carbon) Stainless Steel. The electrodes shall be anti-fouling and self-sealing as standard.
5. All sensing tubes (regardless of size) shall be stamped with the original flow lab calibration factor to allow "dry calibration" and interchangeability between all flow converters and sensing tubes to original accuracy.
6. **Flow tubes shall be NEMA 4X.**

C. Transmitter

1. The magnetic flow meter converter shall be microprocessor based, have "built in" diagnostics and retain program configuration in memory for at least 10 years. The meter shall work on any conductive fluid without re-calibration for different fluid types. The meter shall be capable of switching between 4 different ranges and forward/reverse 2-range switching.
2. The converter shall have a 16-column, two-row display and be LCD backlit for night viewing.
3. The converter shall be remote mounted.
4. The electronic circuit boards shall be conformal coated for protection from moisture.
5. All electronic circuit boards shall use Surface Mount Technology to provide resistance to vibration.
6. The meter shall incorporate high input impedance circuitry and have an input impedance of 50 meg ohm or greater thus negating the need for external electrode cleaning devices and to eliminate errors caused by changing process conductivity.
7. The meter must be capable of normal operation during abnormal voltage conditions from a minimum of 80 volts during low voltage conditions or a maximum of 260 volts during over voltage conditions.
8. The converter housing must be made of corrosion resistance anodized aluminum with Phthalic acid resin coating.
9. The meter shall have the following alarm, output, input and noise suppression capabilities as standard:
 - a. Alarm capability: High, low, empty pipe, rate-of-change, limit alarms, control limit time, self diagnostics and data checking, over-range flow, under-range flow, over totalize, under totalize, range change, preset output, adjustable low flow cutoff, totalizer preset value reached, reverse flow, and converter failure.
 - b. Outputs:
 - i. One 4-20 mA analog
 - ii. HART communications protocol for remote calibration

SPECIFICATIONS

- iii. Two digital outputs (for alarms, batching, and pulse applications)
 - c. Inputs: One input (20 – 30 Volts dc)
 - d. Advanced Noise Suppression: The meter shall incorporate a separate advanced noise suppression and filtering circuit specially designed for slurry applications. Auto zeroing, averaging, or dampening type algorithms in lieu of noise filtering circuitry is not acceptable.
- 10. The meter shall also provide a dedicated circuit that separates the square wave excitation signal into three components and remove any extreme values to eliminate any remaining slurry noise components.
 - 11. The meter shall have user selectable excitation frequencies of 6Hz, 12Hz, or 24Hz to further reduce noise.
 - 12. The meter shall be furnished with the manufacturer's standard interconnection cable(s). Cable(s) shall be of sufficient length to be run continuously, without splices, between the flow tube and transmitter.
- D. Approvals and Certifications
- 1. The magnetic flowmeter shall be FM approved for Class I, Div 2, Groups B, C, and D rated locations, when installed in those classified areas.
- E. Submersible Environmental Specifications
- 1. The unit shall have an ambient temperature rating of at least -10°C to 60°C.
 - 2. The flow tube shall be NEMA 6P (IP67) rated submersible and the converter shall be rated NEMA 4X, watertight.
- F. Calibration
- 1. Each flowmeter shall be flow lab calibrated in the manufacturer's flow lab. The manufacturer shall flow lab calibrate all meters twice at 0%, 50% and 100% of flow for a total of 6 flow point calibrations. The dual flow calibration technique shall confirm the results of the first flow test and ensure that the meter shall exhibit a typical installed accuracy of 0.25% or better of actual flow rate from 0 to 100%. that is traceable to the Nation Institute of Standards Technology or other recognized standards authority. Flow coefficient referencing for larger sizes is unacceptable.
- G. Manufacturer
- 1. The magnetic flowmeter shall by Foxboro, Toshiba. Rosemount, Endress + Hauser, or ABB. or approved equal

2.12 PRESSURE GAUGE ASSEMBLY

2.13 BALL VALVE STAINLESS STEEL

- A. Two piece, full port, 1000 cwp.
- B. Materials of Construction:
 - 1. Body: cast iron, A351.
 - 2. Ball: 316 SS
 - 3. Shaft: Cast iron.
 - 4. Seat: RTFE
 - 5. Handle: 304 SS.

SPECIFICATIONS

- 6. Packing; gasket, PTFE
- C. Valves four inches and below shall have a lever handle with notched mechanical stop plate. Valves six inches and above shall have gear operator
- D. Manufacturer: Valves shall be FNW Figure 200A, Apollo, or approved equal

2.14 TRANSDUCER

- A. Level transducers shall be submersible pressure transducers directly compatible with the Pump Control Panel. The level transmitter shall have an intrinsically safe barrier
- B. The level transducers shall have a range from 0 to 15 feet of water.
- C. The Level Monitor submersible transducer shall convert the pressure exerted by the liquid into a 4-20mA analog signal that shall represent liquid level within the specified range.
- D. A stainless steel diaphragm and silicone oil fill shall be provided to isolate and protect the pressure sensor from the liquid being measured.
- E. The weight of the Level Monitor shall act to reduce its movement when placed in a moving liquid. The Level Monitor submersible transducer shall weigh a minimum of 5.5 pounds, excluding the cable.
- F. The cable shall contain a strength cord capable of providing support for its weight.
- G. All of the metallic components of the Level Monitor shall be 316 Stainless steel.
- H. A vent tube in the Level Monitor cable shall transmit atmospheric pressure down the cable to the reference side of pressure sensor, to correct for changes in atmospheric conditions.
- I. The Submersible Transducer shall be supplied with a Transducer Vent Bellows (TVB1) to prevent moisture from entering the vent tube. Breather bag, desiccant, or ceramic disk methods for protection against moisture intrusion shall not be considered equal. The TVB1 shall be din-rail mountable to allow the moisture intrusion protection to be mounted to the control panel subpanel, thus making the moisture intrusion protection a "permanent" fixture within the control panel.

2.12 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 - 1. Cement: ASTM C 150, Type 1 or 1A.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed as shown on Drawings, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 0.01 foot drop across manhole.
 - 2. Benches: Concrete, sloped 4 percent minimum, to drain into channel.

SPECIFICATIONS

- D. Buttresses, Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.13 MISCELLANEOUS MATERIALS

- A. Polyethylene Sheeting: ASTM D 4397, with at least 8-mil thickness
- B. Casing chocks: Metal components shall be stainless steel, type 304, liner shall be PVC and skids shall be fiberglass reinforced nylon. Manufacturer: PowerSeal Pipeline Products Corporation
- C. Detectable Pipeline Wire: Insulated (green color) solid copper, #14 AWG, 600 volt, of not less than 90% conductivity, conforming to ASTM Designation B.58. Splicing of wires shall be by a solderless, split-bolt lug connector, Type IK-8, by ILSCO or equal.
- D. Detectable Pipeline Warning Tape: Metallic type with metal foil running the full length and width of the tape. Foil shall be encased in a high visibility, color coded, insert plastic jacket with continuous, clearly imprinted identification legends.
 - 1. Manufacturer:
 - a. Allen Systems
 - b. Terra-Tape
 - 2. Colors and legends shall be in accordance with the American Public Works Association's recommended color code and the following:

<u>Utility</u>	<u>Color</u>	<u>Legend</u>
Electric	Safety Red	Caution - Buried electric line below
Gas, oil, flammable materials	High Visibility Yellow	Caution - Buried gas line below
Communication	Safety Alert systems Orange	Caution - Buried telephone line below
Water systems	Safety/Precaution Blue	Caution - Buried water line below
Sewer systems	Safety Green	Caution - Buried sewer line below

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 2 Section "Earthwork."

3.2 OPEN TRENCH GRAVITY SEWER INSTALLATION

- A. Excavation and refill for sanitary sewers shall be in accordance with Section 02300 of these Contract Documents.

SPECIFICATIONS

- B. All PVC pipe and appurtenances shall be installed and placed into service in conformance with ASTM D 2321, the manufacturer's recommendations, and the Contract Documents.
- C. Precautions shall be taken to keep interiors of pipes and fittings clean before installation and kept clean until final acceptance. Pipe delivered for construction shall be stored so as to minimize entrance of foreign material. When pipe laying is not in progress, all openings in the pipeline shall be closed by watertight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.
- D. Pipe and fittings shall be carefully handled and placed in the trench. Special care shall be taken to insure that each length of pipe abuts against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the bottom half of the pipe.
- E. The trench bottom shall be constructed to provide the firm stable and uniform support for the full length of the pipe. Bell holes shall be provided at each joint to permit proper joint assembly and alignment. Any part of the trench bottom excavated below grade shall be backfilled to grade and shall be compacted as required to provide firm pipe support. When an unstable subgrade condition is encountered, which will provide inadequate pipe support, additional trench depth shall be excavated and refilled with suitable foundation material.
- F. Pipe laying shall commence at the lowest elevation and pipe bells shall be placed on the upgrade end. Pipe shall be laid true to the lines and grades shown on the Drawings.
- G. Wye or tee branches shall be located as shown on the Drawings unless relocated in the field by the Engineer. After installation, wye or tee branches shall not be covered with backfill until the location is recorded.
- H. Service branches for laterals in new construction shall be molded or fabricated with gasketed connections. Saddles shall not be permitted in new construction. Pipes requiring cutting to fit into the line or to bring it to a required location shall have square cuts and the spigot end shall be beveled to an angle of 15°.
- I. All caps and plugs should be braced, staked, anchored, wired on or otherwise secured to the pipe to prevent leakage under the maximum anticipated thrust from internal operating conditions or test pressures from water or air.
- J. All house connections shall be constructed to terminate at an angle perpendicular to the property line unless otherwise shown on the Drawings.
- K. A cleanout shall be provided where shown on the Drawings and at the terminal point and each change in direction for each lateral in accordance with the Contract Documents.
- L. All laterals shall be marked at the point where laterals terminate with timber markers. Timber markers shall consist of a 2 inch by 4 inch timber extending from the end of the lateral vertically to one foot above the ground surface. All such markers shall be securely anchored and maintained in a proper vertical position until backfilling has been completed.
- M. The excavation in which pipe is being laid shall be kept free from water and no joint shall be made underwater. Care shall be used to secure water tightness and to prevent damage to or disturbing of the joints during the backfilling process or at anytime. After pipes have been laid and the joints have been made walking on or working over the pipe shall be limited to such as may be necessary in tamping until there is a covering of at least 2 feet in depth over the top of the pipe.
- N. Capped stubs shall be provided for future connections from manholes as shown on the Drawings. An end cap or end plug shall be placed on a short section of pipe extending from a manhole. All plugs and caps shall be braced, staked or anchored to prevent leakage or blow off.
- O. Sewers shall be laid at least 10 feet horizontally from any existing or proposed water main. Sewers crossing water mains shall be laid to provide a minimum vertical separation distance of 18 inches between the water main and the sewer. Crossings shall be arranged so that the joints in the sewer pipe will be as far as possible from water main joints.

SPECIFICATIONS

- P. Detection and warning tape shall be placed between 18 and 24 inches above the gravity sewer being marked when PVC pipe is being installed. At no time shall it be placed at a depth less than 6 inches.

3.3 GRAVITY SEWER MANHOLE INSTALLATION

- A. Manholes shall be built as pipe laying progresses. Failure to do so may result in the Engineer stopping work on pipe laying until manholes have been installed.
- B. Interior and exterior joint spaces of all precast concrete manhole risers shall be filled. The interior joint shall be mortared with Type II Portland cement mortar. The exterior joint shall be mortared or filled with a joint filler compound. Mortar on exterior joints shall receive a bitumastic coating.
- C. Pipe penetrations for connecting sewers to existing manholes shall be core-bored. The annular space between the pipe and the core-bored opening shall be sealed with non-shrink grout.
- D. Channels for receiving and passing water shall be formed in the bottom of manholes as shown on the Drawings. All such channels shall be lined with brick, with brick and split pipe, or concrete. Channels shall slope smoothly and evenly from the main pipe entering the manhole to the outlet pipe. Channels for future pipe shall be built into manholes where shown on the Contract Drawing.
- E. Manhole frames, covers, and steps shall be furnished by the Contractor and set by him as the work progresses. Frames shall be well bedded in mortar. Steps shall be spaced vertically and aligned as shown on the Drawings.

3.4 OPEN TRENCH FORCE MAIN INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Conform to the latest edition in effect at time of bid opening of ASTM D2774, AWWA C-600, the manufacturer's recommendations, and the Contract Documents.
- C. Install piping with 42-inch minimum cover.
- D. Keep interiors of pipes and fittings clean before installation and until final acceptance. Pipe delivered for construction shall be stored so as to minimize entrance of foreign material. When pipe laying is not in progress, all openings in the pipeline shall be closed by watertight plugs. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.
- E. Pipe and fittings shall be carefully handled and placed in the trench. Special care shall be taken to insure that each length of pipe abuts against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the bottom half of the pipe.
- F. Concrete thrust blocking or anchors shall be provided on all buried lines at bends, tees, capped or valved ends, fittings, and where directed by the Engineer. Blocking or anchors shall be poured against undisturbed earth and shall be in accordance with these Contract Documents. Mechanical joint restraints shall be provided at bends, tees, capped or valved ends, and fittings in addition to concrete thrust blocking or anchors at locations shown on the Drawings.
- G. The greatest of care shall be used to secure water tightness and to prevent damage to or disturbing of the joints during the backfilling process or at any time. After pipes have been laid and the joints have been made walking on or working over the pipe shall be limited to such as may be necessary in tamping until there is a covering of at least 2 feet in depth over the top of the pipe.
- H. Install valves of the sizes and at the locations shown on the Drawings in accordance with these Contract Documents. Place bedding uniformly and provide support masonry as needed to

SPECIFICATIONS

maintain the valve stem plumb. Set the valve box plumb, centered over the operating nut, and uniformly bedded. Set the valve box cover flush with finished grade.

- I. Place pipeline detectable tape between 18 inches and 24 inches above the force main. At no time shall detectable tape be placed at a depth less than 6 inches.
- J. Place pipeline detectable wire along the full length of the installed pipe including encased road crossings. Remove the insulation at the splices, so a metal to metal connection is made. Place the wire in the bottom of the trench prior to any backfilling such that it and the force main are separated by not more than 3 inches distance. Bring the wire up to the surface of the ground at the beginning and termination of the pipe, and at any in-line valving (interior of the valve box or manhole) and any other appropriate location, or as directed by the Engineer.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318/318R.

3.6 BURIED VALVE INSTALLATION

- A. Support valves with masonry as needed and bed uniformly to maintain the stem plumb.
- B. Set the valve box plumb, centered over the operating nut, and bed uniformly. Set the valve box cover flush with finished grade.
- C.

3.7 PIPE EXPANSION JOINT INSTALLATION

- A. Ample provisions shall be made in all pipelines to compensate for linear expansion and transverse movement. Unless other forms of expansion joints are specified, all runs of pipe subject to change in length shall be fabricated shorter than their theoretical length to the extent of one-half of the expansion and shall be so erected that the piping is free to expand without increasing the stresses imposed when cold. When the foregoing method of compensation for expansion is not adequate, the Contractor shall furnish and install in the pipelines expansion devices that will be adequate to allow the lines to expand and contract freely without injury to any part of the piping system. The devices may be in the form of expansion joints, swivel or swing joints, or pipe bends, and shall include such anchors and alignment guides as may be shown, specified, recommended by the joint manufacturer, or require to make the devices effective.
- B. Included with these rubber expansion joints, on the suction side of all pumps and air blowers shall be a temporary wire mesh. This mesh shall be for the protection of the equipment during start-up from extraneous material that might have been left within the associated piping. The location of this mesh shall be between flanges of the rubber expansion joints on the suction side of the equipment. Suitable gasketing shall be provided to prevent leakage. After this preliminary equipment start-up, the Contractor shall remove all wire mesh and entrapped material from within piping in preparation of testing.

3.8 TESTING AND ACCEPTANCE - GRAVITY SEWERS

- A. Prior to the request for inspection by the Engineer, it shall be the Contractor's responsibility to examine all completed pipelines to insure that they are laid to the proper alignment and grade and be free from foreign material. After this has been done to the satisfaction of the Engineer, tests shall be made on all portions of the sewers built under the Contract. The Contractor shall cooperate and furnish all assistance necessary to perform the tests as specified herein and to the satisfaction of the Engineer.
- B. Initial inspections and tests shall not be conducted until at least 20 days after the pipeline segment being inspected and tested has been backfilled in accordance with Specifications Section 02300 - Earthwork, and all dewatering pumps have been removed from the area.

SPECIFICATIONS

- C. Visual Testing: Gravity sewers shall be subject to mirror-light testing to determine that the alignment is straight and true. Sewers not allowing the passage of reflected light with the image of a "full moon" shall not be accepted.
- D. Deflection Testing: All PVC sanitary sewers shall be tested for deflection (reduction in vertical inside diameter). Testing shall be performed by passing a 5 percent undersized Go / No-Go mandrel or sewer ball through the pipeline, or measuring deflection continuously by using a deflectometer. Maximum allowable deflection shall be 5 percent.
- E. Leakage Testing: The low pressure air test shall be used as the gravity sewer acceptance test method. The Contractor shall furnish all equipment and personnel to conduct this test in accordance with the following procedure:

1. All branch fittings and ends of lateral stubs shall be securely plugged to withstand the internal test pressures. The section of line being tested shall also be securely plugged at each manhole. All stoppers shall be adequately braced when required.
2. Air shall be slowly supplied to the plugged pipe line until the internal air pressure reaches 4.0 pounds per square inch greater than the average back pressure of any groundwater above the pipe, but not greater than 9.0 pounds per square inch. At least two (2) minutes shall be allowed for temperature stabilization before proceeding further.
3. The rate of air loss shall then be determined by measuring the time interval required for the internal pressure to decrease from 3.5 to 2.5 pounds per square inch above the average groundwater back pressure.
4. The line shall be considered acceptable in time, T, in seconds required for the 1.0 psi pressure drop is not less than the following:

$$T = 0.0850 DK/Q$$

Where:

K = 0.000419DL, but not less than 1.0

Q = rate of loss of 0.0015 cu. ft./min./sq. ft. of internal surface

D = pipe diameter, inches

L = length of line being tested, feet

**MINIMUM HOLDING TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015**

Pipe Diameter (Inches)	Minimum Time (min-sec)	Length for Minimum Time (ft.)	Longer Length (sec.)	Time for Specification Time for Length (L)								
				100'	150'	200'	250'	300'	350'	400'	450'	
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48	
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38	
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04	
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41	
24	22:48	099	1.368 L	22:48	34:11	45:35	57:00	68:23	79:47	91:10	102:34	
27	28:57	088	1.731 L	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	
30	35:37	080	2.137 L	35:37	53:25	71:14	89:02	106:51	124:34	142:28	160:16	

- A. If the measured leakage rate exceeds the allowable, the Contractor shall, at no additional cost to the Owner, conduct such additional tests on individual segments of the gravity sewer system as directed by the Engineer to locate the leaks. The Contractor shall repair to the full satisfaction of the Engineer any observed leakages of the gravity sewers or manholes.
- B. The Contractor shall not make connections to existing sanitary sewers until the final inspection and tests have been approved.

3.9 TESTING AND ACCEPTANCE - FORCE MAIN

SPECIFICATIONS

- A. Test all new force mains before connecting them to the existing system. The Engineer shall determine the amount of main to be tested at any one time and reserves the right to separate the installation into several sections, in the event of long extensions, installations of pipe designed for different head conditions, or for other reasons.
- B. Hydrostatically test the pipe at a pressure 1.5 times the normal working pressure with a minimum pressure of 100 psi. Hold the test pressure for a period of at least two (2) hours during which time the test pressure shall not vary more than +/- 5 psi.
- C. Fill each valved section of pipe with water slowly and apply the specified test pressure, based on the elevation of the lowest point of the line or section under test, corrected to the elevation of the test gauge, by means of a pump connected to the pipe in a manner satisfactory to the Engineer.
- D. Expel air completely from the pipe and valves before applying the specified test pressure. If permanent air vents are not located at all high points, install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, close the corporation cocks and apply the test pressure. At the conclusion of the pressure test, remove the corporation cocks and plug the openings, or leave in place at the discretion of the Engineer.
- E. Conduct a leakage test concurrently with the pressure test. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain the pressure within 5 psi of the specified test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

ALLOWABLE LEAKAGE PER 1000 FT OF PIPELINE - GPH

Avg. Test Pressure psi	Nominal Pipe Diameter-In.								
	6	8	10	12	14	16	20	24	30
150	0.55	0.74	0.92	1.10	1.29	1.47	1.84	2.21	2.76
125	0.50	0.67	0.84	1.01	1.18	1.34	1.68	2.01	2.52
100	0.45	0.60	0.75	0.90	1.05	1.20	1.50	1.80	2.25

- F. Acceptance shall be determined on the basis of allowable leakage as specified above. If any test of pipe laid discloses leakage greater than specified, the Contractor shall, at his own expense, locate and repair the defective material until the leakage is within the specified allowance. Repair all visible leaks regardless of the amount of leakage.

3.10 SITE RESTORATION

- A. Restore all areas, structures, plants, pavements, facilities, and features to not less than the pre-existing conditions.
- B. Relocate all structures removed for the construction as shown and required by the Contract Documents.
 - 1. Relocate to a location to be determined in the field by the Engineer.
 - 2. New locations shall be within ten (10) feet of the original locations.
 - 3. Structures to be relocated shall include, but not be limited to, road signs, mailboxes, and fences.
- C. Restore areas outside of pavement at a uniform rate closely following installation of the pipeline. Neatly dress the area within one week following backfilling operations. Dress again or permanently restore when the soil has consolidated. Restoration of surfaces shall be completed within fifteen (15) days after the installation of the pipeline.
- D. Replace small trees and shrubs in kind at no additional cost to the Owner in the event that existing plants which are to remain are destroyed beyond use.
- E. Water all trees and shrubs as necessary to maintain the plantings until established.

SPECIFICATIONS

- F. Mulch trees, shrubs, and ground cover with at least a 2" cover of mulch. Place mulch on the same day of planting. Wrap all trees with the wrapping material overlapping 1-1/2" from the lowest main branches to the base of the tree. Tie the wrapping at the top and bottom, and at 1' intervals along the trunk with twine.
- G. Topsoil, seed, and mulch non-paved areas in accordance with Division 2 Section "Lawns and Grasses."
- H. Restore paved areas in accordance with Division 2 Section "Hot-Mix Asphalt Paving."
- I. Upon completion of the surface restoration, perform a final clean-up within the limits of the project consisting of completely removing unused materials which will mar the appearance of the project, and sweeping dirt from pavements and structures.
- J. Maintain the restoration work for a period of 12-months after final acceptance of the Project at no additional cost to the Owner. The maintenance of the restoration shall include all labor, equipment, material, and supplies necessary, including trench refill and additional topsoil, seeding, mulching, watering, and erosion protection.

3.11 FLOW METER

A. Shop Calibration

1. Shop calibrate all instruments to listed ranges prior to delivery.

B. Delivery And Protection From Weather

1. Protect all instruments from the weather.
2. Store all instruments in accordance to manufacture's instructions. Take special note of those instruments which need to be stored in a cool dry location.
3. Provide an explosion proof junction box for the termination of instrumentation in classified areas.

C. Installation

1. Install in conformance with manufacturer's printed instructions.
2. Provide all stands and brackets required to support instrumentation or transmitters. Stands and brackets to be 304 stainless steel construction.
3. Coordinate with the start-up and operation of the Treatment System Controls.
4. Verify field wiring continuity.
5. The contractor shall field mount and install all vender provided instrumentation. The contractor shall provide all wall and floor supports. The contractor shall provide all anchors and hardware. Remote transmitters and analytical sampling units shall be mounted at a centerline of 4 ft 6 inches above the finished floor. The contractor shall coordinate the location of all remote transmitters and sampling units with the electrical contractor and the Owner's representative.

END OF SECTION 02530

SPECIFICATIONS

SECTION 02920 - LAWNS AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Seeding.
 - 2. Lawn renovation.
- B. Related Sections include the following:
 - 1. Division 2 Section "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Division 2 Section "Earthwork" for excavation, filling and backfilling, and rough grading.

1.2 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

SPECIFICATIONS

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, from new crop seed, and delivered to the site unopened in original packages in accordance with the Delaware Code and respective state laws.

B. Seed Mixtures:

1. Permanent Grass Seeding - Dry Ground

<u>Species</u>	<u>Max% Weed Seeds⁷</u>	<u>Min% Purity</u>	<u>Min% Germ- ination</u>	<u>Seeding Rate lb/ac</u>
Hard Fescue Blend ² (<i>Festuca Trachyphylia</i>)	0.15	98	85	100.0
Perennial Ryegrass (<i>Lolium perenne</i>)	0.15	98	90	10.0
Total Seed Quantity (lb./Acre)				110.0

Modification Factors for Seeding Rate:

Seeding Period A (2/16 to 4/15):	Add 5.0 lb/ac Redtop (<i>Agrostis alba</i>)
Seeding Period B (4/16 to 8/15):	Add 4.0 lb/ac Korean or Kobe Lespedeza (<i>Lespedeza stipulacea</i>)
Seeding Period C (8/16 to 2/15):	Add 5.0 lb/ac Redtop (<i>Agrostis alba</i>) plus 65.0 lb/ac Winter Rye (<i>Secale cereale</i>)

Modification Factors for Seeding Periods:

North District:	None
Central & South Districts:	Add 3.0 lb/ac Weeping Lovegrass (<i>Eragrostis curvula</i>) during Seeding Period B. ⁸

2. Permanent Crownvetch Seeding

<u>Species</u>	<u>Max% Weed Seeds⁷</u>	<u>Min% Purity</u>	<u>Min% Germ- ination</u>	<u>Seeding Rate lb/ac</u>
Crownvetch (<i>Coronilla varia</i>) variety: Penngift	0.35	99	70 ³	30.0
Annual Ryegrass (<i>Lolium multiflorum</i>)	0.15	95	90	22.0
Total Seed Quantity (lb./Acre)				52.0

Modification Factors for Seeding Rate:

Seeding Period A (2/16 to 4/15):	None
Seeding Period B (4/16 to 8/15):	Add 4.0 lb/ac Korean or Kobe Lespedeza (<i>Lespedeza stipulacea</i>)
Seeding Period C (8/16 to 2/15):	Add 5.0 lb/ac Redtop (<i>Agrostis alba</i>) plus 65 lb/ac Winter Rye (<i>Secale cereale</i>)

3. Permanent Grass Seeding - Wet Ground⁴

SPECIFICATIONS

<u>Species</u>	<u>Max% Weed Seeds⁷</u>	<u>Min% Purity</u>	<u>Min% Germ- ination</u>	<u>Seeding Rate lb/ac</u>
Redtop (<i>Agrostis alba</i>)	0.75	95	90	40.0
Creeping Bentgrass (<i>Agrostis palustris</i>)	0.75	98	90	25.0
Sheep Fescue ⁵ (<i>Festuca ovina</i>)	0.50	98	85	35.0
Rough-Stalked Bluegrass (<i>Poa trivialis</i>)	0.50	98	80	25.0
Total Seed Quantity (lb./Acre)				125.0

Modification Factors for Seeding Rate:

Seeding Period A (2/16 to 4/15):	Add 65.0 lb/ac Winter Rye (<i>secale cereale</i>) from 10/15 to 3/1
Seeding Period B (4/16 to 8/15):	None
Seeding Period C (8/16 to 2/15):	Add 65.0 lb/ac Winter Rye (<i>secale cereale</i>) from 10/15 to 3/1

4. Permanent Grass Seeding - Subdivisions

<u>Species</u>	<u>Max% Weed Seeds⁷</u>	<u>Min% Purity</u>	<u>Min% Germ- ination</u>	<u>Seeding Rate lb/ac</u>
Hard Fescue ² (<i>Festuca Trachyphyllia</i>)	0.15	98	85	100.0
Perennial Ryegrass (<i>Lolium perenne</i>)	0.15	98	90	10.0
Total Seed Quantity (lb./Acre)				110.0

Modification Factors for Seeding Periods:

North District:	Add 50.0 lb/ac Kentucky Bluegrass (<i>Poa pratensis</i>) during Seeding Periods A, B & C ¹
Central & South Districts:	None

5. Temporary Grass Seeding - Dry Ground

<u>Species</u>	<u>Max% Weed Seeds⁷</u>	<u>Min% Purity</u>	<u>Min% Germ- ination</u>	<u>Seeding Rate lb/ac</u>
Annual Ryegrass (<i>Lolium multiflorum</i>)	0.15	95	90	40.0
Total Seed Quantity (lb./Acre)				40.0

Modification Factors for Seeding Rate:

Seeding Period A (2/16 to 4/15):	Add 65.0 lb/ac Winter Rye (<i>Secale cereale</i>)
Seeding Period B (4/16 to 8/15):	None

SPECIFICATIONS

Seeding Period C (8/16 to 2/15): Add 65.0 lb/ac Winter Rye (*Secale cereale*) from 10/15 to 2/15

6. Temporary Grass Seeding - Wet Ground⁶

<u>Species</u>	<u>Max% Weed Seeds⁷</u>	<u>Min% Purity</u>	<u>Min% Germ- ination</u>	<u>Seeding Rate lb/ac</u>
Annual Barnyard Grass/ Duck Millet (<i>Echinochloa spp.</i>)	1.00	90	90	40.0
Total Seed Quantity (lb./Acre)				40.0

Modification Factors for Seeding Rate:

Seeding Period A (2/16 to 4/15): Add 65.0 lb/ac Winter Rye (*Secale cereale*)
 Seeding Period B (4/16 to 8/15): None
 Seeding Period C (8/16 to 2/15): Add 65.0 lb/ac Winter Rye (*Secale cereale*)

7. Seed Mixture Footnotes:

- 1 The seed shall be a blend of certified Bluegrass variations with no one variety representing more than 25% by weight of the total, at least one variety must be a Mid-Atlantic ecotype.
- 2 Combination of improved certified variables with SR 3000 representing a minimum of 50% by weight of the total.
- 3 Germination shall include a total 60% minimum quick germination or normal sprouts plus a minimum of 20% hard seed.
- 4 Permanent seeding - wet ground should be used on saturated or seasonally flooded areas as dictated by defined wetland limits on construction plans.
- 5 *Festuca ovina* shall be an improved variety of sheep fescue as approved by the Department. Selection should be based on performance within the Mid-Atlantic region as determined by the most current National Turfgrass Evaluation Program Progress Report.
- 6 Wet bare ground, leaf liter covered or partially vegetated retention ponds or flooded sites in general may be seeded with temporary seeding - wet ground, no wood fiber mulch shall be added to the hydro seeder. In addition, no mulching item should be included with this seeding. Unless indicated on the plans, *Echinochloa spp.* is equivalent to *E. mucicata* *E. crusgalii* or *E. walteri*. No fertilizer or limestone shall be applied with this seeding.
- 7 No Johnson grass seed (*Sorghum halapense*) or Canada Thistle (*Cirsium arvense*) shall be allowed under the maximum allowable percentage of weed seeds.
- 8 Add 3.0 lb/ac Weeping Lovegrass on all slopes 3:1 or steeper and greater than 10' vertically in height throughout the Central and South Districts during all seeding periods to Permanent Grass Seeding - Dry Ground, Permanent Crownvetch Seeding - and Permanent Grass Seeding - Wet Ground.

8. No Johnson grass seed (*sorghum halapense*) shall be allowed under the maximum allowable percentage of weed seeds.
9. The seed inoculant for crownvetch seeding shall be a pure culture of nitrogen fixing bacteria selected for maximum vitality and for the ability to transform nitrogen from the air into soluble nitrates and deposit them in the soil. Inoculants shall consist of pure bred cultures and shall not be used later than the date indicated on the container. Four times the normal amount of inoculant as indicated on packaging shall be used for wet application. The inoculant shall be kept as cool as possible until used. Temperatures above 75° F will weaken the bacteria and the Contractor shall take every precaution while handling the inoculant.

SPECIFICATIONS

2.2 TOPSOIL

A. Topsoil: Original surface, friable loam topsoil of uniform quality, free from heavy clay, coarse sand, stones over two (2) inch, lumps, frozen clods, plants, roots, sticks, and foreign materials harmful to plant growth.

1. Topsoil shall be reasonably free from two (2) inch or larger fragments of hot-mix, concrete pavement and surface treatment and shall not contain objectionable plant materials, or vegetable debris undesirable or harmful to plant life.
2. Topsoil shall be reasonably free of noxious perennial weeds or woody vegetation and completely void of Johnson grass (*Sorghum halapense*).
3. The topsoil shall have an acidity range of pH 6.0 to pH 7.5.
4. Topsoil shall contain not less than 2 percent nor more than 30 percent organic matter as determined in accordance with AASHTO T267 test method.
5. The method of testing topsoil shall be in accordance with the requirements of AASHTO T88, Modified, AASHTO T89, Method B; AASHTO T90 and meet the following specified grading:

<u>Sieve Size</u>	<u>Min. Percent Passing</u>
2-inch	100
No. 4	90
No. 10	80

6. Sand, silt and clay contents shall be as follows:

<u>Material</u>	<u>Minimum Percent</u>	<u>Maximum Percent</u>
Sand	15	65
Silt	10	60
Clay	5	40

7. Topsoil shall not be delivered until samples have been reviewed by the Engineer.
8. Topsoil shall be secured from areas from which topsoil has not been previously removed either by erosion or mechanical methods, and it shall not be removed to a depth in excess of the depth approved.
9. The area or areas from which topsoil is secured shall possess such uniformity of material depth, color, texture, drainage, and other characteristics as to offer assurance that when removed in commercial quantities, the product will be homogeneous in nature and will conform to the requirements of these specifications.

2.3 INORGANIC SOIL AMENDMENTS

A. Limestone: Ground agricultural limestone containing not less than 85 percent calcium and magnesium carbonates. Dolomitic lime or magnesium lime shall contain at least 10 percent magnesium oxide. The limestone shall be ground to meet the following gradation:

<u>Sieve Size</u>	<u>Min. Percent Passing</u>
No. 10	100
No. 20	98

SPECIFICATIONS

No. 100

80

- B. Perlite: Horticultural perlite, soil amendment grade.
- C. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
- D. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.4 PLANTING ACCESSORIES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.5 FERTILIZER

- A. Fertilizer analysis for use when seeding shall yield the following values in pounds of actual plant food per acre:

- 1. Permanent Roadside, Suburban Development and Temporary Seeding Mix:

- a. 70 pounds nitrogen (N)
- b. 50 percent by weight of the nitrogen content shall be available from ureaformaldehyde.
- c. 42 pounds available phosphoric acid (P_2O_5)
- d. 28 pounds water soluble potash (K_2O)

- 2. Crownvetch Seeding:

- a. 152 pounds nitrogen (N)
- b. 100 percent by weight of the nitrogen content shall be available from ureaformaldehyde.
- c. 100 pounds available phosphoric acid (P_2O_5)
- d. 100 pounds water soluble potash (K_2O)

- B. Ureaformaldehyde shall meet the following requirements:

Total Nitrogen (TN)	38.0 percent minimum
Cold Water Insoluble Nitrogen (IN)	25.0 percent minimum
Activity Index (AI)	40.0 percent minimum
Urea Nitrogen	3.5 percent minimum

2.6 MULCH

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

2.7 EROSION-CONTROL MATERIALS

- A. Bonded Fiber Matrix: 100% biodegradable, hydraulically applied product that upon drying, adheres to the soil in the form of a continuous 100% coverage erosion control blanket.

- 1. Composed of long strand wood fibers held together by a bonding agent that, upon drying, becomes insoluble and non-dispersible.
- 2. Shall not dissolve or disperse upon rewetting
- 3. Contains no germination or growth inhibiting factors
- 4. Shall not form a water impervious crust

SPECIFICATIONS

5. Minimum water holding capacity of 10 L/kg.
 6. No holes greater than 1mm and no gaps between product and soil.
- B. Straw-Coconut Fiber Blankets: Machine produced mat consisting of 70% agricultural straw at a minimum weight of 0.19 kg/square meter and 30% coconut fiber at a minimum weight of 0.08 kg/square meter.
1. Blanket shall be of consistent thickness with the straw and coconut fiber evenly distributed over the entire area of the unit.
 2. Blanket shall be covered on the top and bottom with a woven 100% biodegradable, natural organic fiber netting with an approximate 1/2 inch mesh and sewn together with cotton thread.
 3. Secure to ground with 6-inch U-shaped wire pins or tapered wooden pegs
- C. Jute mesh shall be of a uniform, plain weave with warp and weft yarns of approximately the same size. Range in weight of cloth shall be 1.80 pounds (average) per running yard with a 5 percent minimum tolerance to 1.22 pounds (average) per running yard with a 5 percent minimum tolerance at standard atmospheric conditions. The physical requirements shall be:
- Width - 45 inches to 48 inches, plus or minus 1 inch
 - 78 warp ends per width minimum
 - 41 weft ends per yard minimum

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 1. Protect adjacent and adjoining areas from hydroseeding overspray.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 1. Spread topsoil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if topsoil or subgrade is frozen, muddy, or excessively wet.
- B. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 2. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers and mix thoroughly into top 6 inches of soil. Till soil to a homogeneous mixture of fine texture.

SPECIFICATIONS

3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus ½ inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
- D. Moistened prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow seed at the rates indicated in the seed mixture specifications in PART 2 - PRODUCTS.
- C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:3 with Bonded Fiber Matrix or Straw-Coconut Fiber Blanket, as required by the DeDOT Standard Specifications, installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:3 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.

3.5 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
1. Mix slurry with tackifier.
 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

3.6 LAWN RENOVATION

- A. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
- B. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.
- C. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

SPECIFICATIONS

- D. Mow, dethatch, core aerate, and rake existing lawn.
- E. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- H. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.
- I. Apply seed and protect with straw mulch as required for new lawns.
- J. Water newly planted areas and keep moist until new lawn is established.

3.7 SATISFACTORY LAWNS

- A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches.
- B. Reestablish lawns that do not comply with requirements and continue maintenance until lawns are satisfactory.

3.8 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- C. Remove erosion-control measures after grass establishment period.

END OF SECTION 02920

SPECIFICATIONS

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.

1.2 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.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Steel reinforcement and accessories.
 - 4. Waterstops.
 - 5. Curing compounds.
 - 6. Bonding agents.
 - 7. Vapor retarders.
 - 8. Semirigid joint filler.
 - 9. Joint-filler strips.
- E. Field quality-control test and inspection reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

SPECIFICATIONS

- C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- D. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete," Sections 1 through 5.
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
 - 3. ACI 350 "Code Requirements for Environmental Engineering Concrete Structures and Commentary"

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Form lumber in contact with exposed concrete: New except as allowed for re-use of forms by these Contract Documents.
 - 1. Concrete Exposed to View: Use plywood with DFPA stamp of "B-B Plyform". Plyform shall be 5/8" thick for supports 12" on center maximum or 3/4" thick for supports 16" on center maximum. Use in as large sheets as practical to keep joints to a minimum.
 - 2. Concrete Not Exposed to View: Use clean, straight lumber, plywood, or metal.
- B. Form Oil: Colorless, non-staining, Sinclair No. 1 form oil, or equivalent.
- C. Form Sealers: First quality of their respective kinds and subject to review of the Engineer.
- D. Form Ties: Factory-fabricated, snap-off metal or glass-fiber-reinforced plastic form ties designed to resist form deflection and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1-1/2 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no smaller than 1/2 inch or larger than 1 inch in diameter in concrete surface.
 - 3. Furnish ties adjustable in length so as to permit complete tightening of forms.
 - 4. Form ties used for exposed concrete surfaces shall have a minimum working strength when fully assembled of at least 3,000 pounds.
 - 5. Form Snap Ties: Incorporate waterstops and manufacture by Dayton Sure Grip, Type 42, or equal with 1-1/2" set back from the face of the wall as detailed in ACI 347.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615, Grade 60, Deformed, billet steel bars for concrete reinforcement. Free of loose scale, rust, or other coatings that will reduce bond.

SPECIFICATIONS

- B. Steel Bar Mats: ASTM A 185 intermediate grade, deformed bars. Conform to dimensional requirements as shown on the drawings.
- C. Welded Wire Reinforcement: ASTM A 185 and ASTM A82, plain, fabricated from No. 10 gauge wire into flat sheets. Individual wires on 6-inch centers in each direction as required by the drawings.
- D. Welded Wire Reinforcement for concrete pavement construction: ASTM A 185 and ASTM A 82, fabricated from cold drawn steel wire into flat sheets. Furnish with dimensions, spacing and wire sizes as specified.

2.3 REINFORCEMENT ACCESSORIES

- A. Accessories include all spacers, chairs, bolsters, ties, other devices necessary for properly placing, spacing, supporting and fastening reinforcement in place. Conform to requirements of The Concrete Reinforcing Steel Institute "Manual of Standard Practice of Reinforced Concrete Construction".
 - 1. Metal Accessories: Galvanized after fabrication or plastic protected where legs will be exposed in finished concrete surfaces.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I or Type IA. Use only one brand of any one type for exposed surfaces.
 - a. Cement for all concrete in direct contact with sewage (even if coated): C₃ A content shall be less than 8 percent. Portland blast furnace slag cement (ASTM C 595), Type IS (MS) or IS-A (MS) also may be used as well as Portland Pozzolan Cement (ASTM C 595). Types IP or IPA, with pozzolan content not exceeding 25 percent by weight.
- B. Normal-Weight Aggregates: ASTM C 33 coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Lightweight Aggregate: ASTM C 330, 3/8-inch nominal maximum aggregate size.
- D. Water: Reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Comply with ASTM C 94.
 - 1. Water known to be of potable quality may be used without test.
 - 2. pH: 4.5 to 8.5.

2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
 - 1. Products:
 - a. Sika Corporation; Sika AER
 - b. Master Builders; MBOR

SPECIFICATIONS

B Chemical Admixtures: ASTM C 494. 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: Type A.
2. Retarding Admixture: Type B.
3. Water-Reducing and Retarding Admixture: Type D.
4. Accelerating Admixtures: Type C.
5. Water Reducing and Accelerating Admixtures: Type E

C. Water Reducing Admixtures: ASTM C 494

1. Products:
 - a. Sika Corporation: Plastiment
 - b. Master Builders: Masterpozzolith

2.6 WATERSTOPS

A. Flexible PVC Waterstops: for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes. Compound as necessary to meet the manufacturer's requirements. Do not incorporate reclaimed PVC from any source in the compounding.

1. Manufacturers:
 - a. Sika Greenstreak.
2. Profile: Flat, dumbbell with center bulb.
3. Extruded material: Dense, homogeneous, and free from porosity or other imperfections which could affect its durability of performance.

2.7 VAPOR BARRIERS

A. Plastic Vapor Barrier: Polyethylene sheet not less than 6 mils thick. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.

2.8 CURING MATERIALS

A. Moisture-Retaining Cover: AASHTO M 171 for Polyethylene Film and Waterproof Paper.

1. Waterproof Paper: The name of the manufacturer shall be marked or imprinted clearly on the paper for proper identification and it shall retain 90% of the mix water.

B. Curing Compound: ASTM C 309. Compatible with subsequent finish or completely removed.

1. Available Products:
 - a. Sonneborne-Contech; Hydrocide Curing Compound.
2. Liquid Membrane Curing Compounds: AASHTO M 148 for Type 2, Class A or B, White Pigmented. Acceptance for continued use will be based upon satisfactory field performance.

2.9 RELATED MATERIALS

A. Non-bituminous Expansion Joint Filler: AASHTO M 153, Type I or Type III, unless otherwise specified on the Drawings or in the special provisions.

SPECIFICATIONS

1. Types I Joint Filler: Preformed strips of a durable elastic, sponge rubber compound. Unless otherwise specified, the sponge rubber shall have a cement-gray color to blend with concrete in appearance.
 2. Type III Joint Filler: Preformed strips of clean, granulated cork particles securely bound together by a synthetic resin of an insoluble nature.
- B. Bituminous Expansion Joint Filler: AASHTO M 33, consisting of a bituminous mastic composition formed and encased between two (2) layers of bituminous impregnated felt.
- C. Dovetail Anchor Slots: Type 24-gauge galvanized steel sheet, minimum, with fillers. Standard types to engage anchors supplied.
- D. Rubber Joint Sealant: The sealant shall be a multi-part chemically curing polyurethane sealant which meets or exceeds the curing requirements of Federal Specification TT-S-00227E (3) and TT-S-00230C (2) Nonsag type, Class A, compounds resistant to 50 percent total joint movement. The color shall be gray to match concrete. A primer shall be used as recommended by the sealant manufacturer. A bond breaker such as masking tape, polyethylene film, or backing rod as supplied by the manufacturer shall be used at the bottom of the joint.
1. Manufacturer: Fox Industries, FX-570/571.

2.10 CONCRETE MIXTURES, GENERAL

A. General:

1. 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.
 - a. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
2. Admixtures: Use admixtures according to manufacturer's written instructions.
 - a. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
 - b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 - c. 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.

B. Mix Compositions: The composition of the mix and strength requirements as established by ASTM C94 shall conform to the following:

Class of Concrete	A	B	C
Minimum 28 Day Compressive Strength (PSI)	4,500	4,000	3,000
Cement Content:			
Minimum Sacks/CY	7-1/2	7	6
Minimum Pounds/CY	705	658	564
Water Cement Ratio	0.45	0.45	0.45
Percent Entrained Air	5-7	4-7	4-7
Slump (Inches)	2-4	2-4	2-4

1. All concrete exposed to weather and interior slabs on grade shall contain 4% to 6% entrained air as indicated in Chapter 3, ACI 301. Use an air entraining admixture and normal Portland cement or an air entraining Portland cement. Measure air content at point of discharge at job site.
2. Concrete exposed to weather shall be made with not more than 6 gallons of water per bag of cement, including the free moisture in the aggregate.

SPECIFICATIONS

C. Selection:

1. Concrete not in direct contact with sewage shall be Class C in accordance with the mix compositions in this section, unless otherwise shown or noted.
2. Concrete in direct contact with sewage shall be Class B unless otherwise shown or noted.

2.11 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to ACI 315.

2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94 and furnish batch ticket information to engineer before unloading at the site.
 1. Batch delivery ticket: Indicate the producer's name, delivery date, time of loading, time delivered, truck number, quantities of each material in the batch, and information necessary to calculate the total mixing water added by the producer. Total mixing water includes free water on aggregates, water and ice batched at the plant, and water added by the truck operator.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94 Chapter 7 ACI 301. Mix concrete materials in appropriate drum-type batch machine mixer. Furnish batch ticket for each batch discharged and used in the work.
- C. Volumetrically Batched Concrete: Conform to ASTM C 685.
 1. Adhere to aggregate sizes, slumps, concrete strengths, and air contents as specified herein.
 2. Proportions of the concrete: Determined by Alternate 2, with the request stipulated in Paragraph 5.3.2 of ASTM C 685 being carried out.
 3. The supplier will be required to have one (1) person at the job site to operate the mixers. It shall be the responsibility of this person to set, record, and maintain surveillance of all gauges on the mixers at the job. No other personnel will be allowed to perform this function.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301.
- B. Lay out forms for all required cast-in-place concrete to the shapes, sizes, lines and dimensions indicated on the Drawings. Exercise particular care in the layout of forms to avoid necessity for cutting of concrete after it is in place.
- C. Construct forms to be straight, true, plumb, and square within a tolerance horizontally of one in 200 and a tolerance vertically of one in 500.
- D. Nail Plywood Panels directly to studs and apply in a manner to minimize the number of joints.
 1. Panel joints: Tight butt joints with all edges true and square.
- E. Construct footing forms of wood unless otherwise specifically approved by the Engineer.

SPECIFICATIONS

1. Upon approval by the Engineer, side forms for footings may be of earth provided the soil will stand without caving and the sides of the bank are made with a neat cut to the minimum dimensions indicated on the Drawings. Make all necessary provisions to prevent cave-ins during placement of concrete.
- F. Set all required steel frames, angles, grills, bolts, inserts, and other such items required to be anchored in the concrete before the concrete is placed.
- G. Provide openings, chases, offsets, recesses, anchorage, blocking, and other features as shown or required in the work. Perform all forming required for work of other trades and do all cutting and repairing of forms required to permit such installation. Consult with other trades as required relative to provision for openings, chases, and other items in the forms.
- H. Brace and tie forms together so as to maintain position and shape and to ensure safety to personnel.
 1. Construct bracing, supporting members, and centering of ample size and strength to safely carry, without excessive deflection, all dead and live loads to which they may be subjected.
 2. Properly space the forms apart and securely tie them together, using metal spreader ties that give positive tying and accurate spreading.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete according to ACI 301.
 1. Slots: Install in face of all concrete against which masonry will be installed. Space at 2'-0" on centers horizontally or as required by details and/or job conditions. Also install slots where masonry will abut concrete.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg. F 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.
 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Reuse of forms shall be subject to advance approval of the Engineer. Reuse of forms shall in no way delay or change the schedule for placement of concrete from the schedule obtainable if all forms were new. Reuse of forms shall in no way impart less structural stability to the forms nor less acceptable finish to the concrete.

3.4 VAPOR BARRIERS

- A. Plastic Vapor Barriers: Place, protect, and repair vapor barriers according to ASTM E 1643 and manufacturer's written instructions.
 1. Lap joints 2 feet and seal with manufacturer's recommended tape or mastic. Turn up on walls approximately 4-inches, stretch and weight edges and laps to maintain their positions until concrete is placed.

SPECIFICATIONS

2. Provide wood runways for wheeled equipment for transporting concrete. Do not displace film.
3. Repair all holes in vapor barrier prior to placement of concrete.

3.5 STEEL REINFORCEMENT

A. General: Comply with ACI 301.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Fabricate all reinforcement in strict accordance with shop drawings which have been reviewed by the Engineer. Do not use bars with kinks or bends not shown on the Drawings or on the reviewed shop drawings.

C. Do not bend or straighten reinforcement bars in a manner that will injure the material. Bond all bars cold.

1. Stirrups and Ties: Bend around a pin having a diameter not less than two (2) times the minimum thickness of the bar.
2. Other bars and hooks: Bend around a pin having a diameter not less than six (6) times the minimum of the bar.

D. Before the start of concrete placement, accurately position, support and secure reinforcement against displacement using concrete blocks, metal chairs or spacers or by metal hangers. Locate and support reinforcement with bar supports to maintain minimum concrete cover.

1. Clear space between bars: Not less than 1-1/2 times the normal diameter of round bars.
2. In no case shall the clear distance be less than 1-1/2 inches nor less than 1-1/3 times the maximum size of aggregate.

3. Minimum concrete covering the reinforcement:

- a. Concrete below ground deposited against forms: Two (2) Inches
- b. Concrete deposited against earth: Three (3) Inches
- c. Concrete elsewhere: As indicated on the Drawings or otherwise approved by the Engineer.

E. Splicing:

1. Horizontal bars:

- a. Place bars in horizontal members with minimum laps at splices sufficient to develop the strength of the bars.
- b. Bars may be wired together at laps except at point of support of the member, at which point preserve the clear space described above.
- c. Whenever possible, stagger the splices of adjacent bars.
- d. Splice 36 bar diameters minimum.

2. Wire fabric: Make all splices in wire fabric at least 1-1/2 meshes wide.

3. Other splices: Make only those other splices that are indicated on the shop drawings which have been reviewed by the Engineer.

F. Anchor all steel dowels into position before the concrete is placed.

G. In the event conduits, piping, inserts, sleeves, or any other items interfere with placing reinforcement as indicated on the Drawings or as otherwise required, immediately consult the Engineer to determine a new procedure before placing concrete.

SPECIFICATIONS

3.6 JOINTS

- A. General: Construct joints in accordance with Chapter 6, ACI 301.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations as approved by Engineer prior to starting concrete placement.
 - 1. At construction joints, erect a temporary wood bulkhead so that the jointing will follow a vertical plane perpendicular to the direction of the main reinforcement. To this bulkhead fasten a wood strip 2" thick and of width equal to one-third the depth of the concrete slab to form a tongue and grooved joint.
 - 2. Key and waterstop construction joints below liquid levels.
 - 3. Space vertical joints in walls at thirty (30) feet, maximum. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- C. Contraction Joints in Slab-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.

3.7 WATERSTOPS

- A. Waterstops: Install continuous and weld at butt joints and intersections in strict accordance with manufacturer's written instructions.

3.8 CONCRETE PLACEMENT

- A. Place concrete in accordance with ACI 301 and ACI 304. Do not place concrete until forms and reinforcement are inspected by the Engineer. Notify Engineer of all concrete pours at least 24 hours prior to pouring concrete.
- B. Transmit-mix all concrete in accordance with ASTM C-94 unless otherwise specifically permitted by Engineer.
- C. Place concrete as dry as possible consistent with good workmanship, never exceeding the maximum specified slump.
- D. Deposit and consolidate concrete in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Do not use retempered concrete or concrete that has been contaminated by foreign materials.
 - 2. Do not pour a greater area at one time than can be properly finished without checking. In any case, a slab length pour greater than 60 feet shall not be placed without construction joints.
 - 3. Tamp slabs with a jitterbug to depress the rock, and then pushfloat with a bullfloat as necessary.
 - 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 5. Slab depressions as required for the finishes indicated on the Drawings.

SPECIFICATIONS

6. Plane floor slabs to a Class A tolerance, that is, true planes within 1/8" in 10 feet, as determined by a 10 foot straightedge placed anywhere on the slab in any direction.
 7. Slope surfaces uniformly to drains where required.
- E. Do not use concrete with a placing temperature that will cause difficulty from loss of slump, flash set, or cold joints. Do not allow concrete temperature to exceed 90 degrees F during placement and use all means necessary to avoid drying concrete prior to finishing operations. Provide and use all required windbreaks, sunshades, fog sprays, and other devices to protect the concrete.
- F. Chuting, Pumping, and Pneumatically Conveying Concrete: Use only equipment of such size and design as to ensure a practically continuous flow of concrete at the delivery end without loss or separation of materials.
- G. Cold-Weather Placement: Comply with ACI 306.
1. Cover and insulate concrete to protect concrete and the ground underneath slabs and footings from freezing.
- H. Hot-Weather Placement: Comply with ACI 305.
1. Provide extra protection against moisture loss by keeping all exposed concrete surfaces constantly wet as specified and by keeping the forms continuously wet for the entire curing period.

3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: Comply with Chapter 10, ACI 301.
1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Rubbed Finish: Comply with Chapter 10, ACI 301.
1. Apply to concrete surfaces exposed to public view or in contact with contained liquids even if to be coated.

3.10 FINISHING FLOORS AND SLABS

- A. General: Comply with Chapter 11 of ACI 301.
1. Monolithically finish all concrete slabs. Do not sprinkle dry cement or mixtures of dry cement and sand on the surface of the wearing course to absorb moisture or to stiffen the mix.
 2. Keep the floor moist during the first 48 hours after placing.
- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces of all interior slabs.
- C. Clean exposed concrete. Remove blemishes, form oil stain, and other discolorations. Clean surfaces by brushing with a mild detergent and water.
- D. Cut off flush all nails, tie wires, and form ties. Leave all surfaces smooth and clean. Remove metal spreader ties on exposed concrete by removing or snapping off inside the wall surfaces and pointing up and rubbing the resulting pockets to match the surrounding areas.

SPECIFICATIONS

- E. Flush all holes resulting from the use of spreader rods and sleeve nuts using water, and then solidly pack throughout the wall thickness with cement grout applied under pressure by means of a grouting gun.
 - 1. Grout: One (1) part Portland cement to 2-1/2 parts sand. Apply immediately after removing forms.
- F. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance with a smooth, dense and plane surface.
 - 1. Apply a trowel finish to surfaces of all interior slabs.
 - 2. Apply a curing and sealing compound compatible with finish.
 - 3. Steel trowel finish after sheen has disappeared from the surface.
- G. Trowel and Fine-Broom Finish: Apply a first Trowel Finish to surfaces of exterior stairs, exterior slabs subject to foot traffic, and entrance slabs. After three (3) trowelings, while concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Provide stairs and slabs with sufficient pitch to shed water.

3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. 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.

3.12 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Interior Slab Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, and other surfaces. Cure by fog mist until a curing membrane has been installed.
 - 1. Apply a fog mist above the finished concrete surface, using fog nozzles to keep the air humid and to prevent loss of moisture from the concrete surface. The fog shall produce an appearance of wet sheen on the concrete but in no case shall allow a concentration of water in one place. Continue fogging until a membrane has been installed.
 - 2. Curing Membrane:
 - a. As soon as possible after finishing interior slabs, install the specified curing membrane. Lap all joints six (6) inches and securely join together. Weight down the covering to prevent damage from the wind. Construct so as to achieve a completely sealed membrane over the entire slab.
 - b. Unless otherwise directed by the Engineer keep the curing membrane in place and intact for at least ten (10) days after placement of concrete. Make all inspections and repairs necessary to ensure proper curing.

SPECIFICATIONS

3.13 CONCRETE SURFACE REPAIRS

- A.. Defective Concrete: Repair and patch defective areas in accordance with Chapter 9, ACI 301.
- B. Immediately after forms and curing membrane have been removed, inspect all concrete surfaces and patch all pour joints, voids, rock pockets, form tie holes, and other imperfections before the concrete is thoroughly dry. Do not notch concrete until it has been inspected by the Engineer.
- C. Patching Mortar: One part cement to three parts water, to a consistency as dry as possible within the requirements of handling. Install by ramming it into place.
- D. Repairing Formed Surfaces: Chip away concrete to a depth of about one inch, leaving edges perpendicular to the surface. Wet the area to be patched along with a space of at least six (6) inches wide around it to prevent water from being absorbed out of the mortar. Coat the area to be patched with a cement wash consisting of neat cement and solution of one part "Konsel", or equal, to four parts of water. Apply patching mortar immediately. Screed off the patch so as to leave the patch slightly higher than surrounding surface. Leave undisturbed for a period of one or two hours to permit initial shrinkage, and then final finish by matching the patch to adjacent surfaces and keep it wet for at least seven (7) days. Provide protective covering.
- E. Repairing Major Surface Defects: If the defects are serious or affect the strength of the structure, or if patching does not satisfactorily restore the quality and appearance of the surface, the Engineer may require "cement gun concrete" to be used or the concrete to be removed and replaced complete in accordance with the provisions of this Division, all at no cost to the Owner.

3.14 FIELD QUALITY CONTROL

- A. Notify Engineer when all the provisions of this section are met and the Contractor is ready to place concrete.
 - 1. No concrete shall be deposited before the Engineer has reviewed the reinforcing and given permission to proceed. Such inspection and permission to proceed shall in no way release the Contractor of the responsibility for proper placement of reinforcing and placement of concrete, and the responsibility for adherence to the requirements of the Contract Documents.
 - 2. Notify the Engineer at least 24 hours in advance of all concrete pours.
 - 3. Provide unobstructed access to work areas for the Engineer, furnish a wheel barrow for concrete sampling and a suitable storage box for initial curing of cylinders, as specified in ASTM C31. Make running water available at the testing site.
- B. Testing and Inspecting: The Owner shall engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least four composite samples for each 50 cu. yd. or fraction thereof of each concrete mixture placed each day. Samples shall be taken by the Engineer in accordance with ASTM C172 and cylinders molded in accordance with ASTM C31.
 - 2. Slump: ASTM C 143; one test at point of placement for each composite sample. Perform additional tests when concrete consistency appears to change.
 - a. Slump Limit: 2 inches minimum and 4 inches maximum, unless otherwise noted.
 - b. For slabs the maximum slump shall be 3-1/2 inches.
 - 3. Air Content: ASTM C 231 and ASTM C 138.
 - 4. Compression Test Specimens: ASTM C 31.

SPECIFICATIONS

- a. Cast and cure two sets of two standard 6-inch x 12-inch cylinder specimens for each composite sample.
5. Compressive-Strength Tests: ASTM C 39; test one set of two cured specimens at 7 days and one set of two specimens at 28 days.
 - a. 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.
 - b. Specimens made to check the adequacy of the design for strength of concrete or as a basis for acceptance of concrete will be made and laboratory cured in accordance with ASTM C31.
 - c. Additional tests of specimens cured entirely under field conditions will be utilized to check the adequacy of curing and protection of the concrete as directed.
6. Strength of each concrete mixture will be satisfactory if every average of any five consecutive compressive-strength tests equals or exceeds specified compressive strength and not more than one in ten shall have an average value less than 90% of the specified value.
7. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 - a. When the average of compressive tests for 5 consecutive cylinders falls below the specified strength, the design mix and water content shall be adjusted to produce the specified strength for concrete that is subsequently placed.
 - b. The Engineer may order additional curing for that portion of the structure where the questionable concrete has been placed. In the event that such additional curing does not give the strength required as determined by load tests made in accordance with ACI 318 or cored cylinder tests, the Engineer may order defective parts removed and replaced, or reinforced, all at no additional expense to the Owner.
8. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

END OF SECTION 03300

SPECIFICATIONS

SECTION 03400 - PRECAST CONCRETE

PART 1 – GENERAL

1.1 SUMMARY

- A. This section Includes precast concrete structures, including but not limited to wet wells, valve vaults, metering vaults, etc., joint wrap, and accessories required for precast structures.

1.2 REFERENCES

- A. American Society for Testing and Materials
 - 1. ASTM C-33, Standard Specifications for Concrete Aggregate.
 - 2. ASTM A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 3. ASTM A497, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - 4. ASTM C890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structure.
 - 5. ASTM C913-08, Standard Specification for Precast Concrete Water and Wastewater Structures.

1.3 SYSTEM DESCRIPTION

- A. Concrete Compressive Strength (ASTM C39): 5,000 psi minimum at 28 days.
- B. Water Resistive: No water intrusion through wall, base or top sections.
- C. Concrete shall be designed to be resistant to sulfate.
- D. Design standard precast concrete units to withstand design load conditions in accordance with applicable industry standards. Design must consider stressed induced during handling, shipping, and installation to avoid cracking or other handling damage.

1.4 SUBMITTALS

- A. Comply with Section 01330.
- B. Product Data:
 - 1. Manufacturer's data.
 - 2. Manufacturer's standard storage, handling, and installation instructions.
- C. Shop Drawings: Shop drawings shall be sealed by a Professional Engineer registered in the State of Delaware and shall illustrate:
 - 1. Plans, elevations, sections, and details of base, wall and top components.
 - 2. Joint details illustrating sealant and external wrap material.
 - 3. Pipe penetration details illustrating size, location and type of seal.
 - 4. Liner details illustrating embedment, field welding, joint coverage and interfacing with penetrations.
 - 5. Hatch frame details.

SPECIFICATIONS

D. Calculations: Calculations shall be sealed by a Professional Engineer registered in Delaware and shall include.

1. Buoyancy calculations assuming ground water elevation is at the seasonal high groundwater level indicated on the Contract Drawings.
2. Structural calculations.

E. Quality Assurance/Control Submittals

1. Design date
2. Test Reports
 - a. Upon request, the precast concrete producer shall supply copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for Portland cement, blended cement, pozzolans, ground granulated blast-furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project.
 - b. Upon request, the precast concrete producer shall submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the project conditions. Such tests may include compressive strength, plastic air content, temperature of freshly mixed concrete, and slump of freshly mixed concrete.
 - c. Concrete Testing
 - i. Slump: A slump test shall be performed at least once per day per mix design used. Slump tests shall be performed in accordance with ASTM C 1611 for self-consolidating concrete.
 - ii. Temperature: The temperature of fresh concrete shall be measured each time a slump, air content, or compressive strength tests are made. Temperature shall be measured in accordance with ASTM C 1064.
 - iii. Compressive Strength: At least four compressive strength specimens shall be made each day for each mix design unless otherwise specified. In accordance with ASTM C 31, C 39, C 192.
3. Qualification Statements
 - a. Upon request, the precast concrete producer shall supply copies of in-plant QA/QC inspection reports.

1.5 QUALITY ASSURANCE

A. Qualifications: Manufacturer's standard product listing shall include wastewater products. The precast concerted producer shall have a quality control program which is audited for compliance.

B. Certifications: Manufacturer shall be certified by the National Precast Concrete Association (NPCA) and shall have been for a minimum of five (5) years.

C. Quality Control

1. The precast concrete producer shall show that the following quality control tests are performed as required and in accordance with ASTM International standards:
 - a. Concrete Testing
 - i. Slump: A slump test shall be performed at least once per day per mix

SPECIFICATIONS

- design used. Slump tests shall be performed in accordance with ASTM C 1611 for self-consolidating concrete.
- ii. Temperature: The temperature of fresh concrete shall be measured each time a slump, air content, or compressive strength tests are made. Temperature shall be measured in accordance with ASTM C1064.
 - iii. Compressive Strength: At least four compressive strength specimens shall be made each day for each mix design unless otherwise specified. In accordance with ASTM C 31, C 39, C 192.
 - iv. Air Content: Tests for air content shall be performed if the mix design specifies air entrainment. The air content will be measured in accordance with ASTM C 231. The Air Content shall be measured once per day per mix design.
 - v. Density (Unit Weight): Tests for Density (Unit Weight) shall be performed monthly for each mix design used at a minimum. Tests shall be in accordance with ASTM C 138
- b. Aggregate Testing
- i. A full set of aggregate tests shall be performed on each aggregate at least annually by an independent testing agency or an in house test lab. These tests will include gradations (ASTM C136), Soundness (ASTM C 88), Organic Impurities (ASTM C 40), Sand Equivalent for fine aggregates only (ASTM D 2419).
 - ii. Potential reactivity shall be performed once per each aggregate source, and when aggregate sources change (ASTM C 1260 or C1293).
 - iii. Monthly, at a minimum, gradations shall be performed per ASTM C33.
 - iv. Aggregate Moisture tests: Moisture tests on aggregates shall be performed in accordance with ASTM C 70 or ASTM C 566. Fine aggregate moisture content tests shall be performed at least once per day if there are no moisture meters, otherwise it shall be performed once per month. Alternatively the speedy moisture test is acceptable (ASTM D 4944).
- c. Preplacement Check
- i. All products shall be inspected for accuracy prior to placing concrete. Checks shall include, but not be limited to, form condition and cleanliness, form dimensions, joints, release agent, blockouts, inserts and locations, lifting devices, reinforcing steel size, spacing, clearances and proper placement.
 - ii. Preplacement checks shall be documented and initialed by the inspector. A drawing with verifications of the above criteria can be used as documentation.
- d. Postplacement Check
- i. All products shall be inspected for accuracy after the concrete forms have been removed. Checks shall include, but not be limited to, dimensional checks, finishing, insert locations, squareness, honeycombing, cracking, marking, coatings, racking, hole size and location. Postplacement checks may require a corrective action report.
 - ii. Postplacement checks shall be documented and initialed by the inspector. A drawing with verifications of the above criteria can be used as documentation.

D. Pre-installation Meeting

SPECIFICATIONS

1. Contractor shall coordinate a project site meeting prior to delivery and installation with Owner's representative, precast manufacturer, and installer to review site conditions, access to site, requirements of related of prerequisite work (i.e. excavation, subgrade preparation, etc.), storage and hauling procedures, and protective measures.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading: Ship and handle precast sections in a manner as recommended by the manufacturer that will prevent damage. Units shall not be shipped until they have reached at least 70% of their specified 28-day design strength, unless damage will result.
- B. Acceptance at Site: Contractor shall be available at the site to take acceptance of all deliveries. Authority shall not be responsible for acceptance of deliveries. All deliveries attempted to be made without a Contractor's representative will be refused.
- C. Storage and Protection: Store precast concrete units in a manner that will minimize potential damage.

PART 2 – PRODUCTS

2.1 PRECAST REINFORCED WET WELLS

A. Manufacturers

1. Terre Hill Concrete Products
2. Gillespie Precast

B. Concrete: Comply with Section 03300.

C. Pre-cast Concrete Sections:

1. Pre-cast wet wells shall conform to specifications for ASTM C 478 "Pre-cast Reinforced Concrete Manhole Sections".
2. The minimum wall thickness shall be eight inches. Pre-cast wet-wells shall be constructed with a pre-cast monolithic base structure having a minimum base thickness of twelve inches.
3. All sections shall have tongue and groove or otherwise overlapping joints. Joints shall be self-sealing utilizing a double layer of bituminous, butyl rubber sealant meeting or exceeding the requirements of ASTM C-990-91.
4. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on each pre-cast section.
5. Pre-cast concrete top slabs shall be used.
6. Lift rings or non-penetrating lift holes shall be provided for handling pre-cast sections. Non-penetrating lift holes shall be filled with non-shrink grout after installation of the sections.
7. The wet well joints shall be encapsulated with a heat shrink-wrap with a minimum thickness of 0.100". The wrap shall have a cross-linked polyolefin backing coated with a protective heat activated adhesive. The wrap should effectively bond to the substrate via primer provided by the manufacturer, providing corrosion and moisture protection. Joint wrap shall be ConWrap CS-212 by ConSeal conforming to ASTM E-1745, C-877, C-990 Specifications, or equal.

- D. Pipe Openings: Custom preformed during manufacturing to accommodate type of pipe and pipe opening seal specified.

SPECIFICATIONS

- E. Modular Mechanical Type Pipe Opening Seals: Sleeves shall be cast into the concrete with water stop collar. Seals shall be modular mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Seals shall be "Link-Seal as manufactured by Thunderline Corp., or equal.
- F. Interior walls shall receive a minimum two coat application of an epoxy resin coating. The total average dry film thickness shall measure 20 mils with no single measurement to be less than 16 mils
- G. Exterior walls shall receive two coats of 68 percent solids coal tar type protective coating. The total average dry film thickness shall measure 20 mils with no single measurement to be less than 16 mils. Surfaces shall be prepared and coatings applied in accordance with the manufacturer's written instructions. The coating shall be Ply-Tile Epoxy Tar Coating manufactured by M.A.B. Industrial Coatings, or equal
- H. Access Hatches shall be integrally cast into the concrete top to maximize the opening dimensions based on the wet well dimensions and top configuration.

2.2 PRECAST REINFORCED VAULTS

A. Manufacturers

1. Terre Hill Concrete Products
2. Gillespie Precast

B. Concrete: Comply with Section 03300.

C. Pre-cast Concrete Sections:

1. Pre-cast vaults shall conform to specifications for ASTM C 478 "Pre-cast Reinforced Concrete Manhole Sections".
2. The minimum wall thickness shall be six inches. Pre-cast vaults shall be constructed with a pre-cast monolithic base structure having a minimum base thickness of eight inches.
3. All sections shall have tongue and groove or otherwise overlapping joints. Joints shall be self-sealing utilizing a double layer of bituminous, butyl rubber sealant meeting or exceeding the requirements of ASTM C-990-91.
4. The date of manufacture and the name or trademark of the manufacturer shall be clearly marked on each pre-cast section.
5. Pre-cast concrete top slabs shall be used.
6. Lift rings or non-penetrating lift holes shall be provided for handling pre-cast sections. Non-penetrating lift holes shall be filled with non-shrink grout after installation of the sections.
7. Vault joints shall be encapsulated with a heat shrink-wrap with a minimum thickness of 0.100". The wrap shall have a cross-linked polyolefin backing coated with a protective heat activated adhesive. The wrap should effectively bond to the substrate via primer provided by the manufacturer, providing corrosion and moisture protection. Joint wrap shall be ConWrap CS-212 by ConSeal conforming to ASTM E-1745, C-877, C-990 Specifications, or equal.

D. Pipe Openings: Custom preformed during manufacturing to accommodate type of pipe and pipe opening seal specified.

1. Modular Mechanical Type Pipe Opening Seals: Sleeves shall be cast into the concrete with water stop collar. Seals shall be modular mechanical type consisting of

SPECIFICATIONS

interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Seals shall be "Link - Seal" as manufactured by Thunderline Corp., or equal.

- E. Exterior walls shall receive a minimum two coat application of a 68 percent solids coal tar protective coating. The total average dry film thickness shall measure 20 mils with no single measurement to be less than 16 mils.
- F. Interior walls shall receive a minimum two coat application of an epoxy resin coating. The total average dry film thickness shall measure 20 mils with no single measurement to be less than 16 mils.
- G. Access Hatch frames shall be 6063-T6 aluminum extrusion with a continuous anchor feature incorporated. Frames shall be designed to direct rain water via the channel frame to a drain connection. Covers shall be 1/4" aluminum 6061-T6 allow diamond pattern plate.
 - 1. Covers in non-traffic areas shall be reinforced to withstand a live load of 300 pounds per square foot. Covers subject to off-street vehicular traffic loads shall be reinforced for an AASHTO H-20 loading.
 - 2. Covers shall be equipped with a minimum of two heavy duty hinges with stainless steel pins, an automatic hold-open arm and an enclosed stainless steel spring assist. A non-corrosive locking bar shall be provided. All hardware shall be stainless steel.
 - 3. All material shall have a standard mill finish. The embedded portion of the frame shall receive a heavy shop coat of bituminous paint where in contact with concrete.
 - 4. Products:
 - a. Series W1S or W2S by Halliday Products, Inc.
 - b. Type J-AL or JD-AL as manufactured by the Bilco Company.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Prepare subgrade as specified in Division 2.
- B. Place base unit, wall sections and top unit. Insure that gaskets for water tightness are properly installed between successive units.
- C. Remove or conceal lifting devices or inserts, and protect from rust or corrosion.
- D. Backfill structures in accordance with Division 2.

3.2 FIELD QUALITY CONTROL

- A. Field Test: Leak resistance testing is required for all precast concrete structures. Contractor shall utilize one or both of the of the following methods
 - 1. Vacuum Testing
 - a. Prior to backfill, vacuum test system according to ASTM C 1244 for manholes and ASTM C 1227 for septic tanks.
 - 2. Hydrostatic Testing
 - a. First Backfill the structure, then fill to the high water level, let stand for 24 hours.

SPECIFICATIONS

Refill to the original water line and measure the water level change over a 24 hour period. Loss due to leakage shall not exceed 1% of volume.

B. Inspection

1. Final field elevations and compaction properties shall be verified and documented.

END OF SECTION 03400

SPECIFICATIONS

SECTION 04810 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:

1. Concrete masonry units (CMUs).

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."

C. Five samples for each type and color of exposed masonry units showing quality, size, and texture of blocks.

D. Material Certificates: For each type of product indicated. Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards.

1. Include material test reports substantiating compliance with requirements.

E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1.3 PROJECT CONDITIONS

A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

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. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
2. 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 CONCRETE MASONRY UNITS (CMUs)

A. Shapes: Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.

SPECIFICATIONS

- B. Concrete Masonry Units: ASTM C 90.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi.
 2. Weight Classification: Normal weight.
 3. Pattern and Texture for decorative units:
 - a. Standard pattern, split-face finish
- 2.3 MORTAR AND GROUT MATERIALS
- A. Portland Cement: ASTM C 150, Type I, except Type III may be used for cold-weather construction.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Masonry Cement: ASTM C 91.
- D. Mortar Pigments: Iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar.
- E. Colored Cement Product: Packaged blend made from portland cement and lime or masonry cement and mortar pigments, all complying with specified requirements, and containing no other ingredients.
1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 2. Products:
 - b. Colored Portland Cement-Lime Mix:
 - 1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
 - 2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
 - 3) Lafarge North America Inc.; Eaglebond.
 - 4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
 - c. Colored Masonry Cement:
 - 1) Capital Materials Corporation; Flamingo Color Masonry Cement.
 - 2) Essroc, Italcementi Group; Brixment-in-Color.
 - 3) Holcim (US) Inc.; Rainbow Mortamix Custom Color Masonry Cement.
 - 4) Lafarge North America Inc.; Florida Custom Color Masonry or Magnolia Masonry Cement.
 - 5) Lehigh Cement Company; Lehigh Custom Color Masonry Cement.
 - 6) National Cement Company, Inc.; Coosa Masonry Cement.
 - 7) Approved equal.
- F. Aggregate for Mortar: ASTM C 144.
1. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Mortar Sand: AASHTO M45 and 100 percent of material must pass a number 4 sieve.
- H. Aggregate for Grout: ASTM C 404.
- I. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units.
- J. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

SPECIFICATIONS

1. Products:
 - a. Addiment Incorporated; Mortar Kick.
 - b. Euclid Chemical Company (The); Accelguard 80.
 - c. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Morset.
 - d. Sonneborn, Div. of ChemRex; Trimix-NCA.
- K. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with concrete masonry units, containing integral water repellent by same manufacturer.
 1. Products:
 - a. Addiment Incorporated; Mortar Tite.
 - b. Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
 - c. Master Builders, Inc.; Color Cure Mortar Admix or Rheomix Rheopel.
- L. Water: Potable.

2.4 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.
- B. Masonry Joint Reinforcement: ASTM A 951; mill galvanized, carbon-steel wire for interior walls and hot-dip galvanized, carbon-steel wire for exterior walls.
 1. Wire Size for Side Rods: 3/16"
 2. Wire Size for Cross Rods: No. 9 Gauge.
 3. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 4. Single-Wythe Masonry: Truss type with single pair of side rods.
 5. Multiwythe Masonry:
 - C. Ladder type with 1 side rod at each face shell of hollow masonry units more than 4 inches in width, plus 1 side rod at each wythe of masonry 4 inches or less in width.
 - D. Tab type, with 1 side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.
 - E. Adjustable (two-piece) type, with one side rod at each face shell of backing wythe and with ties that extend into facing wythe. Ties engage eyes or slots in reinforcement and extend at least halfway through facing wythe but with at least 5/8-inch cover on outside face.

2.5 TIES AND ANCHORS

- A. Materials:
 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
 4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
- D. Adjustable Anchors for Connecting to Structures: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch diameter, hot-dip galvanized steel wire.

SPECIFICATIONS

2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.188-inch 0.25-inch diameter, hot-dip galvanized steel wire.
 3. Connector Section for Concrete: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.053-inch 0.097-inch thick, steel sheet, galvanized after fabrication.
- E. Partition Top anchors: 0.097-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- F. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 3/16 inch thick by 16 inches long, with ends turned up 2 inches or with cross pins.
1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.6 MISCELLANEOUS MASONRY ACCESSORIES

- A. Weep/Vent Products: Use one of the following, unless otherwise indicated:
1. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches long.
- B. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
1. Provide one of the following configurations:
 - a. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep.
 - b. Strips, not less than 1-1/2 inches thick and 10 inches wide, with dimpled surface designed to catch mortar droppings and prevent weep holes from being clogged with mortar.
 - c. Sheets or strips full depth of cavity and installed to full height of cavity.
 2. Products
 - a. Archovations, Inc.; CavClear Masonry Mat.
 - b. Dayton Superior Corporation, Dur-O-Wal Division; Polytime MortarStop.
 - c. Mortar Net USA, Ltd.; Mortar Net.

2.7 INSULATION

- A. KORFIL as manufactured by Concrete Block Insulating Systems, Inc. or equal.
- B. Insulation shall be insulation inserts and factory installed in blocks at block producers plant.
- C. Insulation shall be individually molded of expandable polystyrene at a minimum density of 0.90 pcf and a maximum water vapor transmission of 1.1 per inch, and shall conform to ASTM C578 and ASTM C 90. Insulation shall have the following properties:
1. Thermal resistance: 5.00 hr.ft²°F/BTU in.
 2. Moisture resistance: <1.1

2.8 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains from new masonry without damaging masonry. Use product approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
1. Available Manufacturers:
 - a. Diedrich Technologies, Inc.

SPECIFICATIONS

- b. EaCo Chem, Inc.
- c. ProSoCo, Inc.

2.9 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
 - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Mortar for Unit Masonry: Comply with ASTM C 270 Proportion Specification.
- C. Mortar for Unit Masonry: Comply with ASTM C 270.
 - 1. For masonry below grade or in contact with earth, use Type M.
 - 2. For reinforced masonry, use Type N.
 - 3. For mortar parge coats, use Type S.
 - 4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
 - 5. For interior non-load-bearing partitions, Type O may be used instead of Type N.
- C. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
 - 1. Pigments shall not exceed 10 percent of portland cement by weight.
 - 2. Pigments shall not exceed 5 percent of masonry cement by weight.
- D. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 - 2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.
- E. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
 - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

SPECIFICATIONS

3.2 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar, unless otherwise indicated.
- E. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
- F. All joints between bricks shall be completely filled with mortar. Bed joints shall be formed of a thick layer of smooth or slightly furrowed mortar, applied to the units previously laid, with the brick then shoved in place; or bed joints may be formed as specified for cross joints. Cross joints shall be formed by applying to the brick to be laid, a full coat of mortar on the entire end or the entire side, as the case requires, and then shoving the mortar-covered end and/or side of the brick tightly against the bricks previously laid; the practice of buttering the corners of brick and then throwing mortar scrapping into the empty joints will not be permitted. All brick shall be laid without disturbing the brick previously laid. Dry or butt joints will not be permitted. Grouting shall be done only as necessary.
- G. Brick having absorption rate of more than 0.025 ounce per square inch per minute shall be wetted sufficiently so that the rate of absorption when laid does not exceed this amount. All units shall be free from water adhering to their surface when they are laid in the wall. Do not wet concrete masonry units.

3.3 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick as follows:
 - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 - 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint), unless otherwise indicated.

3.4 MASONRY JOINT REINFORCEMENT

- A. General: Install in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

SPECIFICATIONS

- B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

3.5 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than $\frac{1}{2}$ inch in width between masonry and structural member, unless otherwise indicated.
2. Anchor masonry to structural members with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.6 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows, unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing as recommended by flashing manufacturer.
2. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing $\frac{1}{2}$ inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing $\frac{1}{2}$ inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.

C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products to form weep holes.
2. Space weep holes 24 inches o.c., unless otherwise indicated.
3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.

D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

E. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

SPECIFICATIONS

3.7 PARGING

A. Parge masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch with a steel-trowel finish. Form a wash at top of parging and a cove at bottom. Damp-cure parging for at least 24 hours and protect parging until cured.

3.8 CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. No further cleaning work shall proceed until the sample area has been approved by the Engineer.
 2. Protect adjacent surfaces from contact with cleaner.
 3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 4. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

END OF SECTION 04810

SPECIFICATIONS

SECTION 05120 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes structural steel.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
- C. Welding certificates.
- D. Mill test reports.
- E. Source quality-control test reports.

1.3 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Sbd.
- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- C. Structural steel fabrication, erection, and connection design shall conform to AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" latest edition.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A36.
- B. Channels, Angles, S -Shapes: ASTM A 36.
- C. Plate and Bar: ASTM A 36.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- E. Steel Pipe: ASTM 501 or ASTM A 53/A 53M, Type E or S, Grade B.
- F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 - 1. Finish: Plain Hot-dip zinc coating, ASTM A 153, Class C.
- B. Steel bolts, nuts and washers shall adhere to the following criteria:

SPECIFICATIONS

1. Machine bolts, turn bolts, and drift bolts shall conform to ASTM A307.
 2. Bolts used for driving through timber shall be a type which will withstand hard driving without objectionable burring on the driving head.
 3. Bolts used as drift pins shall be made of carbon tool steel having a Rockwell Hardness of C50 to C 53 on the shank and C 30 to C 37 on the head.
 4. All of the above materials shall be galvanized in accordance with ASTM A 153 unless otherwise stipulated.
- C. Cast washers, ogee washers, and special cast washers shall be made of malleable iron in accordance with ASTM A 47. Cast washers shall be galvanized in accordance with ASTM A 153.
- D. Hardware spikes, nails, bolt spikes, wood screws, staples, brads, lag screws, carriage bolts, and other parts coming under the general heading of "Hardware" shall, unless otherwise specified, be composed of approved carbon steel and shall comply with National Bureau of Standards Specification R223. Also, all such hardware shall always be galvanized as per ASTM A 153.

2.3 PRIMER

- A. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

2.4 GROUT

- A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.
- B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 2. Surfaces to be field welded. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

SPECIFICATIONS

1. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

2.8 ERECTION

A. Examination: Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design."

C. Base and Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.

1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.

2. Weld plate washers to top of base plate.

3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.

4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

D. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

2.9 FIELD CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.

B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.

1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.

2.10 FIELD QUALITY CONTROL

A. Welded Connections: Field welds will be visually inspected according to AWS D1.1.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

SPECIFICATIONS

END OF SECTION 05120

SPECIFICATIONS

SECTION 05500 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Miscellaneous steel framing and supports.
 - 2. Shelf angles.
 - 3. Loose bearing and leveling plates.
 - 4. Steel weld plates and angles.
 - 5. Metal bollards.
 - 6. Loose steel lintels.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Prefabricated building columns.
 - 2. Metal nosings and treads.
 - 3. Grout.
- B. Shop Drawings: Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

PART 2 - PRODUCTS

2.1 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.
- B. Ferrous Metals:
 - 1. Steel Plates, Shapes, and Bars: ASTM A 36.
 - 2. Steel Tubing: ASTM A 500, cold-formed steel tubing.
 - 3. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

2.2 FASTENERS

- A. General: Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.
- B. Cast-in-Place Anchors in Concrete: Threaded or wedge type; galvanized ferrous castings, either ASTM A 47 malleable iron or ASTM A 27 cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153.

2.3 MISCELLANEOUS MATERIALS

- A. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI #79.
- B. Galvanizing Repair Paint: SSPC-Paint 20, high-zinc-dust-content paint for regalvanizing welds in steel.

SPECIFICATIONS

- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107.
- D. Concrete Materials and Properties: Comply with requirements in Division 3 Section 03300 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.4 FABRICATION

- A. General: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
 - 1. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
 - 2. Weld corners and seams continuously. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. Obtain fusion without undercut or overlap. Remove welding flux immediately. Finish exposed welds smooth and blended.
 - 3. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Locate joints where least conspicuous.
 - 4. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
 - 5. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 24 inches o.c.
- B. Miscellaneous Framing and Supports: Provide steel framing and supports not specified in other Sections as needed to complete the Work. Fabricate units from steel shapes, plates, and bars of welded construction. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Fabricate steel girders for wood frame construction from continuous steel shapes. Where wood nailers are attached to girders with bolts or lag screws, drill holes at 24 inches o.c.
 - 2. Fabricate steel pipe columns for supporting wood frame construction with steel baseplates and top plates welded to pipe with fillet welds the same size as pipe wall thickness.
- C. Loose Steel Lintels: Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
 - 1. Lintels in Exterior Walls: Galvanized.
- D. Shelf Angles: Fabricate shelf angles of sizes indicated and for attachment to framing. Fabricate with horizontally slotted holes to receive $\frac{3}{4}$ inch bolts, spaced not more than 6 inches from ends and 24 inches o.c.
 - 1. Shelf Angles in Exterior Walls: Galvanized.
 - 2. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.
- E. Loose Bearing and Leveling Plates: Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts.
- F. Metal Bollards: Fabricate from Schedule 40 steel pipe.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Finish metal fabrications after assembly.
- B. Steel and Iron Finishes:

SPECIFICATIONS

1. Hot-dip galvanize items as indicated to comply with ASTM A 123 or ASTM A 153 as applicable.
2. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with requirements indicated below for environmental exposure conditions of installed metal fabrications:
 - a. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - b. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
3. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting," for shop painting.

PART 3 - EXECUTION

3. INSTALLATION

- A. General: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, with edges and surfaces level, plumb, and true.
 1. Fit exposed connections accurately together. Weld connections that are not to be left as exposed joints but cannot be shop welded. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication.
 2. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.
 3. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- B. Set bearing and leveling plates on cleaned surfaces using wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts and pack solidly with nonshrink, nonmetallic grout.
- C. Bollards:
 1. Anchor bollards in place with concrete footings. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.
 2. Fill bollards solidly with concrete, mounding top surface to shed water.
- D. Touch up surfaces and finishes after erection.
 1. Painted Surfaces: Clean field welds, bolted connections, and abraded areas and touch up paint with the same material as used for shop painting.
 2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 05500

SPECIFICATIONS

SECTION 08111 - STANDARD STEEL DOORS AND FRAMES

PART - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

- 1. Steel Crawl Space Door.

- B. Related Sections include the following:

- 1. Division 4 Section "Unit Masonry Assemblies" for building anchors into and grouting standard steel frames in masonry construction.
 - 2. Division 8 Sections for door hardware for standard steel doors.
 - 3. Division 9 painting Sections for field painting standard steel doors and frames.

1.3 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.

1.4 SUBMITTALS

- A. Product Data: Include construction details, material descriptions, core descriptions, label compliance, and finishes for each type of steel door and frame specified.

- B. Shop Drawings: In addition to requirements below, provide a schedule of standard steel doors and frames using same reference numbers for details and openings as those on Drawings:

- 1. Elevations of each door design.
 - 2. Details of doors, including vertical and horizontal edge details.
 - 3. Frame details for each frame type, including dimensioned profiles.
 - 4. Details and locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, accessories, joints, and connections.
 - 7. Details of glazing frames and stops showing glazing.

- C. Coordination Drawings: Drawings of each opening, including door and frame, drawn to scale and coordinating door hardware. Show elevations of each door design type, showing dimensions and locations of door hardware.

- D. Samples for Initial Selection: For units with factory-applied color finishes.

- E. Samples for Verification: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.

- F. Qualification Data: For installer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

SPECIFICATIONS

- B. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated, as documented according to ASTM E 548.
- C. Source Limitations: Obtain standard steel doors and frames through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to finish of factory-finished doors and frames.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store doors and frames under cover at Project site. Place units in a vertical position with heads up, spaced by blocking, on minimum 4-inch wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber.
 - 1. If wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4 inch between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify openings by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating standard steel frames without field measurements. Coordinate wall construction to ensure that actual opening dimensions correspond to established dimensions.

1.8 COORDINATION

- A. Coordinate installation of anchorages for standard steel frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in masonry. Deliver such items to Project site in time for installation.

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, but are not limited to, the following:
 - 1. K&P Inc.
 - 2. Or equal.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

SPECIFICATIONS

- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 zinc-iron-alloy (galvannealed) coating designation.
- D. Electrolytic Zinc-Coated Steel Sheet: ASTM A 591/A 591M, Commercial Steel (CS), Class B coating; mill phosphatized.
- E. Supports and Anchors: After fabricating, galvanize units to be built into exterior walls according to ASTM A 153/A 153M, Class B.
- F. Inserts, Bolts, and Fasteners: Provide items to be built into exterior walls, hot-dip galvanized according to ASTM A 153/A 153M.
- G. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching standard steel door frames of type indicated.
- H. Grout: Comply with ASTM C 476, with a slump of 4 inches for standard steel door frames built into concrete or masonry, as measured according to ASTM C 143/C 143M.
- I. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. density; with maximum flame-spread and smoke-developed indexes of 25 and 50 respectively; passing ASTM E 136 for combustion characteristics.
- J. Glazing: Comply with requirements in Division 8 Section "Glazing."
- K. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD STEEL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces, unless otherwise indicated. Comply with ANSI A250.8.
 - 1. Design: Flush panel.
 - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, core that produces doors complying with ANSI A250.8.
 - a. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 10 when tested according to ASTM C 1363.
 - 1) Locations: Exterior doors.
 - 3. Vertical Edges for Single-Acting Doors: Square edge.
 - 4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- thick end closures or channels of same material as face sheets.
 - 5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
 - 1. Level 1 and Physical Performance Level C, (Standard Duty), Model 1 Full Flush.
- C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior door requirements. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:

SPECIFICATIONS

1. Level 1 and Physical Performance Level C, (Standard Duty), Model 1 Full Flush.
- D. Hardware Reinforcement: Fabricate reinforcement plates from same material as door face sheets to comply with the following minimum sizes:
1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
 2. Pivots: Minimum 0.167 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
 3. Lock Face: Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick.
 4. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.
- E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD STEEL FRAMES

- A. General: Comply with ANSI A250.8 and with details indicated for type and profile.
- B. Exterior Frames: Fabricated from metallic-coated steel sheet.
1. Fabricate frames with mitered or coped and welded face corners.
 2. Frames for Level 1 Steel Doors: 0.042 inch thick steel sheet.
- C. Interior Frames: Fabricated from cold-rolled steel sheet, unless otherwise indicated to comply with exterior frame requirements.
1. Fabricate frames with mitered or coped and welded face corners.
 2. Fabricate knocked-down frames with mitered or coped corners, for field assembly.
 3. Fabricate knocked-down, drywall slip-on frames for in-place gypsum board partitions.
 4. Frames for Level 1 Steel Doors: 0.042 inch thick steel sheet.
- D. Hardware Reinforcement: Fabricate reinforcement plates from same material as frames to comply with the following minimum sizes:
1. Hinges: Minimum 0.123 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
 2. Pivots: Minimum 0.167 inch thick by 1-1/2 inches wide by 6 inches longer than hinge, secured by not less than 6 spot welds.
 3. Lock Face, Flush Bolts, Closers, and Concealed Holders: Minimum 0.067 inch thick.
 4. All Other Surface-Mounted Hardware: Minimum 0.067 inch thick.
- E. Supports and Anchors: Fabricated from electrolytic zinc-coated or metallic-coated steel sheet.
- F. Jamb Anchors:
1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long, or wire anchors not less than 0.177 inch thick.
 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
 3. Compression Type for Slip-on Frames: Adjustable compression anchors.
 4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8 inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- G. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:
1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2 inch height adjustment. Terminate bottom of frames at finish floor surface.

SPECIFICATIONS

- H. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.
- I. Ceiling Struts: Minimum 3/8-inch-thick by 2-inch wide steel.
- J. Plaster Guards: Formed from same material as frames, not less than 0.016-inch thick.

2.5 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
- B. Fixed Frame Moldings: Formed integral with standard steel frames, minimum 5/8 inch high, unless otherwise indicated.
- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.6 FABRICATION

- A. General: Fabricate standard steel doors and frames to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Standard Steel Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 2. Glazed Lites: Factory cut openings in doors.
- C. Standard Steel Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners, unless otherwise indicated.
 - 3. Plaster Guards: Weld guards to frame at back of hardware mortises in frames installed in concrete or masonry.
 - 4. Where installed in masonry, leave vertical mullions in frames open at top for grouting.
 - 5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - 6. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Two anchors per jamb up to 60 inches in height.
 - 2) Three anchors per jamb from 60 to 90 inches in height.
 - 3) Four anchors per jamb from 90 to 120 inches in height.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof more than 120 inches in height.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches in height.
 - 2) Four anchors per jamb from 60 to 90 inches in height.

SPECIFICATIONS

- 3) Five anchors per jamb from 90 to 96 inches in height.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof more than 96 inches in height.
 - 5) Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
- c. Compression Type: Not less than two anchors in each jamb.
 - d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
- D. Hardware Preparation: Factory prepare standard steel doors and frames to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping, according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."
1. Reinforce doors and frames to receive nontemplated mortised and surface-mounted door hardware.
 2. Comply with applicable requirements in ANSI A250.6 and ANSI/DHI A115 Series specifications for door and frame preparation for hardware. Locate hardware as indicated on Shop Drawings or, if not indicated, according to ANSI A250.8.
- E. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of door or frame.
 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings such that each glazed lite is capable of being removed independently.
 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 4. Provide loose stops and moldings on inside of doors and frames.
 5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.7 STEEL FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish standard steel door and frames after assembly.
- B. Metallic-Coated Steel Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
2. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- C. Steel Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning"; remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel; comply with SSPC-SP 3, "Power Tool Cleaning," or SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- D. Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment. Apply a smooth coat of even consistency to provide a uniform dry film thickness of not less than 0.7 mils.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied finish paint system indicated; and providing a sound foundation for field-applied topcoats despite prolonged exposure.

SPECIFICATIONS

- E. Factory-Applied Paint Finish: Manufacturer's standard, complying with ANSI A250.3 for performance and acceptance criteria.
 - 1. Color and Gloss: As selected by Owner from manufacturer's full range.

PART 3- EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of standard steel doors and frames.
 - 1. Examine roughing-in for embedded and built-in anchors to verify actual locations of standard steel frame connections before frame installation.
 - 2. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory.
- B. Prior to installation and with installation spreaders in place, adjust and securely brace standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.
- C. Drill and tap doors and frames to receive nontemplated mortised and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Provide doors and frames of sizes, thicknesses, and designs indicated. Install standard steel doors and frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Standard Steel Frames: Install standard steel frames for doors and other openings, of size and profile indicated. Comply with SDI 105.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. Where frames are fabricated in sections due to shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - b. Install frames with removable glazing stops located on secure side of opening.
 - c. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - d. Check plumb, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

SPECIFICATIONS

- e. Apply bituminous coating to backs of frames that are filled with mortar, grout, and plaster containing antifreezing agents.
2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
 4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar as specified in Division 4 Section "Unit Masonry Assemblies."
 5. Concrete Walls: Solidly fill space between frames and concrete with grout. Install grout in lifts and take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to supporting construction above, unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction above. Provide adjustable wedged or bolted anchorage to frame jamb members.
 9. Installation Tolerances: Adjust standard steel door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Standard Steel Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
- D. Glazing: Comply with installation requirements in Division 8 Section "Glazing" and with standard steel door and frame manufacturer's written instructions.
1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c., and not more than 2 inches o.c. from each corner.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including standard steel doors or frames that are warped, bowed, or otherwise unacceptable.

SPECIFICATIONS

- B. Clean grout and other bonding material off standard steel doors and frames immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.
- D. Galvannealed Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

3.5 DOOR SCHEDULE

ID	W	H	T	HAND	FRAME	GLAZING	LOUVER	HARDWARE SET	REMARKS
A	40"	40"	134"	LHRB	RH	-	-	1	
B									
C									
D									

END OF SECTION 08111

SPECIFICATIONS

SECTION 09912 - PAINTING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes surface preparation and field painting of exposed exterior and interior items and surfaces.

1.2 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Samples: For each type of finish-coat material indicated, submit three (3) copies of the full range of colors available in each of the proposed products.
- C. Before any paint materials are delivered to the job site the Contractor shall submit, a complete list of all materials proposed to be furnished and installed under this portion of the work.

1.3 QUALIFICATIONS

- A. The Contractor shall use only qualified journeyman painters for the mixing and application of paint on exposed surfaces. In the acceptance or rejection of installed painting, no allowance will be made for of skill on the part of painters.
- B. In addition to complying with all pertinent codes and regulations, the Contractor shall comply with "Standard Type 1" as defined by the Painting and Decorating Contractors of America in their "Modern Guide to Paint Specifications" and with Steel Structures Painting Manual, Volume 1, "Good Painting Practice" published by Steel Structures Painting Council.

1.4 PROJECT CONDITIONS

- A. All paint materials shall be delivered to the job site in their original, unopened containers with all labels intact and legible at time of use. Information on the containers shall include:
 - 1. Manufacturer's name.
 - 2. Product name.
 - 3. Color.
 - 4. Batch number.
 - 5. Thinner.
- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain storage containers in a clean condition, free of foreign materials and residue.
- C. Apply waterborne paints only when temperatures of surfaces to be painted and surrounding air are between 50 and 90 deg F.
- D. Apply solvent-thinned paints only when temperatures of surfaces to be painted and surrounding air are between 45 and 95 deg F.
- E. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
 - 1. Further, the days painting should be completed well in advance of the probable time of day when condensation will occur, in order to permit the film an appreciable drying time prior to the formation of moisture.

SPECIFICATIONS

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.
 - 1. M.A. Bruder & Sons, Inc. (M.A.B. Paint)(Referenced for the purpose of establishing standards of acceptability)
 - 2. All paint materials selected for coating systems for each type of surface shall be the product of a single manufacturer.

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, thinners and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- C. Colors: As selected from manufacturer's full range.
- D. The type of material to be used and the number of coats to be applied are listed in the "Painting Schedule" in this section of the Contract Documents.

2.3 GENERAL PREPARATION

- A. Prior to all surface preparation and painting operations, the Contractor shall completely mask, remove, or otherwise adequately protect all hardware, accessories, machined surfaces, plates, lighting fixtures, and similar items in contact with painted surfaces but not scheduled to receive paint.
- B. All exposed nails and other metals which are to be painted with emulsion paints, shall be spot primed using a primer recommended by the manufacturer of the coating system.
- C. All surfaces shall be thoroughly cleaned before applying paint or other surface treatment.
- D. All cleaning and painting shall be scheduled so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

2.4 SURFACE PREPARATION

- A. Concrete block and cinder block walls shall be thoroughly cleaned free of all dust, dirt, loose mortar, and efflorescence by brushing down with stiff brooms or scraping tools, producing a clean surface for painting.
- B. Poured concrete walls, floors, and ceilings shall be cleaned free of all dust, dirt, form oil, curing compounds, efflorescence, or other foreign matter by brush-off abrasive blasting or muriatic acid etching, with a 15-20% solution. Areas acid etched shall be flushed clean with water and dried prior to painting.

SPECIFICATIONS

- C. Ferrous metal shall be thoroughly cleaned, free of all dirt, dust, rust, mill scale, as well as other foreign substances by abrasive blasting in accordance with Steel Structures Painting Council SSPC No. 10 near-white finish. Areas so cleaned shall be primed immediately after cleaning to prevent formation of new rust. All surfaces not cleaned and primed in the shop shall be abrasive blasted in the field prior to the application of primer.
- D. Non-ferrous metal shall be cleaned free of all dust, dirt, oil, scale, and other foreign interference materials by abrasive blasting in accordance with Steel Structures Painting Council SSPC No. 10 near-white finish.
- E. Plaster walls and wallboard shall be cleaned free of all dust, dirt, efflorescence and loose mortar by stiff broom or by brush cleaning.

PART 3 - EXECUTION

3.1 PAINT APPLICATION

- A. The Contractor shall paint all surfaces except glass, exterior flat concrete, and similar items not prefinished and not called out as unfinished.
- B. The Contractor shall paint all grills and other prefinished items where the factory prefinish is not in accordance with the Painting Schedule and color selection.
- C. Adequate drying time shall be allowed between coats. The drying period shall be modified as recommended by the material manufacturer to suit adverse weather conditions.
- D. Oil-base and oleo-resinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.
- E. The Contractor shall sand and dust between coats to remove all defects.
- F. All coatings are to be applied to the dry mil thickness indicated in the "Painting Schedule".
- G. Following completion of painting in each space, the Contractor shall promptly reinstall all items removed for painting, using only workmen skilled in the particular trade.
- H. The Contractor shall apply each coating at the rate and in the manner specified by the manufacturer. If materials have thickened or must be diluted for application by spray gun, the coating shall be built up to the same film thickness achieved with undiluted material. Deficiencies in film thickness shall be corrected by the application of an additional coat(s) of paint. Where thinning is necessary, only the products of the manufacturer furnishing the paint, and for that particular purpose, shall be allowed. All thinning shall be done strictly in accordance with the supplier's instructions, as well as with the full knowledge and approval of the Engineer.
- I. No paint shall be applied when the surrounding air temperature is measured below 40F. No paint shall be applied when the temperature of the surface to be painted is below 35F. Paint shall not be applied in rain, snow, fog, or mist, or when the relative humidity exceeds 85%.
- J. No paints shall be applied when it is expected that the relative humidity will exceed 85% or that the air temperature will drop below 40F, within 18 hours after the application of the paint. Dew or moisture condensation should be anticipated and if such conditions are prevalent, painting should be delayed until midmorning to be certain that the surfaces are dry. Further, the day's painting should be completed well in advance of the probable time of day when condensation will occur, in order to permit the film an appreciable drying time prior to the formation of moisture. The Contractor shall provide adequate air exhaust equipment to ventilate paint dust and solvent fumes.

SPECIFICATIONS

3.2 CLEANING AND PROTECTING

- A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from Project site.
- B. Protect work of other trades, whether being painted or not, against damage from painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Engineer.
- C. Provide "Wet Paint" signs to protect newly painted finishes. After completing painting operations, remove temporary protective wrappings provided by others to protect their work.
 1. After work of other trades is complete, touch up and restore damaged or defaced painted surfaces.
 2. Comply with procedures specified in PDCA P1.

3.3 PAINTING SCHEDULE

A. Woodwork:

1. Interior - 1 coat M.A.B. Ply-Tile 520-W-45 Epoxy, 1 coat M.A.B. Ply-Thane 890HS
2. Exterior - 1 coat M.A.B. Ply-Tile 520-W-45 Epoxy, 1 coat M.A.B. Ply-Thane 890HS

B. Concrete, Masonry, Plaster and Wallboard:

1. Poured and Precast Concrete, Dense Masonry, and Plaster; Interior - 1 coat - M.A.B. 51-P-3 Crete Prime, 1 coat - M.A.B. Ply-Mastic Epoxy - 044 Line
2. Concrete Floors, Interior - 1 coat - M.A.B. 51-P-3 Crete Prime, 1 coat - M.A.B. Ply-Mastic Epoxy - 044 Line
3. Porous Masonry; Interior - 1 coat - M.A.B. Block-Kote 2000, 1 coat - Ply-Mastic Epoxy - 044 Line
4. Dry Wall; Interior - 1 coat - M.A.B. Prime Fast 037-138, 1 coat - M.A.B. Ply-Mastic 044
5. Poured and Precast Concrete; Porous Masonry; Exterior; Below Grade - 2 coats - 796/998/999 Ply-Tile Epoxy Tar Coating
6. Poured and Precast Concrete and Porous Masonry; Exterior; Above Grade - 2 coats - M.A.B. MODAC F 019
7. Poured and Precast Concrete; Submerged; Non-Potable - 2 coats - 796/998/999 Ply-Tile Epoxy Tar Coating
8. Poured and Precast Concrete; Submerged; Potable - 1 coat - M.A.B. Crete-Prime 51-P-3, 1 coat - M.A.B. Hippo-Poxy 52 series

C. Metals; Ferrous, Non-Ferrous, and Galvanized Steel:

1. Ferrous; Interior - 1 coat - M.A.B. Ponamid 54-PG-1 gray, 1 coat - M.A.B. Ply-Mastic 044
2. Non-Ferrous and Galvanized Steel; Interior - 1 coat - Hydro Primell, 1 coat - Rust-O-Lastic DTM 043
3. Ferrous; Exterior - 1 coat - M.A.B. Ponamid 54-PG-1 gray, 1 coat - M.A.B. Ply-Tile 520 HB, 1 coat - M.A.B. Ply Thane 890 HS
4. Non-Ferrous and Galvanized Steel; Exterior - 1 coat - M.A.B. Hydro Prime II, 1 coat - M.A.B. Rust-O-Lastic DTM 043
5. Ferrous; Submerged; Potable - 1 coat - Ponamid 54-PG-1 gray, 1 coat - Hippo-Poxy 52 Series
6. Non-Ferrous and Galvanized Steel; submerged; Potable - 2 coats - M.A.B. 54 Series High Build Epoxy
7. Ferrous; Submerged; Non-Potable - 1 coat - M.A.B. Ponamid 54-PG-1 gray, 1 coat - M.A.B. 52 Series Hippo-Poxy 100% solids
8. Non-Ferrous and Galvanized Steel; Submerged; NonPotable - 1 coat - M.A.B. Ply-Tile 520-W-45 Epoxy Primer, 1 coat - M.A.B. 52 series Hippo-Poxy 100% solids
9. Ferrous; Interior and Exterior; High Temperature to 750F - 1 coat - M.A.B. Hi-Temp Gray Prime 073-800, 1 coat - M.A.B. Hi-Temperature Aluminum 091-020

SPECIFICATIONS

D. Miscellaneous:

1. Mill Coated Steel Pipe; Interior and Exterior; Submerged and Non-Submerged; Potable and Non-Potable - 1 coat - M.A.B. 52 series Hippo-Poxy 100% solids
2. Galvanized Chain Link Fence - 1 coat - M.A.B. 29 Series Elephant-Hide
3. Insulated Pipe; Interior - 1 coat - M.A.B. Ply-Mastic Epoxy - 044 Line
4. Ferrous in Contact with Concrete - 2 coats - 796/998/999 Ply-Tile Epoxy Tar Coating
5. Aluminum in Contact with Concrete - 1 coat - M.A.B. Ply-Tile 520-W-45 Epoxy Primer, 1 coat - 796/998/999 Ply-Tile Epoxy Tar Coating

E. The following coverages, film thickness requirements, and drying time between coats shall apply:

PRODUCT	COVERAGE IN SQ. FT. PER GAL MINIMUM DRY AT MIN. DRY FILM THICKNESS	FILM IN MILS	DRYING TIME BETWEEN COATS @ 75° F IN HRS.
51-P-3 Crete Prime	375	2.0	6
52 Series Hipp-Poxy	110	13.0	12
Block-Kote 2000	50-75	15.0	8
Hi-Temp Aluminum 091	250	1.5	3
Hi-Temp Primer Gray 073-800	425	1.5	18
Hydro Prime II	200	3.0	6
MODAC F 019	60	8.0	16-24
Ply-Mastic 044	250	5.0	16-24
Ply-Thane 890HS	350	2.0	16-24
Ply-Tile Epoxy Tar Coating	155	8.0	16-24
Ply-Tile 520 HB	350	2.0	16-24
Ply-Tile 520-W-45 Epoxy	312	2.0	16-24
Ponamid 54-PG-1 Gray	187	4.0	8-24
Prime-Fast 037-138	257	1.5	6
Rust-O-Lastic DTM 043	175	3.0	8

F. Painted surfaces and materials:

STRUCTURE	LOCATION	SURFACES TO BE PAINTED
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SPECIFICATIONS

Cast-in-Place Concrete Structures	Interior	Ferrous Metals, Concrete
Precast Concrete Structures	Interior, Exterior	Ferrous Metals, Concrete
	Interior	

G. The following items shall be painted:

1. Ductile Iron Piping, Fittings and Valves
2. Interior CMU block wall
2. Pumps and appurtenances (factory applied)
3. Electrical Transformers and Switchgear (factory applied)

3.4 PIPE IDENTIFICATION AND COLOR CODING

- A. For exposed interior and exterior piping, a legend showing the name of the contents and an arrow showing the direction of flow shall be stenciled on each pipe. The color of all legends shall be black. The legends shall be located not more than ten (10) feet apart and in general, at each valve and piece of equipment. The size and location of the legend shall be in general accordance with American National Standards Institute Scheme for the Identification of Piping Systems A13, I-956.
- B. All exposed pipes in the various systems shall be color coded, as specified in Paragraph 54.5 of the most recent edition of the Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, Recommended Standards for Wastewater Facilities (Ten States Standards).
- C. The Contractor shall submit, for review and approval by the Engineer, a piping identification schedule including, but not limited to, the piping systems to be identified, the specific color name, manufacturer and manufacturer's identification code of the color, and the letter size, arrow size and stencil text to be used as a legend for each piping system. Where piping systems include various sized pipes, the letter and arrow sizes shall be identified for each individual pipe size.

END OF SECTION 09912

SPECIFICATIONS

SECTION 10200 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes extruded-aluminum louvers.

1.2 PERFORMANCE REQUIREMENTS

- A. Air-Performance, Water-Penetration, and Wind-Driven Rain Ratings: As demonstrated by testing manufacturer's stock units according to AMCA 500-L.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include printed catalog pages showing AMCA Certified Ratings Seals.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other Work.
 - 1. Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for each louver is based on the product named. Subject to compliance with requirements, provide the named product or a comparable product by another manufacturer.

2.2 FABRICATION, GENERAL

- A. Fabricate frames to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- B. Join frame members to each other and to louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.
- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.
- C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- E. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

SPECIFICATIONS

3.2 LOUVER SCHEDULE

- A. Furnish and install louvers in accordance with schedule on the drawings.

END OF SECTION 10200

SPECIFICATIONS

SECTION 10520 - FIRE-PROTECTION SPECIALTIES

PART1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Portable fire extinguishers.
 - 2. Mounting brackets for fire extinguishers.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Fire Extinguishers: Include rating and classification.
- B. Maintenance data.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

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. Basis-of-Design Product: The design for each product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by another manufacturer.

2.2 PORTABLE FIRE EXTINGUISHERS

- A. Manufacturers:
 - 1. Kidde Fyrnetics, Pro 460
 - 2. First Alert Model FE4A60B.
 - 3. Or equal.
- B. UL Rating: 60-B:C
- C. General: Provide fire extinguishers with surface mount, clear door, cabinet suitable for outdoor use.
 - 1. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B inspections, maintenance, and recharging.

SPECIFICATIONS

2.3 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.
- B. Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 10520

SPECIFICATIONS

SECTION 11315 - SUBMERSIBLE PUMPS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section includes submersible pumps, pump accessories, and appurtenances.

1.2 SUBMITTALS

- A. Product data and shop drawings shall comply with Section 01330.
- B. Product Data: Include certified performance curves with operating points plotted on curves and rated capacities of selected models, furnished specialties, and accessories.
- C. Shop Drawings; Diagram power, signal and control wiring.
- D. Provide operation and maintenance manuals in accordance with Section 01770.

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.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling

PART 2 - PRODUCTS

2.1 SUBMERSIBLE PUMPS

A. Manufacturers

- 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. Flygt, Model NP-3202 SH 3 - 275.

B. The pumps shall have the following characteristics:

- 1. Capacity, GPM - 703.6
- 2. TDH, feet - 143
- 3. Minimum Allowable Shutoff Head, feet - 256

SPECIFICATIONS

4. Minimum efficiency % - 60.7
 5. Minimum Solids Capacity, In. - 3
 6. Discharge diameter, inches - 4
 7. Motor horsepower, BHP - 50
 8. Motor speed, RPM - 3560
 9. Motor operating voltage - 460 VAC, 60 Hz, 3 Phase
- C. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. All exposed nuts or bolts shall be AISI type 304 stainless steel construction. All metal surfaces coming into contact with the pumpage, other than stainless steel or brass, shall be protected by a factory applied spray coating of alkyd primer with and acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.
- D. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile or Viton rubber O-rings. Fittings shall be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.
- E. The cable entry shall consist of a single cylindrical elastomer grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top.
- F. The pump motor shall be induction type with a squirrel cage rotor, shell type design, housed in an air filled, water tight chamber, NEMA B type. The stator windings and stator leads shall be insulated with moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be dipped and baked three times in Class F varnish and shall be heat-shrink fitted into the stator housing. The motor shall be designed for continuous duty handling pumped media of 40°C (104°F) and capable of up to 15 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of cast aluminum. Thermal switches set to open at 125°C (260°F) shall be embedded in the stator lead coils to monitor the temperature of each phase winding. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the control panel.
- G. The junction chamber containing the terminal board, shall be hermetically sealed from the motor by an elastomer compression seal. Connection between the cable conductors and stator leads shall be made with threaded compression type binding posts permanently affixed to a terminal board.
- H. The combined service factor (combined effect of voltage, frequency and specific gravity) shall be a minimum of 1.15. The motor shall have a voltage tolerance of plus or minus 10%. The motor shall be designed for operation up to 40°C (104° F) ambient and with a temperature rise not to exceed 80°C (176°F). A performance chart shall be provided showing curves for torque, current, power factor, input/output, kW and efficiency. This chart shall also include data on starting and no-load characteristics.
- I. The power cable shall be sized according to the NEC and ICEA standards and shall be sufficient length to reach the junction box shown on the Contract Drawings. The outer jacket of the cable shall be oil resistant chlorinated polyethylene rubber. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet.

SPECIFICATIONS

- J. The motor horsepower shall be adequate so that the pump is non-overloading throughout the entire pump performance curve from shut-off through run-out.
- K. The pump shaft shall be an extension of the motor shaft. The shaft shall be AISI Type 420 stainless steel.
- L. The pump shaft shall rotate on two bearings. Motor bearings shall be permanently grease lubricated. The upper bearing shall be a single deep groove ball bearing. The lower bearing shall be a two row angular contact bearing to compensate for axial thrust and radial forces.
- M. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary ceramic seal ring and one positively driven rotating carbon seal ring. Each seal interface shall be held in contact by its own spring system.
- N. Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and to provide lubricant expansion capacity. The drain and inspection plug, with positive anti-leak seal shall be easily accessible from the outside. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load.
- O. The impeller shall be of gray cast iron, Class 35B, dynamically balanced, double shrouded non-clogging design. The impeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Impeller shall be keyed to the shaft and retained with an allen head bolt.
- P. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impeller. Each pump shall be equipped with a brass, or nitrile rubber coated steel ring insert that is drive fitted to the volute inlet.

2.2 PUMP ACCESSORIES

- A. Leak detection: A float leakage sensor (FLS) shall be provided to detect water in the stator chamber. When activated, the FLS will stop the motor and send an alarm to the control panel. The thermal switches and FLS shall be connected to a Mini CAS (Control and Status) monitoring unit. The Mini CAS shall be flush mounted in the door of the control panel.
- B. Discharge Connection: Each of the pumps shall be automatically and firmly connected to a discharge connection, Class 125 flange, anchored to the wet well floor. Pump removal shall be guided by two 2-inch diameter Schedule 40, 316 stainless steel (or other material proven resistant to ferric hydroxide solutions) guide rails extending from the top of the station to the discharge connection. Provide upper and intermediate guide rail brackets. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. No portion of the pump shall bear directly on the wet well floor.
- C. Lifting System: Each pump shall be equipped with a lifting system with a rated capacity at least 50 percent greater than the weight of the pump. A portable davit crane in flush mount base shall be provided and have 360 degree pivoting 316 stainless steel boom and 316 stainless steel wire rope. Davit crane shall be Ensign Series Model 5PA10S with type M3 stainless steel spur gear hand winch with brake.

SPECIFICATIONS

- D. Provide stainless steel cable holder capable of holding no less than 5 cables.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all components in strict accordance with manufacturer's written instructions.
- B. Anchor guide-rail supports to wet well bottom, sidewall and access hatch.
- C. Install pumps so pump and discharge pipe disconnecting flanges make positive seals when pumps are lowered into place.

3.2 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."
- C. Connect wiring according to Division 16 Section "Conductors and Cables."

3.3 STARTUP SERVICES

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify bearing lubrication.
 - 3. Disconnect couplings and check motors for proper direction of rotation.
 - 4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - 5. Verify that pump controls are correct for required application.
- B. Start pumps without exceeding safe motor power:
 - 1. Start motors.
 - 2. Open discharge valves slowly.
 - 3. Check general mechanical operation of pumps and motors.
- C. Test and adjust controls and safeties.
- D. Remove and replace damaged and malfunctioning components.
- E. Set pump controls for automatic start, stop, and alarm operation as required for system application.
- F. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

END OF SECTION 11315

SPECIFICATIONS

SECTION 15060 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Fastener systems.
5. Equipment supports.

1.2 DESIGN AND PLACEMENT

A. Hangers and supports for piping, valves, and pipeline appurtenances are shown on the Drawings only in selected instances. As a part of the piping work, the Contractor shall securely support all piping valves and pipeline appurtenances in a manner directed by the Engineer at no extra cost to the Owner. The lump sum price bid shall include the cost of all hangers and concrete supports, structural steel supports and all necessary pipe saddles, pipe rolls, bearing plates, fastenings, expansion anchors or other anchors and appurtenances.

B. Hangers and support shall be adequate to maintain the piping, valves and equipment in proper position and alignment, and to prevent sway under all operating conditions. They shall have springs where required. Hangers and supports shall be of standard design where possible and be suited for the service required. All supporting devices shall be designed in accordance with the best practice and shall be reviewed by the Engineer prior to installation. The lack of mention or of location on the Drawings of all hangers or supports shall not preclude their necessity should field conditions dictate their use, or should they be required by the Engineer. Where practicable, hangers and supports shall be screw adjustable after installation.

1.3 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.

1.4 QUALITY ASSURANCE

A. Hangers and supports shall conform to the requirements specified herein and to the latest revisions of the following standards except where noted otherwise:

Structural	ASTM A36
Rivets	ASTM A141
Steel Castings	ASTM A27(Grade 65-35, full annealed)
Wrought Iron	ASTM A189 and A42
Steel Pipe	ASTM A53 (Schedule 40)

SPECIFICATIONS

Iron Castings	ASTM A48 (Class No. 35)
Cast Iron Pipe Stanchions	ASTM A125
Malleable Iron Castings	ASTM A47
Threaded Rod, Bolts, Studs and Nuts	ASTM A307
Chains	ASTM A56
Spring Hangers	ASTM A31.1

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.
4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Unless otherwise specified, noted or approved, pipe hangers and supports shall be of the following types of construction:

1. Pipe Rings: Malleable iron fitted with an adjusting nut of the locking type, threaded to take a rod.
2. Pipe Rolls: Provided with threaded nuts or with sockets to take threaded rods.
3. Pipe Clamps: Heavy steel, each equipped with socket clamp washers to take a rod.

B. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

D. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

E. Saddle stands shall be of the adjustable type. Each stand shall consist of a length of galvanized steel pipe fitted at the base with a standard screw threaded cast iron flange and at the top with an adjustable saddle or roll. The base flange shall be bolted to floor or foundation, and grouted.

SPECIFICATIONS

- F. Stanchions shall be of similar construction to the saddle stand. They shall be fitted at the top with a cast iron pipe saddle support or with a pipe stanchion saddle consisting of a yoke and nuts.
- G. Brackets: Brackets shall be made of welded wrought steel and shall be designed for three (3) maximum loads classified as follows:
 - 1. Light - 750 pounds
 - 2. Medium -1,500 pounds
 - 3. Heavy - 3,000 pounds

2.3 ANCHORS AND INSERTS

- A. Anchors shall be furnished and installed when specified, shown, or required for holding the pipe and equipment in position or alignment. All anchors shall be designed for rigid fastening to the structures either directly or through brackets. The design of all anchors shall be subject to the Engineer's review.
- B. Anchors for piping shall be of the cast iron chair type with galvanized steel straps, except where anchors form an integral part of the pipe fittings, or where an anchor of special design is required.
- C. All individual concrete inserts shall be malleable iron and shall be installed in the concrete structures where required for fastening supporting devices. To facilitate installation, nail slots shall be provided in the exposed flanges of the insert. Working loads as recommended by the manufacturer shall not be exceeded, regardless of allowable rod load. These inserts shall be "rocket type" concrete insert anchors as manufactured by Richmond Screw Anchor Co.
- D. On pipes 3 inches and larger, which are covered with heating insulation, hangers and supports shall include proper pipe covering protection saddles. Saddles shall not be less than 12 inches long and shall be made of curved steel plates with the side edges turned up. For pipe 8 inches and larger, the saddle shall have a welded center plate to provide a three-point support. The saddles shall be filled before being placed, either with plastic cement or with sectional covering cut to suit.
- E. Mechanical-Expansion Anchors: Not permitted unless reviewed by the Engineer.

2.4 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, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGERS

- A. Overhead hangers shall be supported by vertical threaded rods, fastened to the various types of construction in the following manner:
 - 1. Attachment to Steel - I-Beam clamps or channel iron clamps of forged steel fastened directly to the steel beams or channels. Welded brackets fastened to steel columns. Additional steel members required to support hangers shall be designed in accordance with ASIC Specifications.
 - 2. Attachment to Concrete - All hangers attached to concrete shall be malleable iron concrete inserts. Maximum loading on inserts shall not exceed the manufacturer

SPECIFICATIONS

recommended loads. To minimize concentrated loads on concrete slabs maximum allowable load per insert shall be 4,000 pounds. Expansion bolts for hangers will not be permitted unless reviewed by the Engineer.

- B. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- D. Use padded hangers for piping that is subject to scratching.
- E. Regardless of the type of hanger rod, the sizes shall be determined by the pipe to be supported. Single rod hangers supporting individual runs of pipe shall be sized in accordance with the following schedule, except as otherwise noted:

<u>Pipe Size</u> (inches)	<u>Rod Diameter</u> (inches)	<u>Maximum Load</u> (pounds)
3/4 to 2	3/8	1,500
2-1/2 to 3-1/2	1/2	2,000
4 to 5	5/8	3,000
6	3/4	4,500
8 to 12	7/8	6,500
14 to 16	1	8,500
18	1-1/8	10,500
20	1-1/4	13,500
24	1-1/2	19,500

- F. The foregoing schedule is based on ANSI Standard B36.10, Schedule 80 pipe filled with water. Pipe larger than 24 inches diameter shall be supported by double rod hangers sized and spaced such that the maximum rod loads above are not exceeded unless otherwise shown or noted. The maximum loads are based on AISC requirements for threaded fasteners of A307 steel.

3.2 SADDLE, STANCHIONS AND COLUMN SUPPORTS

- A. Pipe supports from the various structures shall be as follows:
 - 1. From Walls or Columns
 - a. Welded steel brackets
 - b. Adjustable stands of the roll type.
 - 2. From Floors or Piers
 - a. Pipe rolls or chairs with bases
 - b. Saddle stands or stanchions
 - 3. From Inserts Embedded in Concrete Slabs
 - a. Pipe rolls suspended from threaded rod hangers.
- B. When medium or heavy brackets are bolted to walls, backing plates of adequate size and thickness shall be furnished and installed to distribute the load against the wall. Where the use of

SPECIFICATIONS

backing plates is not practicable, the brackets shall be fastened to the wall in an approved manner. Pipe rolls or chairs shall be of cast iron adjustable type.

- C. Column supports of cast iron or steel pipe type or of an approved design, built-up structural steel type, shall be installed, where required.
- D. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- E. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- F. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 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.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.5 PAINTING

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15060

SPECIFICATIONS

SECTION 16010 – BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of services and work of an administrative nature as well as general requirements concerning certain products and operations, all common to the entire Division 16 Sections.
- B. Contractor shall consult these sections in detail, as he will be responsible for and governed by conditions set forth therein and work indicated.

1.02 JOB CONDITIONS

- A. The Contractor shall visit the site and familiarize himself with all existing and limiting conditions that have a bearing on his work. Failure to do so will not relieve him of any subsequent responsibilities pertinent to this project.
- B. The Contractor shall be responsible for familiarizing himself with the civil drawings, pump and pump control requirements for the project. All power and control wiring and raceways shall be provided for the project.

1.03 PERMITS AND INSPECTIONS

- A. Permits and licenses necessary for the execution of this work shall be secured and paid for by the Contractor.
- B. Contractor shall arrange for all inspections specified herein, or required by all agencies having jurisdiction, and furnish required certificates of inspection to Owner, including electrical certificate from State licensed agency

1.04 REFERENCES

- A. Reference Standards: The following standards, as referenced throughout the Sections of Division 16, along with all associated addenda and/or revision thereto, shall serve as the minimum standards and requirements directly appropriate to the work and workmanship.
 1. American National Standards Institute: ANSI C1, National Electrical Code. ANSI C2, National Electrical Safety Code.
 2. Insulated Cable Engineers Association (ICEA) Standards for Wire and Cable and the testing thereof.
 3. National Electric Manufacturer's Association (NEMA) Standards of Construction.
 4. American National Standards Institute (ANSI) Standards of Equipment.
 5. American Society for Testing Materials (ASTM) Standards for Equipment Testing.
 6. Institute of Electrical and Electronics Engineers (IEEE) Standards for Equipment.
 7. Underwriters' Laboratories (UL) Listings on specified Products.
 8. Guidelines for seismic restraints of mechanical/plumbing piping and electrical systems.

1.05 SUBMITTALS

- A. Product Data: Include in submittals such manufacturer's descriptive literature, product specifications, published details, performance/capacity rating schedules or charts and installation instructions, as applicable to items listed under Submittals in each Section of Division 16, and such items as may be Scheduled or noted on the Drawings.
- B. Shop Drawings: Submit shop drawings certified for construction by Product manufacturers, and approved by the Contractor, which includes location of electrical connections; wiring diagrams; anchor bolt layout; details indicating construction and materials of construction; dimensions; rated horsepower of applicable equipment, service factors and weights of principal parts and the completely

assembled item. Equipment arrangements shown on the drawing are approximate, based on the expected typical manufacturer equipment sizes. Contractor shall not run underground conduits or pour concrete foundations unless factory-certified equipment drawings are utilized to finalize equipment layouts.

1. Shop drawings applicable to items listed under Submittals in each Section of Division 16; and such items as may be Scheduled or noted on the Drawings.
2. Shop drawing Submittals shall also include the associated Installation and Maintenance Manuals (I & M) for the respective equipment.

C. Installation Certificates: Submit installation certificates for selected equipment as follows:

1. Low Voltage Motor Control Centers and Main Distribution Panels
2. Installation certificates shall state that the equipment has been installed under either the continuous or periodic supervision of the manufacturer's authorized representative, that it has been adjusted and initially operated in the presence of the manufacturer's authorized representative, and that it is operating in accordance with the specified requirements to the manufacturer's satisfaction.

1.06 REPORTS

- A. Certified Test Reports: Where certified test reports are required by the Contract Documents and elsewhere in these specifications, they shall meet the following requirements: Before delivery of materials for which certified test reports are required, certified copies of the reports of all tests required in reference publications or specified within the Contract Documents shall be submitted for approval to the Engineer. The testing shall have been performed in an approved independent laboratory, within one year of submittal of the reports for approval. Test reports shall be accompanied by a notarized certificate from the manufacturer or supplier certifying that the tested material meets the specified requirements and is the same type, quality, manufacturer and make as that proposed to be supplied.
- B. Certificate of Compliance: At the option of the Engineer, or where specified, the Contractor may, in lieu of the specified tests and other tests required in the various reference documents, furnish a Certificate of Compliance from the manufacturer. The certificate shall state that the manufacturer has performed all required tests; that products to be supplied meet all test requirements; that tests have been performed within one year of submittal of the certificate; that products tested were of the same type, quality, manufacturer and make as those proposed to be supplied.

1.07 QUALITY ASSURANCE

- A. Regulatory Requirements: The construction code requirements of State, County, Utility Companies or other political subdivision, which exceed the requirements of national codes, standards and approving bodies, shall be met and complied with. Modify work to be in conformity with such laws, ordinances, rules and regulations without additional expense to the Owner.
- B. Contractor Pre-Qualification: Electrical Contractor shall have a proven, successful track record of no less than five similar projects, all being completed within the last five years. Projects shall be of a size and scope which is similar to this project, including the furnishing, installing, testing and commissioning of smart motor control centers, DCS Systems, control panel systems, transformers and panelboards, as well as lighting and miscellaneous power systems and all types of the associated interconnecting wiring and conduit systems.
- C. Code Requirements: Materials, equipment and installation for this project shall meet or exceed all seismic requirements for the project area.
- D. Certifications: Upon completion of work, and prior to final payment, furnish formal certification of

final inspections to the Engineer from authorities having jurisdiction and secure required permits or certificates from such authorities. Additionally, prepare detailed diagrams and drawings which may be required by those authorities having jurisdiction.

- E. Source Quality Control: Products used throughout these Specifications and as indicated on the Drawings are those of companies having established reputations in the manufacture of the particular materials, equipment or apparatus specified. Such products shall be of their own make, or products of others, for which the manufacturer assumes full responsibility for products used in said outfits which are not manufactured completely by them, and with replacement parts available.
- F. U.L. Listing: Products shall be U.L. listed where possible; i.e., where products of like design, function and appearance have been submitted and have received the U.L. Label. Products shall also be labeled for the specific use intended and the location where it shall be installed.
- G. Code Compliance Inspection: Have the work inspected by an authorized inspection agency for compliance with National Electrical Code and obtain certificates of approval, acceptance, and compliance with code regulations. Work shall not be deemed complete until such certificates have been delivered to the Owner with copies furnished to the Engineer for review.

1.08 INTERFACING/SCHEDULING

A. Interferences:

1. Construct Electrical Systems when and in a manner not to delay or interfere with other operations of work in the Project. Prior to making Electrical installations, coordinate Electrical work locations with the work of other operations of work, especially in congested areas, such as mechanical equipment rooms and above hung ceilings.
2. In the event that interferences develop, the Engineer's decision shall be final and no additional compensation shall be allowed for relocation of Electrical Products.

B. Electrical Interface:

1. Make connections of electrical power and control services specified in the various Specifications Sections of this Contract to those products of this Division 16 and to other specification sections requiring connections.

C. Scheduling:

1. Coordination and agreement of work schedule between the Owner, Engineer, the Contractor, the local power utility company, and the local telephone company is vital; and no work in any area shall be started without approval from the Engineer and/or Owner.
2. The Contractor shall coordinate the Work in such manner as not to interfere or conflict with the performance of Work by the Owner's employees, or the obligations and duties of his maintenance personnel during the normal operating hours.
3. Schedule and coordinate outages with Owner and utility personnel as required.

1.07 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:

1. Deliver materials and equipment to the Project site in a clean condition with openings plugged or capped (or otherwise sealed by packaging) both during shipping and during temporary storage. Delivered electrical equipment crating and/or packaging shall clearly identify pick-points or lift-points. In the absence of crating or packaging, pick-points or lift-points shall be identified on the equipment.
2. When unloading materials and equipment, provide special lifting harness or apparatus as may be required by manufacturers. Handle materials and equipment in accordance with

SPECIFICATIONS

manufacturer's written instructions. The Contractor shall determine the required equipment needed for unloading operations and have such equipment on site to perform unloading work on the date of equipment delivery.

- B. Storage and Protection: Store materials and equipment, both on and off site, in accordance with manufacturer's written instructions. Provide all required temporary power connections and means for temporary heating of equipment.

1.08 COORDINATION

- A. Equipment layouts are based on preliminary equipment selections. Adjust layouts as required based on actual equipment furnished under the Contract. Contractor shall obtain approved project-specific factory-certified shop drawings to layout all equipment, prior to roughing-in all conduit runs and concrete pad layouts. Coordinate arrangement, mounting, and support of electrical equipment as required: to allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated; to provide for ease of disconnecting the equipment with minimum interference to other installations; and to allow right of way for piping and conduit installed at required slope.
- B. Install so connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
- C. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors. Coordinate with General Contractor's Construction Schedule, Subcontracts, Submittals and Weekly Construction Quality Control Reports.
- D. Coordinate the installation of wiring, raceways, outlet boxes, sleeves, anchors, and other concealed or embedded items so that this work is properly in place before concrete or partitions are in place.

1.09 SUBMITTALS FOR RECORD

- A. Submit one set of marked-up (red-lined) Record Prints.
- B. Initial Record Drawing Submittal: Submit one set of plots from corrected Record CAD Drawings and one set of marked-up Record Prints. Owner will initial and date each plot and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. Owner will return plots and prints for organizing into sets, printing, binding, and final submittal.
- C. Final Record Drawing Submittal: Submit one set of marked-up Record Prints, one set of Record CAD Drawing files, one set of Record CAD Drawing plots, and three copies printed from record plots. Plot and print each Drawing, whether or not changes and additional information were recorded. Electronic Media shall be CD-R.
- D. Record Specifications: Submit three copies of Project's Specifications, including addenda and contract modifications.
- E. Record Product Data: Submit three copies of each Product Data submittal. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in manual instead of submittal as Record Product Data.

SPECIFICATIONS

1.10 LAYOUTS

- A. Electrical system layouts indicated are generally diagrammatic and location of outlets and equipment is approximate; exact routing of raceways, locations of outlets and equipment shall be governed by structural conditions and obstructions. The Contractor shall be responsible for the exact layout of all equipment. This is not to be construed to permit redesigning systems; all outlets and equipment shall be interconnected as indicated. Locate and install equipment requiring maintenance and operation so that it will be readily accessible. Any relocation of outlets or equipment must be approved by the Engineer or authorized representative before erection. The right is reserved to make any reasonable change in location of outlets and equipment prior to "roughing in" without involving additional cost.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT REQUIREMENTS

- A. Provide materials and equipment conforming to those specified herein. Manufacturers' names and catalog numbers are given to describe type, quality and design of material and equipment required.
- B. All material and equipment shall conform to capacity, efficiency, design and material specified and shall meet dimension and space requirements. Sizes of materials and equipment indicated or specified are minimum requirements. The Contractor may use larger sizes to expedite the work provided that such change meets space requirements and does not result in additional installation, maintenance or operating cost to the Owner. Equipment or materials of the same type or classification, used for the same purpose, shall be the products of the same manufacturer.
- C. All materials shall be new, of the best of their respective kind and shall conform to accepted standards of the trade in every case where such a standard has been established for the particular type of material in question. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with applicable technical standards and specification of societies, organizations and/or agencies listed herein, suitable for maximum working pressure and shall have neat and finished appearance.
- D. Materials and appliances of types for which there are UL standard requirements, listings or labels shall have such listing of UL, be so labeled, and shall conform to their requirements.
- E. In all cases where a device or part of the equipment is herein referred to in the singular number, it is intended that such reference shall apply to as many such items as are required to complete the installation.
- F. Contractor shall, without charge, replace any work or material, which develop defects, except ordinary wear and tear, or fail to perform satisfactorily, within one (1) year from the date of final acceptance.

2.02 SUBSTITUTES

- A. Manufacturers' names and catalog numbers of materials and equipment are given to describe type, quality and design of material and equipment required. Where possible three (3) or more manufacturers are listed.
- B. Where materials or makes are specified and where the words "or equal" or "approved equal" are not used, only the makes specified shall be furnished and installed. Where "equal" is used, equal equipment shall be submitted for approval in ample time, but no less than ten (10) days prior to bid date to permit checking and appropriate action. If approved, an Addendum will be issued. No request for substitution will be considered later than ten (10) days before bids are due.

SPECIFICATIONS

2.03 RECORD DRAWINGS

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
 2. Content: Types of items requiring marking include, but are not limited to, the following:
 - i) Dimensional changes to Drawings.
 - ii) Revisions to details shown on Drawings.
 - iii) Locations and depths of underground utilities.
 - iv) Revisions to routing of piping and conduits.
 - v) Revisions to electrical circuitry.
 - vi) Actual equipment locations.
 - vii) Changes made by Change Order Directive.
 - viii) Changes made following Owner's written orders.
 - ix) Details not on the original Contract Drawings.
 - x) Field records for variable and concealed conditions.
 - xi) Record information on the Work that is shown only schematically.
 3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
 4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
 5. Mark important additional information that was either shown schematically or omitted from original Drawings.
 6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record CAD Drawings: Immediately before inspection for Certificate of Substantial Completion, review marked-up Record Prints with Owner and Construction Manager. When authorized, prepare a full set of corrected CAD Drawings of the Contract Drawings, as follows:
- (a) Format: Same CAD program, version, and operating system as the original Contract Drawings: AutoCad 2004 operating in Microsoft Windows operating system.
 - (b) Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
 - (c) Refer instances of uncertainty to Owner through Construction Manager for resolution.
 - (d) Engineer will furnish Contractor one set of the 'For Construction' CAD Drawings of the Contract Drawings for use in recording information.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
- (a) Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.

SPECIFICATIONS

- (b) Record CAD Drawings: Organize CAD information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each CAD file.
- (c) Identification: As follows:
 - i) Project name.
 - ii) Date.
 - iii) Designation "PROJECT RECORD DRAWINGS."
 - iv) Name of Owner and Engineer.
 - v) Name of Contractor.

2.04 WEEKLY CONSTRUCTION QUALITY CONTROL REPORTS

- A. Prepare a weekly report recording the following information concerning events at Project site:
 - 1. Equipment at Project site.
 - 2. Material deliveries.
 - 3. Accidents.
 - 4. Stoppages, delays, shortages, and losses.
 - 5. Orders and requests of authorities having jurisdiction.
 - 6. Services connected and disconnected.
 - 7. Equipment or system tests and startups.

PART 3 EXECUTION

3.01 INSTALLATIONS AND REMOVALS

- A. General Installation Requirements: Installation particulars and requirements are as specified in the various Sections included under Division 16 - Electrical. Perform required interconnection of the differing electrical systems to the various electrical equipment, devices, or apparatus, regardless of where such Products are specified throughout Division 16 - Electrical, in order to ensure the completeness of such electrical system.
- B. Factory Finishes and Field Painting:
 - 1. At the discretion of the Owner, the Contractor shall provide painting of the materials, equipment, apparatus, and items installed as work of this Division 16.
 - a. The above requirement does not apply to fully factory-finished items, that is, items having factory applied primer and final finish coatings, except as specified in the following paragraphs.
 - b. Painting factory-finished items shall be required in the cases where the factory finish is damaged. Such painting shall be performed as work under this Division 16, and as specified herein.
 - 2. Surface Preparation: This Contractor is responsible for the quality of the repaint work insofar as proper surface preparation shall affect the finished appearance. The quality of the repaint work shall be subject to the Owner's approval.
 - a. Perform surface preparation of damaged areas in conformance with the latest edition of the Steel Structures Painting Council Standard SSPC-SP2, Hand Tool Cleaning.
 - b. Where a damaged area occurs on one surface of an item having several surfaces, that entire surface where the damage occurs shall require repainting. The surface preparation for outside the damaged area shall consist of a light sanding to profile the existing paint.
 - 3. Paint Application: Apply paint in such a manner so that the finished appearance shall match as nearly as possible the factory finish.

SPECIFICATIONS

- a. Use paint material matching the composition of the factory applied products.
 - b. Comply with the paint manufacturer's label instruction for mixing, thinning, proper spreading rate, drying time, and environmental limitations concerning application.
4. Factory Finish:
- a. Factory finish on all exterior electrical equipment shall conform to the following:
 - (1) After fabrication, all welded steel, galvanized parts and welded assemblies shall be thoroughly cleaned and phosphatized to provide a crystalline phosphate coating which shall give an excellent corrosion resistance and superior adhesion of paint finish.
 - (2) All metal enclosing sheets and framework, both inside and outside, shall then be given a priming coat of rust inhibiting paint and a finished coat of Sherwin-Williams, Fawn Color (MC-56, LRV 46 percent); which shall have a high performance protection against atmospheric exposure to chemicals, salt spray, stains, abrasion and moisture.
 - (3) Following paint application, uncured parts shall be baked to produce a hard durable finish. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling. A minimum of two top coats shall be applied and the total thickness of the finish shall be maintained at an average of 2 mils.
 - (4) Adequacy of paint finish to inhibit the buildup of rust on ferrous metal materials shall be tested and evaluated per paragraphs 5.2.8.1-7 of ANSI C37.20.2-1987. Salt spray withstand tests in accordance with paragraph 5.2.8.4 of ANSI C.37.20.2-1987 shall be performed on a periodic basis to insure conformance to this corrosion resistance standard.

3.02 RECORD DRAWING RECORDING

- A. Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Owner's and Construction Manager's reference during normal working hours.

END OF SECTION 16010

SPECIFICATIONS

SECTION 16050 - BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SCOPE

- A. Provide material and perform all work as outlines in this Section for all basic material and methods required in the installation of the electrical work.
- B. Contractor shall consult Section 16010, General Conditions in detail, as he will be responsible for and governed by conditions set forth therein and work indicated.

1.02 SUBMITTALS

- A. Furnish shop drawings and descriptive data, complete with project designation for the following:
 1. Conductors / Cables
 2. Wiring Devices
 3. Cable Supports
 4. Disconnect Switches
 5. Grounding Material
 6. Junction/Pull Boxes
 7. Manual Motor Starters
 8. Lighting Control Photoeye
 9. Door Switches

PART 2 - PRODUCTS

2.01 CONDUCTORS/CABLES

- A. Single Conductor
 1. Copper single or multi-conductor 600 volts 75°C wet and 90°C dry XHHW/XHHW-2 insulated.
 2. Minimum wire size for branch circuits shall be #12 AWG except non-load carrying control circuits may be No. 14 AWG.
 3. Stranded conductors for control circuits.
 4. Manufacturers: Aetna, Allied, Okonite or Southwire.
- B. Multi-conductor Cable
 1. 600-volt multi-conductor power and control cable shall be composed of single conductors, Type XHHW/XHHW-2. The single conductors are to be cabled and taped, with a flame-retardant, moisture and sunlight resistant PVC jacket.
 2. 600-volt multi-conductor cables shall satisfy the requirements of NEC and UL for Type TC power and control tray cables.
 3. Manufacturers: Aetna, Allied, Okonite or Southwire.
- C. Instrumentation/Signal Cable
 1. 300 volt, 90°C, Type ITC/PLTC, individual shielded pairs or triads, multiple pairs or triads individually and overall shielded, PVC jacketed construction.
 2. 18 AWG, soft annealed stranded copper conductors, PVC fire retardant, moisture and sunlight resistant insulation with nylon overcoat.
 3. NEC Type ITC/PLTC. UL Subject 2250.
 4. Shield type: 100% coverage, aluminum polyester foil or tape with drain wire.
 5. Manufacturer: Belden, Alpha, Okonite, or Dekoron

SPECIFICATIONS

D. VFD Cable

1. Insulation Type: XLPE
2. Jacket Type: PVC
3. Type of Ground: Full size.
4. Shielding: Braided and Foil.
5. Manufacturer: Belden or approved equal

E. Fiber Optic Cable (when applicable)

1. Fiber Type: 62.5µm multimode (OM1)
2. Number of Fibers per Cable: 6.
3. Type of Cable: Loose-tube, gel-free, single-jacket, steel-armored, all-dielectric, for direct-buried outdoor installation.
4. Corrugated steel tape armor and UV-resistant, polyethylene outer jacket.
5. Fiber coloring; Blue, Orange, Green, Brown, Slate, White
6. Design and Test Criteria: ANSI/ICEA S-87-640
7. Fiber Operating Wavelength: 850 nm / 1300nm
8. Maximum Attenuation: 3.4dB/km / 1.0 dB/km
9. Manufacturer: Corning ALTOS or approved equal

2.02 CONDUITS

A. Rigid Polyvinyl Chloride Conduit (PVC)

1. Material: Schedule 40 and Schedule 80 Polyvinyl chloride, rigid conduit, listed for 90°C conductors and use in direct sunlight.
2. Fittings: Coupling type.
3. Joints: Connections shall be made by solvent welding.
4. Testing: Conforming to NEMA TC-2, NEMA TC-3 and UL-651 and 514.
5. Manufacturers: Carlon, Allied, or Thomas & Betts

B. Rigid Aluminum Conduit

1. Material: Aluminum.
2. Fittings: Cast copper-free aluminum screwed fittings: 1-1/2" and larger, mogul type.
3. Standard: UL listed and labeled.
4. Manufacturers: Anaconda, American Brass Co., Kaiser, Reynolds Metal Co.

C. Rigid Galvanized Conduit (RGS)

1. Material: Hot-dipped Galvanized Steel with threads galvanized after cutting.
2. Fittings: Hot-dipped Galvanized Steel with threads galvanized after cutting.
3. Standard: UL listed and labeled.
4. Manufacturers: Allied Tube and Conduit, Calbrite, Republic Conduit, Wheatland Tube Co. or equal.

D. Liquid-tight flexible metallic conduit

1. Flexible galvanized steel core with continuous copper ground in the convolutions covered with extruded polyvinyl chloride.
2. Connectors: Nylon insulated screw in ground core type connectors constructed of 304 stainless steel Thomas & Betts Liquid-tight 53SST Series fittings or equal.
3. Manufacturers: Electri Flex, Thomas & Betts, Triangle, or Robroy.

2.03 OUTLET BOXES & FITTINGS

A. Non-Metallic Outlet Boxes and Fittings

1. Boxes shall be constructed of either high temperature PVC or polyester with reinforcing fiberglass.
2. Enclosures shall be NEMA 4 or 4X.
3. Screw covered boxes shall use stainless steel screws and brass threaded inserts in box.

SPECIFICATIONS

4. Hinge covered boxes shall use stainless steel hinges and latches.
5. Manufacturers: Carlon, Stahlin Bros., Hoffman, or Crouse Hinds.

B. Cast Boxes, Fittings and Conduit Bodies

1. Standard general purpose cast type ferrous metal or aluminum constructed with threaded hubs, gaskets and covers.
2. Choice of body types shall be made to conform to installation requirements.
3. Aluminum metallic finish.
4. Manufacturers: Crouse Hinds, Appleton or Killark.

2.04 ENCLOSURES, JUNCTION BOXES AND PULL BOXES

A. Main Electrical Enclosures

1. Free standing dual access NEMA 4X enclosure modified for NEMA 3RX rating by addition of rain shield and continuous steel hinge.
2. Stainless steel enclosure and exterior hardware.
3. 3-point latches on each door.
4. Manufacturers: nVent Hoffman Bulletin A30S4 or equal.
5. Size: 90"H x 72"W x 36"D
6. Ventilation louvers covered by rain hoods.

B. Other Electrical Enclosures

1. Wall mounted NEMA 12 or 3RX enclosures.
2. 3-point latches on each door.
3. Manufacturers: nVent Hoffman Bulletin or equal.

C. Smaller than 150 cubic inches: Standard outlet boxes with cover.

D. 150 cubic inches and larger: Construct same as cabinets and conforming to UL "Standards for Cabinets and Boxes".

E. Junction and pull boxes shall be:

1. NEMA Type 4X enclosure.
2. Type 316L stainless steel enclosure and exterior hardware.
3. Stainless steel hinged door with clamps, hasp and staple for padlocking.
4. External mounting brackets.
5. Manufacturers: nVent Hoffman Bulletin A4S or equal.

2.05 CONNECTORS AND INSULATED TAPE

A. Connectors

1. Conductors No. 8 and larger terminated and spliced with Burndy or T&B mechanical connectors.
2. Conductors No. 10 and smaller terminated and spliced with insulated expandable live spring type twist-on compression type connector. Connectors shall be Buchanan "B-Cap", 3M "Performance Plus" or Ideal "Twister".
3. Connect conductors to apparatus by means of approved lugs or connectors as manufactured by Thomas & Betts, or equal.

B. Insulating tape

1. Vinyl plastic insulating tape, 7 mil thick, Scotch 33+ or equal.
2. Apply at all joints and splices.

2.06 MOTOR LEAD TERMINATION KITS

SPECIFICATIONS

- A. The motor lead terminations must be capable of continuous operation at the rated voltage of the conductors it is to be used on, up to 1000 V. It must be rated for continuous operation at 90°C, with an emergency overload temperature rating of 130°C. The splice kit must contain all of the necessary materials required to make three splices (except for the lugs). The splice shall be made of peroxide cured EPDM which is applied by a slip-on method, without heat or flame. The splice kit, manufacture by 3M or equal, shall be designed for moisture resistance and re-entry.

2.07 DISCONNECT SWITCHES

- A. General Indoor and Outdoor Disconnects
 - 1. Type: Heavy duty, single-throw, non-fusible except as indicated otherwise. Rating and size as indicated.
 - 2. Terminal lugs: UL listed for copper cables and front removable.
 - 3. Switch blades: Blades shall have quick make and quick break operating handle with dual cover interlock to prevent door opening in "ON" position.
- B. Enclosure:
 - 1. Outdoor: NEMA-4X, Stainless Steel
 - 2. Indoor: NEMA-1 except where indicated otherwise.
- C. Electrical interlock: One normally open contact on all switches on equipment served by power and control wiring.
- D. Manufacturers: Square-D "Heavy Duty or equal.

2.08 EQUIPMENT SUPPORTS AND STANDS

- A. Provide supporting structures of strength required to withstand stresses to which subjected and to distribute properly the load over the support structure. Structure members are to be stainless assembled with stainless steel hardware or welded.

2.09 WIRING DEVICES

- A. Manufacturers: Arrow-Hart, Hubbell or Bryant devices comparable to those listed herein.
 - 1. Wall switches: Hubbell No. 1221, 1223, 20 ampere, 120/277 volt, quiet type, brown bakelite housing, back and side wiring, single pole and three-way devices.
 - 2. Receptacles:
 - a. Grounding duplex outlet receptacle, with break off terminals for switch control or split circuiting, 20 ampere, 125 volt. Hubbell Cat. No. HBL5362
 - b. Ground fault circuit interrupter duplex receptacle, 20 ampere, 125 volt. Hubbell No. GF-5362.
 - c. Grounding single outlet receptacle, 20 ampere, 125 volt. Hubbell Cat. No. HBL5361.
 - 3. Wall plates:
 - a. Standard toggle switch cover: Sheet aluminum cover for FS box mounting, Crouse-Hinds Cat. No. DS32-SA
 - b. Standard duplex receptacle cover: Sheet aluminum cover for FS box mounting. Crouse-Hinds Cat. No. DS23-SA.
 - c. Weatherproof toggle switch: die cast aluminum for FS mounting, Grouse-Hinds Cat. No. DS185
 - d. Indoor GFI receptacle cover: Cast aluminum cover for FS box mounting, Crouse-Hinds Cat. No. DS-23GFI.
 - e. Weatherproof, while-in-use type with latching cover, gasketed die cast copper-free aluminum construction for cast device boxes. Hubbell Type WP8.

2.10 CABLE LUBRICANT

- A. The cable lubricant shall meet the following performance specs:

SPECIFICATIONS

1. When subjected to a 100 lbs. /ft. normal force, between cable and galvanized conduit, the lubricated cable system shall have a coefficient of kinetic friction less than .25 (pulling force <25 lbs./ft.).
 2. The lubricant shall be UL (or CSA) listed.
 3. The lubricant shall not affect the tensile/elongation properties of the cable jacket more than existing ICEA/NEMA aging specifications allow.
 4. The cable lubricant shall be a low solids type whose residue does not melt or support the spread of flame.
 5. No wax or paraffin based cable lubricants permitted (ie, Yellow 77 not approved)
- B. The cable lubricant shall be Polywater J by American Polywater Corporation or equal by Condux International, Inc.
- 2.11 GROUNDING
- A. Refer to section 16060 – Grounding and Bonding
- 2.12 CABLE SUPPORTS
- A. Standard duty, stainless steel wire mesh support grips sized as required with double eye, rod closing for assembly when end of cable not available.
- B. Manufacturers: Hubbell Kellums, OZ-Gedney or Woodhead.
- 2.13 MANUAL MOTOR STARTERS
- A. Interior:
1. Enclosure: NEMA 1 General Purpose
 2. Operator: Toggle Switch with Red Pilot Light
 3. Thermal Overload Relay: Melting Alloy Type
 4. Manufacturer/Model: Square D Class 2510
- B. Exterior:
1. Enclosure: NEMA 4 Water Tight, Die Cast Zinc
 2. Operator: Lockable Toggle Switch
 3. Thermal Overload Relay: Melting Alloy Type
 4. Manufacturer/Model: Square D Class 2510
- 2.14 LIGHTING CONTROLLER WITH PHOTOEYE INPUT
- A. Photo-Eye: Intermatic K4221C or equal – mounted to the north side of the electrical building and shielded from all exterior lighting.
- B. Hand-Off-Auto Switch: Square D 9999SC8 or equal.
- C. Relay/Contactor: Square D Class 8903 NEMA 1 enclosed contactor rated for 30 amps.
- D. Execution: Lighting circuits should be energized through the contactor if the selector switch is in the Hand position or in the Auto position and the photoeye is active (not daylight).
- 2.15 DOOR SWITCHES – Heavy Duty Industrial Limit Switches
- A. Contacts
1. Voltage Rating: 600V
 2. Configuration: two (2) electrically independent sets of DPDT contacts.
- B. Enclosure
1. Metal
 2. IP67
 3. 1/2" NPT Conduit Entry

SPECIFICATIONS

- C. Head – metal plunger or roller.
- D. Manufacturers: Square D series 9007C or equal.

3 - EXECUTION

3.01 CONDUIT CLASSIFICATION

- A. Schedule 80 PVC conduit shall be used as follows;
 - 1. Underground electric service from service transformer.
 - 2. Underground wiring between electrical building and generator.
 - 3. Underground wiring between electrical building and the following:
 - Pump pit
 - Pump Disconnects
 - Instrument Terminal Box
 - Flow meter pit.
 - 4. Wiring between Pump Disconnects and pumps.
 - 5. Or when indicated otherwise.
- B. Schedule 40 PVC conduit shall be used as follows:
 - 1. Interconnection of equipment within pump pit and flow meter pit.
 - 2. Or when indicated otherwise.
- C. Rigid aluminum conduit shall be used for inter-connections between wall mounted components in the electrical building.
- D. Rigid galvanized conduit shall be used for all above ground exterior conduit, unless otherwise noted.
- E. Liquid-tight flexible conduit shall be used as follows:
 - 1. Final connections to motors or other equipment subject to motion or vibration.
 - 2. Final connections to instrumentation control and signaling devices.
 - 3. Maximum of 36" length.

3.02 CONDUIT INSTALLATION

- A. Install conduit in accordance with following:
 - 1. Minimum size conduit shall be 3/4". Other sizes shall be as indicated or required by the NEC for number and size of conductors installed.
 - 2. All conduit joints shall be cut square, threaded, reamed smooth, and drawn up tight. Bends or offsets shall be made with Standard conduit ells, tied bends made with an approved bender or hickey, or hub type conduit fitting. Number of bends per run shall conform to NEC limitations.
 - 3. Underground conduits shall be run with long sweep bends and offsets.
 - 4. Conduits shall be continuous from outlet to outlet and from outlets to cabinets, pull or junction boxes, and shall be secured to all boxes with locknuts and bushings in such a manner that each system shall be electrically continuous throughout. Conduit ends shall be capped to prevent entrance of foreign materials during construction.
 - 5. Conduit terminals at cabinets and boxes shall be rigidly secured with locknuts and bushings as required by the NEC. On all conduit 1-1/4" trade size and larger, bushings shall be of the insulated or insulating type with double locknut as manufactured by Thomas & Betts or approved equal.
 - 6. All conduit systems must be installed complete before conductors are pulled in. All empty raceways shall have a pull cord installed, with 12 in. coiled in box and in the capped end for future wire pulling.
 - 7. All underground conduits entering enclosures shall be effectively sealed to prevent water moisture or any other foreign matter from entering enclosure.

SPECIFICATIONS

8. Underground conduit system shall consist of wide sweep elbows and bends and shall be completely watertight, but provided with drain fittings per the NEC.
9. Routing of all underground conduits to be identified by placing a continuous plastic tape in the trench backfill six to eight inches below finished grade. The tape is to be non-biodegradable type plastic at least 4" wide, red in color, and imprinted with the legend "Caution - Buried Electric Line Below".

3.03 SUPPORTS AND HANGERS

- A. Conduit shall be supported in accordance with the National Electrical Code.
- B. No electrical equipment (i.e.; cabinets, enclosures, panelboards, etc.) shall be fastened directly to concrete surfaces. Lengths of stainless steel channels (Strut) members shall first be fastened to the structure, and then the electrical equipment fastened to the channel with non-corrosive metal fasteners designed for the purpose.
- C. Where the supporting channels are fastened to masonry walls, non-corrosive toggle bolts, expansion inserts shall be used.
- D. Provide supports (brackets, plates, rods, channel, etc.) where required to fasten or support electrical equipment to the structures as shown on the plans.
- E. The required strength of the supporting equipment, and the size and type of anchors, shall be based on the combined weight of equipment, conduit and cables.
- F. Clamps used in installing PVC conduit shall be PVC coated steel body with nylon hardware. Straps used shall be all plastic for PVC conduits. All hardware associated with PVC conduit shall be for non-corrosive use.

3.04 JUNCTION AND OUTLET BOX INSTALLATION

- A. Install boxes approximately as indicated:
 1. Set boxes true and flush and rigidly secure in position.
- B. Provide boxes of sizes and types to accommodate following:
 1. Structural conditions
 2. Size and number of conductors or cables entering
 3. Device or fixture for which required

3.05 PULLBOX INSTALLATION

- A. All boxes shall be of physical size as required by the NEC for the number and size of conduits and conductors involved. Boxes shall have removable screw covers and be installed in a convenient location.
- B. Boxes shall be securely mounted structure with supporting facilities independent of the conduits entering or leaving the boxes.

3.06 CONDUCTOR INSTALLATION

- A. Install conductors of size and number indicated or required in accordance with requirements of NEC.
 1. Do not draw conductors into conduit until conduit is free from moisture.
 2. Leave sufficient slack to permit connection of fixtures, switches and equipment without additional splices; 8" minimum.
 3. Minimum wire size for branch circuits shall be #12 AWG except that home runs longer than 100 feet from panel to load shall be minimum #10 AWG.
 4. Each motor shall be wired with an individual branch circuit, unless indicated otherwise.

SPECIFICATIONS

B. Make taps and splices in wire as follows:

1. Conductors shall be square cut with a hacksaw or cable cutter without deforming the strands. Insulation shall be removed with a penciling cut to avoid nicking the strands and surface oxides shall be removed by brushing exposed strands with a wire brush or card file. Where conductor bends are less than 8 times cable diameter, foregoing operations shall be done after bending.
2. Compression connectors shall be selected to fit the conductor.
3. Splice only in accessible pull, junction or outlet boxes.
4. Use mechanical wire splices and joints for #8 wire and larger and AL/CU compression connectors for #10 wire or smaller.
5. Insulate joint at least 100% in excess of wire insulation.

C. Wire Color

1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Black, red and blue for three phase circuits at 120/240 volts.
2. Wires sizes 8 AWG and larger, use colored tape to identify wires at terminals, splices and boxes.
3. Neutral Conductors: White. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
4. Ground Conductors:
 - a. For 6 AWG and smaller: Green.
 - b. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

3.07 CUTTING AND PATCHING

- A. Contractor shall install all hangers, supports and sleeves as required to permit their work to be built into place.
- B. All cutting of concrete, or other materials for the passage of conduit through floors, walls, and foundations shall be done by the Contractor where necessary to install his work. Contractor will close all such openings around conduit with material equivalent to that removed and any necessary material to make penetration through exterior walls watertight. All exposed surfaces shall be left in suitable condition for refinishing without further work.
- C. No structural member shall be altered or cut without the special permission of the Engineer.

3.08 EXCAVATION AND BACKFILLING

- A. Contractor shall perform all necessary excavation and backfilling required for the installation of their work.
- B. Excavate bottom of trenches to required depth (minimum of 24"). Deposit excavated materials on side of trench; do not leave material where it will interfere with traffic. Suitable protect trenches and openings with signs, barricades, enclosures or flashing light.
- C. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand-tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
- F. Routing of all underground conduits to be identified by placing a continuous plastic tape in the trench backfill finished grade. The tape is to be non-biodegradable type plastic at least 4" wide, red in color, equipped with tracer wire and imprinted with the legend "Caution-Buried Electric Line Below".
- G. Construction shall be arranged so that trenches will be left open for the shortest practical time to avoid creating a hazard to the public and to minimize the likelihood of trench collapse due to other construction activity, rain, accumulation of water in the trench, etc.

SPECIFICATIONS

3.09 ACCEPTANCE CABLE TESTING (SINGLE CONDUCTOR & MULTICONDUCTOR ASSEMBLIES)

A. Cables - Low Voltage (600 volts and less)

1. Visual and Mechanical Inspection
 - a. Cables to be inspected for physical damage and proper connection in accordance with single line diagram.
 - b. Cable mechanical connections shall be tested to manufacturer's recommended values with a calibrated torque wrench.
2. Electric Tests
 - a. Perform insulation resistance test on each cable with respect to ground and adjacent cables.
 - b. Perform continuity test to insure proper cable connections.
3. Test Values
 - a. Insulation resistance tests shall be performed at 1000 volts D.C. for one (1) minute.
 - b. When insulation resistance must be determined with all switchboards, panelboards, fuse holders, switches, and overcurrent devices in place, the insulation resistance when tested at 500 volts D.C. shall be no less than Table 3.1.

Table 3.1
MINIMUM INSULATION RESISTANCE

<u>Conductor or Circuit Size</u>	<u>Minimum Resistance</u>
No. 14 and 12 AWG	1,000,000 ohms
25 ampere circuits and above	250,000 ohms

END OF SECTION 16050

SPECIFICATIONS

SECTION 16060 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes methods and materials for underground loop grounding systems and equipment grounding.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, including ground loop bonding clamps.
- B. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by nationally recognized testing laboratory (NRTL) or trade association.
- C. 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 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. Testing Agency's Field Supervisor shall be a person currently certified by the InterNational Electrical Testing Association 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. Comply with UL 467 for grounding and bonding materials and equipment.

1.5 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes. Drawings may not show all required air terminals. Provide additional air terminals and cabling as required to protect metal bodies of mechanical equipment, at no additional cost to the Owner.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and installer.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors shall be Stranded Conductors as per ASTM B 8.
- C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches in cross section, unless otherwise indicated; with insulators. See project drawings for other dimensions and details.

2.2 CONNECTORS

- A. Listed and labeled by UL or a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts. Pipe Connectors shall be 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-bonded steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install bare stranded copper cables in all cases, unless copper braids are indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade.
- C. Grounding Bus: Install in electrical equipment rooms as indicated. Install bus on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
 - 5. Connections to Fencing: Bolted connectors.
 - 6. Connections to Concrete Pad Rebar: Ufer clamps designed for that purpose.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Provide ground grids as indicated on the project drawings.

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.
 - 2. Single-phase motor and appliance branch circuits.
 - 3. Three-phase motor and appliance branch circuits.
 - 4. Flexible raceway runs.
 - 5. Cable Trays
 - 6. Armored and metal-clad cable runs.

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. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
- C. 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.

- D. Grounding and Bonding for Piping:
 - 1. Metal Process Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal process piping. Connect grounding conductors to 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.
- E. Ground Ring: Install a grounding conductor, electrically connected to each ground rod and to each indicated item, extending around the perimeter of area or item indicated. Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to concrete pad rebar. Bury ground ring not less than 24 inches from pad foundations.

3.5 FIELD QUALITY CONTROL

- A. Perform the following field 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, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance not less than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- B. Report measured ground resistances that exceed 5 ohms. Notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 16060

SPECIFICATIONS

SECTION 16075 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 1. Identification for single- and multi-conductor cables and raceways.
 2. Underground-line warning tape.
 3. Warning labels and signs.
 4. Instruction signs.
 5. Equipment identification labels.
 6. Miscellaneous identification products.

1.3 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.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.5 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 equipment designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

PART 2 - PRODUCTS

2.1 RACEWAY AND MULTI-CONDUCTOR CABLE IDENTIFICATION

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
 1. Power Circuits: Black letters on an orange field.

2. Legend: Indicate system or service and voltage, if applicable.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.

1. Not less than 6 inches wide by 4 mils thick.
2. Compounded for permanent direct-burial service.
3. Embedded continuous metallic strip or core.
4. Printed legend shall indicate type of underground line.

2.3 WARNING LABELS AND SIGNS

A. Comply with NFPA 70, National Electrical Safety Code and 29 CFR 1910.145.

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. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.

E. 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 48 INCHES."

2.4 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 sizes.

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.

2.5 EQUIPMENT IDENTIFICATION LABELS

A. For Interior Use, Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 1 inch.

B. For Exterior Use - stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.

3. Temperature Range: Minus 40 to plus 185 deg F .
 4. Color: Black, except where used for color-coding.
- B. 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. Accessible Raceways and Multi-Conductor Cables More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.
- B. Accessible Raceways and Multi-Conductor Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 100 A: Identify with orange snap-around label.
- C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape and metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use write-on tags. Identify each ungrounded conductor according to source and circuit number.
- E. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- F. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- G. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power: 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: Power transfer switches and 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.
- H. 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.
- I. 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: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where 2 lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Stenciled legend 4 inches high.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
2. Equipment to Be Labeled:
 - a. Electrical Cabinets, and Enclosures.
 - b. Electrical Switchgear.
 - c. Motor Control Centers.
 - d. Transformers.
 - e. Motor Starters.
 - f. Power Transfer Equipment.
 - g. Voice and Data Cable Terminal Equipment.

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. Attach non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- E. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- 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 sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

END OF SECTION 16075

SPECIFICATIONS

SECTION 16400 – SERVICE AND DISTRIBUTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide material and perform all work as outlined in this Section for all basic material and methods required in the installation of the electrical work.
 - 1. Installation of secondary electrical services, main circuit breaker and panelboards.
- B. Contractor shall consult Section 16010, General Provisions in detail, as he will be responsible for and governed by conditions set forth therein and work indicated.

1.02 RELATED WORK SPECIFIED ELSEWHERE

Please refer to the following specification sections for additional information. The information included in these sections does not supersede any information included herein, but complements and supplements

- A. Related Electrical Specifications Sections
 - Section 16010 – Basic Electrical Requirements

1.03 SUBMITTALS

- A. Consult Section 16010 - Submittals, for shop drawing requirements on all materials specified in this section.

1.04 ELECTRIC SERVICES

- A. Service shall be a secondary metered 100A 480 volt, 3-phase, 4-wire feed from Delmarva Power supplied pad mount transformer.
- B. Contractor shall coordinate the installation of the electric service with Delmarva Power, submitting an application for service and providing all customer work as required. A preliminary application has been submitted by the Engineer.

PART 2 - PRODUCTS

2.01 ENCLOSED MAIN CIRCUIT BREAKER

- A. Circuit breaker sizes shall be as indicted on project drawings. Minimum RMS symmetrical amperes interrupting rating shall be 35,000 at 480 volts AC.
- B. Thermal magnetic, current limiting, with factory-sealed electronic trip unit suitable for reverse connection and with LSI functions provided. Lugs shall be furnished for both line and load terminations. The main breaker enclosure shall be equipped with an insulated groundable neutral.
- C. Enclosures: Overall circuit breaker enclosure shall be NEMA-1, UL-listed, and equipped with padlock provisions.
- D. Manufacturers: Square-D, HG series or equal of Cutler-Hammer or Siemens

2.02 PANELBOARD AND PANELBOARD CIRCUIT BREAKERS

- A. Panelboards
 - 1. Type: Factory assembled dead-front safety type.
 - 2. Cabinet: Constructed in accordance with UL Standard 50 for cabinets, 26" Maximum width, and 14-gage minimum steel.
 - 3. Door: Flush mounted with lock, two keys and typewritten directory. Doors shall be flush or surface type as required. All panelboard locks are to be keyed alike.

SPECIFICATIONS

4. Gutters: Sizes of gutters shall be in accordance with UL Standard 67 for panelboards; 5" minimum on top, bottom and sides.
5. Finish: Rust inhibiting primer and gray baked enamel finish.
6. Bussing assembly: Copper bus structure and main lugs or main breaker shall have current ratings as indicated. Ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar not to exceed 50°C rise above ambient and constructed in accordance with UL Standard UL 67. All bus work shall be constructed of copper.
7. Safety barriers: Main lugs, main breakers and bus structure shall have proper barriers.

B. Panelboard Circuit breakers

1. Type: Bolt-on, quick-make and quick-break type with inverse time characteristics secured through use of bimetallic tripping element supplemented by magnetic trip.
2. Interrupting capacity: Minimum RMS symmetrical amperes rating shall be 10,000 amps AIR for lighting and power branch circuit breakers operating at 240 VAC and below. For main circuit breakers in lighting and power panels.
3. Tripping element: Non-interchangeable, non-removable type for 225 amperes and less; interchangeable type for over 225 amperes.
4. Tripping indication: Tripping indication shall be clearly visible by operating element assuming neutral position between "on" and "off".
5. Identification: Each breaker shall be identified by an individual circuit number.
6. Multi-pole breakers: Breakers designed so that overload in one pole automatically causes all poles to open by means of common trip.
7. Branch circuit breakers feeding convenience outlets shall have instantaneous sensitive trip setting of not more than 10 times the breaker trip rating.

C. Standards – Panelboards shall be UL-listed and bear the UL Label.

D. Manufacturer/Model:

480Y/277V 3Ø - Square D NF

208Y/120V 3Ø - Square D NQ

Supply these or the equal by Cutler-Hammer.

2.03 SURGE PROTECTION DEVICE

- A. IEEE C62.41, plug-in-style, solid-state, parallel-connected, sine-wave tracking suppression and filtering modules. Minimum single-impulse current rating shall be Line to Ground 100,000 A. Protection mode shall be line to ground. Units shall be mounted adjacent to panelboard via a close nipple conduit section. Mounting unit inside panelboard is not acceptable.
- B. EMI/RFI Noise Attenuation Using 50-ohm Insertion Loss Test: 55 dB at 100 kHz. Maximum Category C combination wave clamping voltage shall not exceed 1000 V, line to ground on 480 V systems. Maximum UL 1449 clamping levels shall not exceed 800 V, line to neutral and line to ground on 480 V systems. Withstand Capabilities: 3000 Category C surges with less than 5 percent change in clamping voltage.

2.04 DRY-TYPE TRANSFORMER

A. Construction

1. Type: Air insulated air cooled.
2. Taps: Transformer shall have two (2) 2-1/2 full capacity taps above and four (4) 2-1/2% full capacity taps below normal rated primary voltage.
3. Core and Coil: Manufactured from high-grade, non-aging, silicon steel with high magnetic permeabilities, low hysteresis and eddy current losses. Aluminum coils must be vacuum impregnated with non-hygroscopic, thermosetting varnish and have a final wrap of electrical insulation material designed to prevent injury to magnet wire. Visible magnet wire constructed coils will not be acceptable. The core and coil unit shall be isolated from

SPECIFICATIONS

enclosure by means of vibration absorbing mounts and be supported from base frame. Non-ventilated transformers to have an epoxy-resin encapsulated core and coil assembly.

4. Enclosure: Air ventilated transformer enclosures to be heavy gauge sheet steel, degreased, phosphatized and finished in baked enamel, NEMA-1, designed to be rodent, bird, and tamper resistant.
5. Insulation: Transformers rated 0.50 through 2 KVA shall have insulating materials rated Class B by NEMA and be designed not to exceed an 80°C rise above a 40°C ambient with a 100% continuous load applied to the secondary. Transformers rated 3 KVA through 15 KVA shall have Class H insulation and be designed not to exceed 115°C rise above 40°C ambient under the above full load conditions. Transformers 30 KVA and above shall be Class H, 115°C transformers and shall have the ability to carry a continuous 15% overload without exceeding 150°C rise above 40°C ambient.
6. Sound Level: Sound levels shall be guaranteed by the manufacturer not to exceed the following values:
 - 015 to 050 KVA - 42 db
 - 051 to 150 KVA - 47 db
 - 151 to 300 KVA - 52 db

- B. Operation: Primary and transformed secondary voltages shall be as indicated.
- C. Standards: Unit shall be tested in accordance with NEMA, meet ANSI Standards, and to be UL-listed.
- D. Manufacturers: Square D Type EX or equal.

2.05 STANDBY GENERATOR AND AUTOMATIC TRANSFER SWITCH

- A. The Standby generator and Automatic Transfer Switch will be provided by the Owner. The Contractor shall coordinate with the Owner and Manufacturer for installation and testing.
- B. The Contractor shall transport the generator from the Owner's Water Treatment Plant site to the Pumping Station No. 1 site. The Contractor shall transport the Automatic Transfer Switch (ATS) to the Power and Control Enclosure fabricator.
- C. The generator and ATS shall be installed by the Contractor in accordance with the Drawings, the Manufacturer's shop drawings (as provided by the Owner) and the Manufacturer's instructions.
- D. Installation shall comply with all applicable state and local codes as required by the Authority Having Jurisdiction.
- E. Owner will provide for generator and ATS startup services. The Contractor is responsible for coordinating and scheduling of these services with the Owner.
- F. The Contractor shall fill the generator's fuel tank at the time of project acceptance.

PART 3 - EXECUTION

3.01 ELECTRIC SERVICE INSTALLATION

- A. Contractor shall install the new underground secondary from Delmarva Power's transformers to the Main Circuit Breaker through the cold sequence switch and meter pan. Utility transformer secondary termination will be performed by Delmarva Power. Contractor shall coordinate the secondary service and metering installation with Delmarva Power.
- B. Provide utility transformer base and meter base in accordance with the requirements of Delmarva Power.

SPECIFICATIONS

- C. Contractor to provide grounding and bonding per utility, 2014 NEC, and local Authority Having Jurisdiction requirements.

3.02 CIRCUIT BREAKER AND PANELBOARD INSTALLATION

- A. Install circuit breakers and panelboards in accordance with manufacturer's recommended procedures. Provide necessary protection during construction period to insure against mechanical damage and dust accumulation.
- B. Field tests prior to energization:
 - 1. Megger check of phase-to-phase and phase-to-ground insulation level.
 - 2. Continuity.
 - 3. Short Circuit.
- C. Adjust operating mechanisms for free mechanical movement. Tighten bus connections and mechanical fasteners. Touch-up scratched or marred surfaces to match original finish.
- D. Connect panelboard branch circuit loads so that the load is distributed as equally as possible among the phase busses.
- E. Provide typed, not hand-written, circuit directories indicating location and nature of the loads served. Install applicable circuit directories in each panelboard.
- F. Install a 1-inch by 3-inch laminated plastic nameplate with 1/4-inch white letters on a black background on each panelboard. Nameplate lettering shall be as shown on drawings. Nameplates shall be stainless-steel screw mounted.

3.03 TELEPHONE SERVICE INSTALLATION

- A. Contractor shall install the new underground telephone service from existing utility pole.
- B. Contractor to coordinate with telephone utility as needed for connection/reconnection of service.

3.04 CIRCUIT BREAKER AND PANELBOARD INSTALLATION

- A. Install circuit breakers and panelboards in accordance with manufacturer's recommended procedures. Provide necessary protection during construction period to insure against mechanical damage and dust accumulation.
- B. Field tests prior to energization:
 - 1. Megger check of phase-to-phase and phase-to-ground insulation level.
 - 2. Continuity.
 - 3. Short Circuit.
- C. Adjust operating mechanisms for free mechanical movement. Tighten bus connections and mechanical fasteners. Touch-up scratched or marred surfaces to match original finish.
- D. Connect panelboard branch circuit loads so that the load is distributed as equally as possible among the phase busses.
- E. Provide typed, not hand-written, circuit directories indicating location and nature of the loads served. Install applicable circuit directories in each panelboard.
- F. Install a 1-inch by 3-inch laminated plastic nameplate with 1/4-inch white letters on a black background on each panelboard. Nameplate lettering shall be as shown on drawings. Nameplates shall be stainless-steel screw mounted.

SPECIFICATIONS

END OF SECTION 16400

SPECIFICATIONS

SECTION 16403 – STANDBY POWER SYSTEM

PART 1 - GENERAL

1.01 SCOPE

- A. Furnish all equipment for a complete diesel-powered standby power generator system as described herein.
- B. Consult Section 16050 for related work, materials and methods specified in these Sections.

1.02 SHOP DRAWINGS

- A. Consult Section 01330 for requirements in submitting documentation on all materials specified in this section. As a minimum, furnish Shop Drawings and descriptive data, complete with project designation for the following:
 - 1. Power Generator with accessory equipment,
 - 2. Automatic Transfer Switch

1.03 MANUFACTURER

- A. The engine, generator and all major items of auxiliary equipment shall be manufactured in the U.S. by manufacturers currently engaged in the production of such equipment. The unit shall be factory assembled and tested by the engine manufacturer and shipped to the job site by his authorized dealer having a parts and service facility within a 100 mile radius.
 - 1. Acceptable Units:

Engine-Generator:	Cummins C80D6C
Automatic Transfer Switch:	Cummins OTPC
 - 2. Substitutions will not be accepted.

1.04 WARRANTY

- A. A no deductible warranty shall be provided for all products against defects in materials and workmanship for a five (5) year period or 1500 hour period from the start-up date. Warranty shall cover all costs of covered repairs, including travel expenses.

PART 2 - PRODUCTS

2.01 POWER GENERATOR

- A. Diesel Engine-Generator Set Ratings: 4-cycle, 1800 rpm, diesel-fueled engine, 80 kW, 79.9 kVA at 0.8 PF, standby rating, system voltage of 480Y/277 Volts AC, three phase, four-wire, 60 hertz;
 - 1. Prototype Tests and Evaluation: prototype tests shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement. Prototype testing shall comply with the requirements of NFPA 110 for level 1 systems.
 - 2. Performance:
 - a. Voltage regulation shall be +/- 1.0 percent for any constant load between no load and rated load. Random voltage variation with any steady load from no load to full load shall not exceed +/- 1.0 percent.
 - b. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.

- c. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
 - d. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and not more than 3% in any single harmonic.
3. Engine:
- a. The engine shall be diesel fueled, radiator and fan cooled. Minimum displacement shall be 272 cubic inches with 4 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Engine accessories and features shall include:
 - 1) Complete engine fuel system, including all pressure regulators, strainers, and control valves. The fuel system shall be plumbed to the generator set skid for ease of site connections to the generator set.
 - 2) An electronic governor system shall provide automatic isochronous frequency regulation.
 - 3) Skid-mounted radiator and cooling system for full load operation in 104 degrees F (40 degrees C) ambient as measured at the generator air inlet. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with 50/50 ethylene glycol/water mixture by the equipment supplier. Rotating parts shall be guarded against accidental contact per OSHA requirements.
 - 4) An electric starter capable of three complete cranking cycles without overheating.
 - 5) Positive displacement, mechanical, full pressure, lubrication oil pump.
 - 6) Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
 - 7) Flexible fuel lines.
 - 8) Replaceable dry element air cleaner with restriction indicator.
 - 9) Engine mounted battery charging alternator and solid-state voltage regulator.
 - 10) The engine shall be filled with a high quality synthetic lubricant such as Mobil Delvan 1300 or equivalent that meets the manufacturer's specifications.
4. AC Generator:
- a. The AC generator shall be synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125°C.
 - b. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.
 - c. The generator shall have PMG excitation.
5. Engine-Generator Set Control:
- a. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this Specification.
 - b. The control system shall be mounted on the generator set. The control system shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
 - c. The control system shall be UL508 listed, CSA282-M1989 certified, and meet IEC8528 part 4. All switches, lamps and meters shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts. The controls shall meet or exceed the requirements of Mil-Std 461C part 9, and IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions. The entire control shall be tested and meet the requirements of IEEE587 for voltage surge resistance.
 - d. The generator set mounted control shall include the following features and functions:

- 1) Three position control switch labeled RUN/OFF/AUTO. The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
- 2) RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
- 3) PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
- 4) Generator Set AC Output Metering: The generator set shall be provided with a metering set including the following features and functions:
 - 4.1) Analog voltmeter, ammeter, frequency meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0-90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.
 - 4.2) Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.
- 5) Generator Set Alarm and Status Message Display: The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing alarm and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on a digital display panel:
 - low oil pressure (alarm)
 - low oil pressure (shutdown)
 - oil pressure sender failure (alarm)
 - low coolant temperature (alarm)
 - high coolant temperature (alarm)
 - high coolant temperature (shutdown)
 - engine temperature sender failure (alarm)
 - low coolant level (alarm or shutdown--selectable)
 - fail to crank (shutdown)
 - overcrank (shutdown)
 - overspeed (shutdown)
 - low DC voltage (alarm)
 - high DC voltage (alarm)
 - weak battery (alarm)
 - high AC voltage (shutdown)
 - low AC voltage (shutdown)
 - under frequency (shutdown)
 - over current (warning)
 - over current (shutdown)
 - short circuit (shutdown)
 - over load (alarm)

In addition, provisions shall be made for indication of two customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above-specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

- 6) Engine Status Monitoring: The following information shall be available from a digital status panel on the generator set control:
- engine oil pressure (psi or kPA)
 - engine coolant temperature (degrees F or C)
 - engine oil temperature (degrees F or C)
 - engine speed (rpm)
 - number of hours of operation (hours)
 - number of start attempts
 - battery voltage (DC volts)
 - low fuel level
 - fuel leak detection alarm
- The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.
- 7) Control Functions: The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
- 7.1) The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
- 7.2) The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this Specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
- 7.3) The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.
- 7.4) The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
- 8) Alternator Control Functions: The generator set shall include an automatic digital voltage regulation system that is matched and prototype tested with the governing system provided. It shall be immune from mis-operation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alpha-numeric LED readout to indicate setting level.
- 8.1) Controls shall be provided to monitor the output current of the generator set and initiate an alarm when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator.
- 8.2) Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load-shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
- 8.3) An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional

delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

- 8.4) A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 12VDC or more than 32 VDC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.
- 9) Control Interfaces for Remote Monitoring: All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:
 - 9.1) Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.
 - 9.2) One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.
 - 9.3) A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
 - 9.4) A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.
6. Base: The engine-generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
7. Generator Set Auxiliary Equipment and Accessories:
 - a. Coolant heater: Engine mounted thermostatically controlled coolant heater voltage shall be as shown on the Drawings.
 - 1) The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
 - 2) The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
 - 3) The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40°F ambient, in compliance with NFPA110 requirements.
 - b. Vibration Isolators: Vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
 - c. Starting and Control Batteries: Starting battery bank, calcium/lead antimony type, 12 volt DC, sized as recommended by the generator set manufacturer, shall be supplied for each generator set with battery cables and connectors.
 - d. Exhaust Silencer: Exhaust muffler shall be provided for size and type as recommended by the generator set manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the generator set manufacturers recommendations and applicable codes and standards.
 - e. Generator Set Main Circuit Breaker: Generator main circuit breaker: set mounted and wired, UL listed, molded case rated at 100 amps, 3 pole, 480 volts. Submittals shall

demonstrate that the circuit breaker provides proper protection for the alternator by a comparison of the trip characteristic of the breaker with the thermal damage characteristic of the alternator. Field circuit breakers shall not be acceptable for generator overcurrent protection.

- f. Battery Charger: A UL listed/CSA certified 10-amp voltage regulated battery charger shall be provided for each engine-generator set. The charger will be mounted on the back panel of the Station Enclosure. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output along with individual form C contacts rated at 4 amps, 120 VAC, 30VDC for remote indication of:
 - Loss of AC power - red light
 - Low battery voltage - red light
 - High battery voltage - red light
 - Power ON - green light (no relay contact)
 - Analog DC voltmeter and ammeter, 12 hour equalize charge timer, AC and DC fuses shall also be provided on the charger.
- g. Maintenance Tools: One set of tools required for maintenance of the engine-generator set, packaged in an adequately sized metal toolbox.
- h. Sub-Base Fuel Storage Tank: Provide a dual wall sub-base fuel storage tank. Tank capacity shall have sufficient capacity for 24 hours of operation at full load. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The equipment, as installed shall meet all local and regional requirements for above ground tanks. Low fuel level detection shall be provided with alarm when level is reduced 50% of usable capacity and shall be annunciated on the generator instrument panel. Ruptured fuel-sub base tank detection shall be annunciated on the generator instrument panel.
- i. Protective Enclosure: Provide the generator with an aluminum, weather-protective, sound-attenuating enclosure. The enclosure shall reduce the average sound pressure level at 7 meters to 67.1 ± 1 dB(A) and be capable of withstanding 150 mph winds.

2.02 AUTOMATIC TRANSFER SWITCH

- A. Provide complete factory assembled power transfer equipment with digital electronic controls designed for surge voltage isolation, and including voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts.
- B. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided. Technicians specifically trained to support the product and employed by the generator set supplier shall service the transfer switches.
- C. Codes and Standards:
 - 1. The automatic transfer switch shall conform to the requirements of the following codes and standards:
 - UL1008. The transfer switch shall be UL listed and labeled.
 - CSA C22.2, No. 14 - M91 Industrial Control Equipment.
 - CSA 282, Emergency Electrical Power Supply for Buildings
 - EN55011, Class B Radiated Emissions
 - EN55011, Class B Conducted Emissions
 - IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991
 - IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
 - IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
 - IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
 - IEC 1000-4-6 Conducted Field Immunity
 - IEC 1000-4-11 Voltage Dip Immunity
 - NFPA70 - National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 - NFPA110 - Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.

- IEEE446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 - NEMA ICS10-1993 - AC Automatic Transfer Switches.
2. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

D. Power Transfer Switch:

1. Ratings: 125 amps, 3-poles. Main contacts shall be rated for 600 Volts AC minimum.
2. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
3. Transfer switch equipment shall have minimum withstand and closing rating (WCR) of 14,000 in RMS symmetrical amperes. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

E. Construction:

1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
2. Transfer switches rated through 1000 amperes shall be equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms.
3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
4. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
5. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with line voltage components.
6. Transfer switches that are designated on the Drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

F. Connections:

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the generator set.

G. Transfer Switch Control:

1. Operator Panel: Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.
 - a) High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control.

- b) High intensity LED lamps to indicate that the transfer switch is "not in auto" (due to control being disabled or due to bypass switch enabled or in operation) and "Test/Exercise Active" to indicate that the control system is testing or exercising the generator set.
 - c) "OVERRIDE" pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
 - d) "TEST" pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
 - e) "RESET/LAMP TEST" pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.
2. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via the service tool or an operator display panel.
 3. Security Key Switch to allow the user to inhibit adjustments, manual operation or testing of the transfer switch unless key is in place and operated.
 4. Analog AC meter display panel, to display 3-phase AC Amps, 3-phase AC Volts, KW load level, and load power factor. The display shall be color-coded, with green scale indicating normal or acceptable operating level, yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.
 5. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
 - Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
 - Display source status, to indicate source is connected or not connected.
 - Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
 - The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
 - Set nominal voltage and frequency for the transfer switch.
 - Adjust voltage and frequency sensor operation set points.
 - Set up time clock functions.
 - Set up load sequence functions.
 - Enable or disable control functions in the transfer switch, including program transition.
 - Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
 - Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall be "Year 2000" compliant and incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
 - Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to each source. Display number of times transferred, and total number of times each source has failed.
 - Display information for other transfer switches in the system, including transfer switch name, real time load in KW on the transfer switch, current source condition, and current operating mode.
 - Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.
 6. Internal Controls: The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is

accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions are not acceptable.

7. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
 - Monitoring all phases of the normal service (source 1) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
 - Monitoring all phases of the emergency service (source 2) for under voltage conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
 - Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
 - Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
 - Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
 - Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
 - Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
 - Monitoring the neutral current flow in the load side of the transfer switch. The control system shall initiate an alarm when the neutral current exceeds a preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.
 8. All transfer switch sensing shall be configurable from a Windows PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. Designs utilizing DIP switches or other electromechanical devices are not acceptable. The transfer control shall incorporate a series of diagnostic LED lamps.
 9. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
 10. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cool-down) (adjustable in a range of 0-30 minutes).
 11. The transfer switch shall provide a relay contact signal prior to transfer or retransfer. The time period before and after transfer shall be adjustable in a range of 0 to 50 seconds.
 12. The control system shall be designed and prototype tested for operation in ambient temperatures from -40C to +70C. It shall be designed and tested to comply with the requirements of the following voltage and RFI/EMI standards.
 13. The control system shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
- H. Control Interface:
1. The transfer switch will provide an isolated relay contact for starting of a generator set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.
 2. Provide one set of Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

I. Enclosure:

1. Enclosures shall be UL listed and be NEMA type 1 rated. The cabinet door shall be key-locking. The cabinet shall provide code-required wire bend space at point of entry. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this Specification and are not acceptable.

J. Operation:

1. Open Transition Sequence of Operation: Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the generator set.
2. Generator Set Exercise (Test) With Load Mode: The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:
 - Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
 - The transfer switch shall issue a compatible start command to the generator set, and cause the generator set to start and run at idle until it has reached normal operating temperature.
 - When the generator set has reached normal operating temperature or after an adjustable time period (whichever is shorter), the control system shall accelerate the generator set to rated voltage and frequency.
 - When the control system senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
 - On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
 - The transfer switch shall operate the generator set unloaded for a cool-down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment shall be installed by the Contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The Contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- C. Equipment shall be installed on concrete housekeeping pad or isolation pad as indicated. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- D. Equipment shall be initially started and operated by representatives of the manufacturer.

- E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.
- F. The generator's fuel tank shall be full at time of project acceptance.

3.02 FACTORY TESTS

- A. Equipment supplied shall be fully tested at the factory for function and performance. Factory testing may be witnessed by the Owner and Consulting engineer. Costs for travel expenses will be the responsibility of the Owner and Consulting engineer. Supplier is responsible to provide two weeks notice for testing.
- B. Generator set factory tests on the equipment shall be performed at rated load and rated PF. Generator sets that have not been factory tested at rated PF will not be acceptable. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

3.03 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested for compliance with the Specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.
- B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.

3.04 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.
- B. Contractor shall adjust time delays as recommended by manufacturer to provide standby transfer after emergency transfer to generator power and on re-transfer to normal. Time delays for generator cool down period shall be 5 minutes.

END OF SECTION 16403

SPECIFICATIONS

SECTION 16460 - ELECTRICAL POWER SYSTEM STUDIES

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination and arc-flash studies. Protective devices shall be set based on results of the protective device coordination study. Arc-Flash Hazard Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis

The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D.

1.02 SUBMITTALS

A. For Review and Approval

1. Contents - consult Section 16010 - Submittals, for shop drawing requirements. Submittals specific to the studies shall include:
 - a. Product Data: For computer software program to be used for studies.
 - b. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.
 - c. Qualification Data: For coordination and arc-flash studies specialist.
2. Timing - the short-circuit and protective device coordination studies shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing.
If formal completion of the studies may cause delay in equipment manufacturing, approval from the Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

B. For Construction

1. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No less than two (2) bound copies of the complete final report shall be submitted. Additional copies, where required, shall be provided on CD in PDF format.
2. The report shall contain the following sections:
 - a. One-line diagram showing protective device ampere ratings and associated designations, cable size & lengths, transformer kVA & voltage ratings, motor & generator kVA ratings, and switchgear/switchboard/panelboard designations
 - b. Descriptions, purpose, basis and scope of the study
 - c. Tabulations of the worst-case calculated short circuit duties as a percentage of the applied device rating (circuit breakers, fuses, etc.); the short circuit duties shall be upward-adjusted for X/R ratios that are above the device design ratings
 - d. Protective device time versus current coordination curves with associated one-line diagram identifying the plotted devices, tabulations of ANSI protective relay functions and adjustable circuit breaker trip unit settings
 - e. Fault study input data, case descriptions, and current calculations including a definition of terms and guide for interpretation of the computer printout
 - f. Incident energy and flash protection boundary calculations
 - g. Comments and recommendations for system improvements, where needed
 - h. Executive Summary including source of information and assumptions made

1.03 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. SKM Systems Analysis, Inc., Power Tools for Windows (SKM PTW) latest version, no substitutions.

SPECIFICATIONS

- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the State of Delaware, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.01 STUDIES

- A. Contractor to furnish short-circuit and protective device coordination studies. The coordination study shall begin with the utility company's feeder protective device and include all of the electrical protective devices down to and include the largest feeder circuit breaker in the 480 Volt power distribution switchboards and panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators and distribution switchboard.:

2.02 DATA COLLECTION

- A. Contractor shall obtain all data as required by the power system studies. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future utility supplies, motors, and generators.
- C. Load data utilized may include proposed loads obtained from Contract Documents. Include fault contribution of motors in the study, with motors < 50 hp grouped together.

2.03 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 - 2. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 241, IEEE 242 recommendations for fault currents and time intervals.
- C. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- D. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

SPECIFICATIONS

- a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- E. Completed data sheets for setting of overcurrent protective devices.

2.04 ARC-FLASH HAZARD ANALYSIS

- A. The Arc-Flash Hazard Analysis shall be performed with the aid of computer software intended for this purpose and will result in Arc-Flash Incident Energy (AFIE) levels and approach boundary distances.
- B. The Arc-Flash Hazard Analysis shall be performed in conjunction with a short-circuit analysis and a time-current coordination analysis.
- C. Results of the Analysis shall be submitted in tabular form, and shall include device or node bus name, bolted fault and arcing fault current levels, approach boundary distances, personal-protective equipment classes and AFIE levels.
- D. The analysis shall be performed under worst-case Arc-Flash conditions, and described in the final report, how these conditions differ from worst-case bolted fault conditions.
- E. The Arc-Flash Hazard Analysis shall be performed by a registered professional engineer.
- F. The Arc-Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584-2018, the IEEE Guide for Performing Arc-Flash Calculations.
- G. The Arc-Flash Hazard Analysis shall include recommendations for reducing AFIE levels and enhancing worker safety.
- H. The Study Vendor shall supply Arc-Flash Hazard labels in compliance with NEC-2014 section 110 and ANSI Z535.4 to identify AFIE and appropriate Personal Protective Equipment classes provided in conformance with the analyses and shall affix on electrical equipment in conformance with applicable standards.

PART 3 - EXECUTION

3.01 FIELD ADJUSTMENT

- A. Adjust protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion. The same procedure shall be followed for all non-overcurrent relays.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies at no additional cost to Owner.
- C. Notify Owner in writing of any required major equipment modifications.
- D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a 2-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.02 ARC FLASH WARNING LABELS

- A. The Study Vendor shall provide an ANSI Z535.4 compliant (size 4 in. x 6 in.) thermal transfer type two color die-cut arc flash label as provided by DuraLabel or Brady for each work location analyzed and included in this project. Material type to be suitable for the locations; IE indoor, outdoor, chemical resistively, etc.

SPECIFICATIONS

- B. The label shall have either an orange header with the wording, "WARNING, ARC FLASH HAZARD", or a red header with the wording, "DANGER, ARC FLASH HAZARD". The Danger signal wording shall be provided for all incident energy values calculated greater than 40 cal/cm²; Warning to be used for all values calculated below 40 cal/cm². These labels shall include the following information:
1. Location designation
 2. Nominal voltage
 3. Flash protection boundary
 4. Hazard risk category including PPE Classification
 5. Available Fault Current at this equipment location (*SS Value from study*)
 6. Incident energy
 7. Working distance
 8. Engineer, report number, revision number and issue date
- C. Labels shall be machine printed, with no field markings. They shall be provided in the following manner and all labels shall be based on recommended over-current device settings. Coordinate the data provided with the Arc Flash Study results and the ANSI labeling requirements. Quantities outlined below are considered minimum quantities necessary; provide additional labeling as may be required by Regulatory or Inspection Agencies at no additional cost to the project.
1. For 240 and/or 208 volt panelboard, individually mounted circuit breaker and safety disconnect device, one arc flash label shall be provided.
 2. For each motor controller, one arc flash label shall be provided.
 3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.
- D. Labels shall be field installed by the Contractor at the conclusion of the project after acceptance by the Owner.

3.03 ARC FLASH TRAINING

- A. The equipment vendor shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces, shall be provided in the equipment manuals.

END OF SECTION 16460

SPECIFICATIONS

SECTION 16483 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This section provides specification requirements for a variable speed drive (identified herein as AC Drives) for use with NEMA® MG1 Part 31 inverter-duty motors,
- B. The manufacturer shall furnish, field test, adjust, and certify all installed AC Drives for satisfactory operation.
- C. Any exceptions or deviations to this specification shall be indicated in writing and submitted with the quotation.

1.2 REFERENCES

- A. ANSI®/NFPA® 70 – National Electrical Code® (NEC®)
- B. ANSI C84.1 – Voltage Tolerances for North America
- C. CSA® C22.2 No. 14-13 – Industrial Control Equipment
- D. IEC 61000 – Electromagnetic Compatibility
- E. IEEE 519 – Guide for Harmonic Content and Control
- F. NEMA ICS 6 – Industrial Control and Systems Enclosures
- G. NEMA 250 – Enclosures for Electrical Equipment
- H. NEMA ICS 7.0 – Industrial Control and Systems Adjustable Speed Drives
- I. NEMA ICS 7.1 – Safety Standards for Construction and Guide for Selection Installation and Operation of Adjustable Speed Drives
- J. UL® 50 – Enclosures for Electrical Equipment, Non Environmental Considerations
- K. UL® 50E – Enclosures for Electrical Equipment, Environmental Considerations
- L. UL 98 – Disconnect Switches
- M. UL 507 – Electric Fans
- N. UL 508 – Industrial Control Equipment
- O. UL 508C – Power Conversion Equipment
- P. UL 991 – Safety Tests for Safety Related Controls Employing Solid State Devices
- Q. OSHA® 1910.95 – AC Drive Controller Acoustical Noise
- R. ASCE/SEI 7® – Seismic Performance Requirements
- S. ICC ES AC156 – Shake-Table Test Acceptance Criteria

1.3 SUBMITTALS

- A. Consult Sections 16010 for general requirements in submitting submittals on all materials specified in this section.
- B. Copies of the approval drawings shall be furnished for the engineer's approval prior to factory assembly of the AC Drives. These drawings shall consist of elementary power and control wiring diagrams and enclosure outline drawings. The enclosure drawings shall include front and side views of the enclosures with overall dimensions and weights, conduit entrance locations, and nameplate legends.

SPECIFICATIONS

- C. Standard catalog sheets shall be furnished for each different horsepower rated AC Drive, showing voltage, horsepower, maximum current ratings, and recommended replacement parts with part numbers.

1.4 WARRANTY

- A. An 18-month parts warranty shall be provided on materials and workmanship from the date of invoice from an authorized distributor.

1.5 QUALITY ASSURANCE

- A. The manufacturer of the AC Drive shall be a certified ISO 9001 facility.
- B. The drive controller component and all associated optional equipment shall be UL Listed according to UL 508A. A UL / cUL label shall be attached inside each enclosure as verification.
- C. The AC Drive shall be designed, constructed, and tested in accordance with UL, CSA, NEMA, ASCE/SEI 7, and NEC standards.
- D. Every power converter shall be quality assurance tested with an AC induction motor under 100% load conditions and temperature cycled within an environmental chamber at 104 deg. F. Documentation shall be furnished to verify successful completion at the request of Owner/Owner's Engineer.
- E. Equipment marked cUL mark shall further be subject to a dielectric voltage-withstand test, with all enclosed devices mounted and wired, prior to shipment.
- F. Quality assurance documentation shall be furnished to verify successful completion upon written request of the engineer.

PART 2 – PRODUCT

2.1 MANUFACTURERS

- A. The AC Drive shall be an Altivar 660 Drive System, with Line Reactors, provided by Schneider Electric or equal.
- B. Alternate control techniques, other than pulse width modulated (PWM) control, are not acceptable.

2.2 GENERAL DESCRIPTION

- A. The AC Drive shall convert the input AC mains power to an adjustable frequency and voltage as defined below and indicated on the drawings.
 - 1. The AC Drive manufacturer shall use a 6-pulse bridge rectifier design with a 5% equivalent impedance input line reactor. The diode rectifiers shall convert fixed voltage and frequency, AC line power to fixed DC voltage. The power section shall be insensitive to phase rotation of the AC line.
 - 2. For AC Drives rated 150–800 hp, the AC Drive manufacturer shall supply a passive harmonic filter using a combination of inductors and capacitors. Filter shall be Matrix from MTE. The harmonic filter configuration shall result in a current waveform that approximates near sinusoidal input current waveform and compliant with requirements of IEEE 519. The power section shall be insensitive to phase rotation of the AC line.
- B. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall use insulated gate bipolar transistors (IGBT) or intelligent power modules (IPM) as required by the current rating of the motor.

SPECIFICATIONS

2.3 CONSTRUCTION

- A. The AC Drive shall be mounted in a NEMA 3R enclosure with an externally operated disconnect device.
- B. A mechanical interlock shall prevent an operator from opening the AC Drive door when the disconnect is in the ON position. Another mechanical interlock shall prevent an operator from placing the disconnect in the ON position while the AC Drive door is open. It shall be possible for authorized personnel to defeat these interlocks.
- C. Provisions shall be made for locking all disconnects in the OFF position. Provisions for additional padlocking shall be made by the customer using an approved lockout/tagout device.
- D. Enclosure door to come with keyed lock.

2.4 MOTOR DATA

- A. The AC Drive shall be sized to operate the following AC motors and shall be defined to match the load schedules and the type of connections used between the motor and the load, such as a direct connection or a power transmission connection:
 - 1. Motor horsepower rating is 34.
 - 2. Motor utilization voltage 480 VAC
 - 3. Motor service factor 1.00

2.5 APPLICATION DATA

- A. The AC Drive shall be sized to operate a variable torque load and shall carry a Normal Duty rating.
- B. The speed range shall be from a minimum speed of 0.1 Hz to a maximum speed of 60 Hz.

2.6 ENVIRONMENTAL RATINGS

- A. The AC Drive shall meet IEC 60664-1 and NEMA ICS-1 Annex A standards.
- B. The AC Drive shall be designed to operate in an ambient temperature of -10 to + 40 °C (+14 to 104 °F).
- C. The storage temperature range shall be -25 to +65 ° C (-13 to +149 °F).
- D. The maximum relative humidity shall be 95% at 40 °C (104 °F), non-condensing with no dripping water, conforming to IEC 60068-2-3.
- E. The AC Drive shall be rated to operate at altitudes less than or equal to 3,300 feet (1000 meters) without derating. For altitudes above 3,300 feet (1000 meters), the manufacturer's derating factors shall apply.
- F. The AC Drive shall conform to IEC 600721-3-3-3M3 Amplitude for Operational Vibration Specifications.
- G. The AC Drive shall meet environmental conditioning to IEC60721-3-3, electronic cards with protective coating.

2.7 RATINGS

- A. The AC Drive shall be designed to operate from an input voltage of 460 V ac plus 10% or minus 15%.
- B. The AC Drive shall operate from an input voltage frequency range of 57–63 Hz.
- C. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.

SPECIFICATIONS

- D. The efficiency of the AC Drive at 100% speed and load shall typically not be less than 96%. Efficiency shall vary with the power rating of the AC Drive.
- E. The variable torque rated AC Drive overcurrent capacity shall be 110% for one minute.
- F. The output carrier frequency of the AC Drive shall be randomly modulated depending on the Drive rating for low noise operation. No AC Drive with an operable carrier frequency above 16 kHz shall be allowed.
- G. The output frequency shall be from 0.1–200 Hz.
- H. The AC Drive shall develop rated motor torque at 0.5 Hz (60 Hz base) in a sensorless flux vector (SVC) mode using a standard induction motor without an encoder feedback signal.

2.8 PROTECTION

- A. Upon power-up, the AC Drive shall automatically test for valid operation of memory, valid operation of option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power, and the pre-charge circuit.
- B. The AC Drive shall be UL Listed according to UL 508A for use on distribution systems with 100 kA available fault current. The AC Drive shall have a coordinated short circuit rating designed to UL 508C and listed on the nameplate.
- C. The AC Drive shall have protection against short circuits, protection between output phases and ground; and protection between the logic and analog outputs.
- D. The AC Drive shall have minimum AC undervoltage power loss ride-through of 200 milliseconds. The AC Drive shall have the user-defined option of frequency fold-back to allow motor torque production to continue to increase the duration of the powerloss ride-through.
- E. The AC Drive shall have a selectable ride-through function that shall allow the logic to maintain control for a minimum of one second with the ability to restart when power is restored.
- F. The AC Drive shall have an auto restart function that shall provide programmable restart attempts for a fault condition other than a ground fault, short circuit, or internal fault condition. The programmable time delay before restart attempts shall be unlimited.
- G. The AC Drive shall have a programmable deceleration mode for normal and tripped conditions. The stop modes shall include freewheel stop, fast stop, and DC injection braking.
- H. Upon loss of the analog process follower reference signal, the AC Drive shall enter a tripped condition and/or operate at a user-defined speed set between software programmed low-speed and high-speed settings.
- I. The AC Drive shall have solid state I²t protection that is UL Listed and meets UL 508C as a Class 10 overload protection and meets IEC 60947. The minimum adjustment range shall be from 40–150 % of the nominal output current rating of the AC Drive.
- J. A thermal switch with a user selectable pre-alarm shall provide the AC Drive with a minimum of 60 seconds delay before overtemperature fault.
- K. The heatsink shall have bonded fin, molded, or block-milled construction for maximum heat transfer.
- L. The AC Drive shall have a fold-back function that shall automatically anticipate a controller overload condition and fold back the frequency to avoid a trip condition.
- M. The output frequency of the AC Drive shall be software enabled to fold back when the motor is overloaded.
- N. There shall be three skip frequency ranges with hysteresis adjustment that can each be programmed independently, back to back, or overlapping.

2.9 ADJUSTMENTS AND CONFIGURATIONS

SPECIFICATIONS

- A. The AC Drive shall self-configure to the main operating supply voltage and frequency. Operator adjustments shall not be required.
- B. Upon power up, the AC Drive shall automatically send a signal to the connected motor. The stator resistance data shall be measured at rated current. The AC Drive shall automatically optimize the operating characteristics according to the stored data.
- C. The AC Drive shall be configured to automatically restart after a power interruption and be factory preset to operate for common applications.
- D. A choice of at least two types of acceleration and deceleration ramps shall be available in the AC Drive software: linear and S curve. Other product specific curves may be available.
- E. The acceleration and deceleration ramp times shall be adjustable from 0.01 to at least 3,200 seconds.
- F. The volts per hertz ratios shall be user selectable to meet variable torque loads, normal and high-torque machine applications.
- G. The memory shall retain and record run status and trip type of at least the past four trips.
- H. Slip compensation shall be adjustable from 0–150%.
- I. The software shall have an “Energy Saving” function that shall reduce the voltage to the motor when the variable torque setting is selected. A constant volts/hertz ratio shall be maintained during acceleration. The output voltage shall then automatically adjust to meet the torque requirement of the load.
- J. The AC Drive shall offer programmable DC injection braking that will brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current shall be adjustable between 10% and 100% of rated current and available from 1.0 to at least 20 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50% of the nameplate current of the motor.
- K. Sequencing logic shall coordinate the engage and release thresholds and time delays for the sequencing of the AC Drive output, mechanical actuation, and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

2.10 GRAPHIC DISPLAY TERMINAL INTERFACE

- A. The graphic display terminal shall provide 8 lines of 240 by 160 pixels (in English) to control, adjust, and configure the AC Drive. All electrical values, bar charts, configuration parameters, I/O assignments, application and activity functions, faults, local control, adjustment storage, self-test, and diagnostics shall be accessible through the terminal interface. There shall be a standard selection of six additional languages built into the operating software.
- B. The AC Drive model number, torque type, software revision number, horsepower, output current, motor frequency, and motor voltage shall be listed on the drive identification display as viewed on the graphic display terminal.
- C. At a minimum, the selectable outputs shall consist of speed reference, output frequency, output current, motor torque, output power, output voltage, line voltage, DC voltage, motor thermal state, drive thermal state, elapsed time, motor speed, machine speed reference, and machine speed.
- D. The graphic display terminal shall consist of programmable function keys. The functions shall allow both operating commands and programming options to be preset by the operator. A hardware selector switch shall lock out the graphic display terminal from unauthorized personnel.
- E. The graphic display terminal shall offer a simple to advanced user menu consisting of parameter setting, I/O map, fault history, and drive configuration. A software lock shall limit access to the main menu.
- F. The navigation scheme shall provide the ability to scroll through menus and screens, select or activate functions, or change the value of a selected parameter.

SPECIFICATIONS

- G. An Escape key shall return a parameter to the existing value if an adjustment is not required and the value shall be displayed. The escape function shall also return to a previous menu display.
- H. A Run key and a Stop key shall command a normal start and stop as programmed when the AC Drive is in keypad control mode. The Stop key must be active in all control modes.
- I. The keypad shall include a Local/Remote pushbutton selection. Both start/stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.
- J. A user interface shall be available that is a WINDOWS® based personal computer, serial communication link, or detachable graphic display terminal.
- K. The keypad and all door-mounted controls must be Type 12 rated.

2.11 CONTROL

- A. Unit shall have Ethernet TCTP/IP embedded in the power converter.
- B. Unit shall have an Energy meter integral to the power converter. Energy dashboard should be available to view on the display terminal or available to export via Ethernet.
- C. External pilot devices may be connected to a terminal strip for starting/stopping the AC Drive, speed control, and displaying operating status. All control inputs and outputs shall be software assignable.
- D. A 2-wire or 3-wire control strategy shall be defined within the software. The 2-wire control shall allow automatic restart of the AC Drive without operator intervention after a fault or loss of power. The 3-wire control shall require operator intervention to restart the AC Drive after a fault or loss of power.
- E. The control power for the digital inputs and outputs shall be 24 Vdc, converter and 120VAC for external.
- F. The internal power supply shall incorporate an automatic current fold-back function that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs shall be current limited to 220 mA and shall not be damaged if shorted or if excess current is pulled.
- G. All logic connections shall be furnished on pull-apart terminal strips.
- H. There shall be two software assignable analog inputs with interference filtering. The analog inputs shall be software selectable and shall consist of user-defined configurations: x-y mA or x-y V.
- I. There shall be at least four software assignable logic inputs that shall be selected and assigned in the software. The logic input assignments shall consist of forward, reverse, jog, plus/minus speed (2 inputs required), setpoint memory, preset speeds (up to 8 inputs), auto/manual control, controlled stop, terminal or keypad control, output contactor (2 inputs required), motor switching, and fault reset.
- J. There shall be at least one software assignable analog output with interference filtering. The analog outputs can be selected and assigned in the software. The analog output assignments shall be proportional to the following motor characteristics: frequency, current, power torque, voltage, and thermal state. The output signal shall be user-defined configurations: x-y mA or x-y V.
- K. Two voltage-free Form-C relay output contacts shall be provided. One of the contacts shall indicate AC Drive fault status. The other contact shall be user assignable.
- L. Terminals shall be provided for the following connections to the Pump Control Panel (PCP):
 - 1. H-O-A Switch in the Auto Position (dry contact)
 - 2. Run Command (dry contact)
 - 3. Running Status (dry contact)
 - 4. Faulted Status (dry contact)
 - 5. Speed Command (4-20mA Analog Input)

SPECIFICATIONS

- M. There shall be a hardware input/output extension module that also provides interlocking and sequencing capabilities. The module shall be fully isolated and housed in a finger-safe enclosure with pull-apart terminal strips. The module shall add four logic inputs, two analog inputs, two relay outputs, and one analog output. All of the inputs and outputs shall be user assignable in the software as previously defined.
- N. The combination enclosure shall have the following optional 22mm door-mounted operators:
 - 1. Power ON pilot light (red)
 - 2. Drive Run pilot light (green)
 - 3. Drive Trip pilot light (yellow)
 - 4. Hand-Off-Auto selector switch
 - 5. Speed Potentiometer

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify that the location is ready to receive work and the dimensions are as indicated.
- B. The AC Drive equipment shall not be installed until the building environment can be maintained within the service conditions required by the manufacturer.

3.2 PROTECTION

- A. Before and during the installation, the AC Drive equipment shall be protected from site contaminants.

3.3 FACTORY TESTING

- A. The following factory tests shall be performed on the equipment provided. All tests shall be performed in accordance with the latest version of UL, NEMA, ANSI/IEEE, and NETA ATS standards.
 - 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
 - 2. After all tests have been performed, each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.
 - 3. After the burn-in cycle is complete, each VFD shall be put through a motor load test prior to final inspection and shipping.
- B. The Manufacturer shall provide three (3) certified copies of factory test reports.

3.4 INSTALLATION

- A. Installation shall comply with manufacturer's instructions, drawings, and recommendations.
- B. The AC Drive manufacturer shall provide a certified technical service representative to supervise the contractor's installation, testing, and start-up of the AC Drive(s) furnished under this specification for a maximum total of one (1) day. The start-up service shall be quoted as a separate line item.
- C. The installation Contractor shall provide three (3) copies of the AC Drive manufacturer's field start-up report before final payment is made.

SPECIFICATIONS

3.5 TRAINING

- A. An on-site training course of one (1) training day shall be provided by an authorized representative of the AC Drive manufacturing plant and/or maintenance personnel, and shall include instructions on proper operation of the equipment and preventive maintenance recommendations.

END OF SECTION 16483

SPECIFICATIONS

SECTION 16900 – ELECTRICAL CONTROLS AND INSTRUMENTATION

PART 1 - GENERAL

1.01 SCOPE

- A. Perform all work necessary and/or required and furnish all materials and equipment for complete system of electrical controls for the project. Such work includes, but is not limited to, the following:
 - 1. Installation of electrical controls and instrumentation devices in association with the installation of the pump station.
 - 2. Installation of miscellaneous relays, contractors, level monitoring, lighting/surge protectors, intrinsically safe barriers, operators, pilot lights, signal devices, control devices and control and interface panels

1.02 RELATED WORK

- A. Please refer to the following specification sections for additional information. The information included in these sections does not supersede any information included herein, but complements and supplements it.
- B. Related Electrical Specification Sections
 - 1. Section 16010 - General Provisions
 - 2. Section 16483 - Variable Frequency Drives
 - 3. Section 16920 – Plant Pump Control

1.03 SUBMITTALS

- A. Consult Sections 16010 for general requirements in submitting submittals on all materials specified in this section.
- B. Submittals shall fully demonstrate that the equipment and services to be furnished will comply with the provisions of this Section and shall provide a true and complete record of the equipment as manufactured and delivered. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, with all Drawings reduced to a maximum size of 11-in by 17-in for inclusion within the binder.
- C. Separate submittals shall be made as follows:
 - 1. Project plan – which shall include a list of submittals and intended date of release for review. This plan must be accepted before any shop drawing submittals will be processed.
 - 2. Instrumentation and controls
 - 3. The project plan shall be submitted and approved before any further submittals will be accepted.
- D. Instrumentation and Controls
 - 1. This submittal shall provide complete documentation of all field instruments, control panels and other instrument and control equipment.
 - 2. Provide equipment specification sheets, which shall fully describe the devices, the intended function, how it operates and its physical environmental and performance characteristics. Each data sheet shall have appropriate cross-references to control devices or equipment identification tags.
 - 3. Provide detailed diagrams on a single 11-in by 17-in or 8.5-in by 11-in sheet showing the following requirements:

SPECIFICATIONS

- a. Show all interconnecting wiring between equipment, panels, terminal junction boxes and field mounted components. The diagrams shall show all components and panel terminal board identification numbers and all wire numbers. This diagram shall include all intermediate terminations between field elements and panels (e.g. terminal junction boxes). The diagrams shall be coordinated with the electrical supplier and shall bear his/her mark showing this has been done.
 - b. Show location of all devices.
 - c. Show instrument description showing type, manufacturer, model number, range, set points and operation (e.g. fail open, normally closed, etc.) as applicable.
 - d. Show all instrument loop power back to termination on terminal block, fuse block (including fuse size), etc, as applicable.
 - e. Show all grounding points within cabinets and panels and identify the connection point of individual components.
4. Provide detailed Drawings covering control panels consoles and/or enclosures, which shall include:
 - a. Cabinet assembly and layout Drawings to scale. These shall include both front and interior layouts.
 - b. Material, fabrication and painting specifications.
 - c. Panel wiring diagrams showing all power connections to equipment within and on the panel, combined panel power draw requirements (volts, amps), breaker sizes, fuse sizes and grounding. This wiring diagram shall be in ladder logic format and shall reference the appropriate drawing for continuations or details where required. Show all wire numbers, and terminal block designations.
 5. All equipment and control panel submittals must be approved prior to acquisition of materials and construction of control panels.
 6. The submittal shall also contain all planning information, site preparation instructions, grounding and bonding procedures, cabling diagrams, plug identifications, safety precautions or guards and equipment layouts in order to enable the Contractor to proceed with the detailed site preparation for all equipment.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM).
 1. ASTM A269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- B. Instrument Society of America (ISA)
 1. ISA S5.2 - Binary Logic Diagrams for Process Operations
 2. ISA S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation Logic and Computer Systems.
 3. ISA S5.4 - Standard Instrument Loop Diagrams
- C. American National Standards Institute (ANSI)
 1. ANSI X3.5 - Flowchart Symbols and Their Usage in Information Procession.
- D. National Electrical Manufacturers Association (NEMA)
- E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 CONTRACTOR RESPONSIBILITY

- A. It shall be the Contractor's responsibility to furnish a complete and functional, fully integrated package of controls and instrumentation as described in the contract documents. This includes all hardware devices necessary to interface the components of the various systems.

SPECIFICATIONS

- B. Responsibility shall include review of all appropriate drawings and specifications sections for this entire project. This shall include review of specifications for all equipment, electrical contract drawings and specifications, and any other equipment interfacing to the control panel systems, as required to provide necessary point-to-point wiring schematics and compliance with the functional requirements of these specifications.
- C. All special cables, such as co-axial cable, or sensor/transmitter specialty interconnection wiring, shall be furnished.
- D. The Contractor shall be responsible for the detailed design, installation and the proper functioning and performance of the control and instrumentation systems, the operator interface, the preparation of the required submittal data, conducting all tests, calibrations and operational demonstrations, and providing technical supervision for the installation and connections to equipment. The system supplier shall not necessarily be the manufacturer of the equipment to be furnished.
- E. The Contractor shall, for the duration of this contract and the guarantee period, provide next day, on-site service for all controls and instrumentation problems as discussed in other areas of this specification.
- F. Provide integrated operation and maintenance manuals and operation training.

1.06 QUALITY ASSURANCE

- A. The manufacturers of the equipment and fabricators of panels and/or cabinets supplied under this Section shall allow the Engineer and/or Owner to inspect and witness the testing of the equipment at the site of fabrication. Equipment shall include the cabinets, special control systems, level measuring devices and other pertinent systems and/or devices. A minimum of ten (10) working days' notification shall be provided to the Engineer prior to testing. No shipments shall be made without the Engineer's prior, written approval.

1.07 WARRANTY

- A. The warranty shall provide (a) a minimum of next-day, on-site service for emergency failures, and (b) replacement of the defective component within one week, if repairs cannot be affected within that time. A five-day response time, on-site service, is required for non-critical failures. Warranty work shall be provided by the installation Contractor. This warranty shall cover a period of one year from the date of final acceptance of the project.

PART 2 - PRODUCTS

2.01 MISCELLANEOUS COMPONENTS

- A. Pilot Type Indicating Lights
 - 1. Type
 - a. Lights shall be 30 mm.
 - b. Push-to-test style lights
 - c. Heavy duty oiltight type, which utilizes a LED 7 lumen lamp.
 - 2. Functional/Performance
 - a. Units shall be provided with voltage lamps suitable for the voltage supplied.
 - b. Lamps shall be replaceable from the front of the unit.
 - 3. Physical
 - a. Lens color shall be as indicated on the instrument device schedule. Lens shall be approximately 1-1/4-in in diameter.
 - b. Provide legend faceplates engraved to indicate the required function of each device.
 - c. Units shall be rated NEMA 13 for indoor panels. Units located outdoors or indicated to be weatherproof shall be rated NEMA 4X.
 - 4. Manufacturers: Square D, no substitutions will be accepted.

SPECIFICATIONS

B. Selector Switch and Pushbutton Operators

1. Type
 - a. Operators shall be 30 mm heavy-duty oiltight type with stackable contact blocks.
2. Functional/Performance
 - a. Provide contact arrangement and switching action as required for the control system specified.
3. Physical
 - a. For 120 Vac service provide contacts rated 10 Amps at 120 Vac, for 24 VDC service provide silver sliding contacts rated 5 Amps at 125 VDC, for electronic (millivolt/ milliamp) switching provide contacts rated 1 amp at 28 VDC.
 - b. Pushbuttons shall have flush type operators. Selector switches shall have knob or wing lever operators.
 - c. Units shall be rated NEMA 13 for indoor service. Units located outdoors or indicated to be weatherproof shall be rated NEMA 4X.
 - d. Provide legend plates denoting switch/pushbutton position/ function.
 - e. Provide padlock attachments for outdoor selector switches and pushbuttons and where indicated otherwise. Padlock attachments for stop pushbuttons shall hold button in the depressed position.
4. Manufacturers: Square D, no substitutions will be accepted.

C. Industrial Relays and Time Delays

1. Type
 - a. Industrial heavy duty NEMA rated relays.
2. Functional/Performance
 - a. Contact arrangement/function shall be as required to meet the specified control function specified.
 - b. Standard contacts shall be rated 10 Amps continuous at 600 Volts. Master contacts (when required) shall be rated 20 Amps continuous at 600 Volts.
 - c. Relays shall be provided with convertible contact blocks.
 - d. Pneumatic time delay relays shall be used on time delays less than 180 seconds and shall be adjustable.
 - e. Solid state time delay relays shall be used on time delays between 180 seconds and one-hour.
3. Options/Accessories Required
 - a. Provide all mounting rails, etc, that are required.
4. Manufacturers: Square D, no substitutions will be accepted.

D. General Purpose Relays and Time Delays

1. Type
 - a. Units shall be of the general purpose NEMA rated plug-in type.
2. Functional/Performance
 - a. Coil voltage shall match supply voltage.
 - b. Contact arrangement/function shall be as required to meet the specified control function.
 - c. Mechanical life expectancy shall be in excess of 10 million.
 - d. Duty cycle shall be rated for continuous operation.
 - e. Units shall be provided with integral indicating light to indicate if relay is energized.
 - f. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
 - g. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.
3. Physical
 - a. For 120 VAC service provide contacts rated 15 Amps at 120 VAC, for 24 VDC service provide contacts rated 7.5 Amps at 28 VDC, for electronic

SPECIFICATIONS

(milliamp/millivolt) switching applicator provide gold plated contacts rated for electronic service.

- b. Relays shall be provided with dust and moisture resistant covers.
4. Options/Accessories Required
 - a. Provide mounting sockets with pressure type terminal blocks rated 300 Volt and 10 Amps.
 - b. Provide mounting rails/holders as required.
5. Manufacturers: Square D, no substitutions will be accepted.

E. Power Relays

1. Type: Electromagnetically operated and held type, single and double pole and single and double throw as indicated.
2. Contacts: 30 ampere rated at 300V resistive load and a horsepower rating of 1.5.
3. Coil: Continuous duty rated.
4. Operating Voltage: 120 VAC, 60 Hz unless indicated otherwise.
5. Manufacturer: Square "D" Class 8501, no substitutions will be accepted.

F. Controllers/PLCs

1. The use of a programmable logic controller (PLC) with operator interface terminal (OIT) is preferred over the use of relays, switches and indicator lights.
2. Programming Language: Relay Ladder Logic.
3. Software: Licensed copies of PLC & OIT programming software shall be provided.
4. Manufacturer & Model: Schneider Electric SCADAPack for PLC and Schneider Electric, Square D HMIGTO5310 for OIT. No substitutions will be accepted.

2.02 FLOAT TYPE LEVEL SWITCHES

A. Type:

1. Multi-switch assembly with electrical connection manifold for all switches and sealing plugs with boots for all unused manifold ports. Each switch shall be weighted and suspended on its own cable (not by the manifold).

B. Functional/Performance:

1. Temperature Rating – 0 to 50 degrees C
2. Contact Rating – Up to 250 VAC/VDC and 10 Amps NC/5 amps DC.
3. Contact Arrangement – Normally Open or Open as required.

C. Physical

1. Contact – Sealed mercury switch housed in a chemically resistant polypropylene casing.
2. Flexible Support Cable – Synthetic three wire cable, minimum 19 AWG cable.
3. Specific gravity – Match to fluid being treated.

D. Options/Accessories Required:

1. Provide flexible support cable of sufficient length to ensure that splices are made in junction boxes
2. Provide junction box outside the tank for connection of cable.
3. Provide stainless steel supports/mounting accessories as required.
4. Provide weight located on support cable to provide level function indicated.
5. One intrinsically safe relay by MPE (or equal) for each float switch (located in PCP).

E. Manufacturers/Models:

1. SJE Rhombus EZconnex™ 3 port float connection system
2. Primex KwikSwitch™

SPECIFICATIONS

2.03 FLOW TRANSMITTER

- A. Type:
 - 1. Magnetic flow sensor with separately mounted transmitter.
- B. Functional/Performance:
 - 1. Sensor Temperature Rating – -40 to 70 degrees C
 - 2. Enclosure Rating – IP68
 - 3. Flow Range – 600 – 2000 GPM
 - 4. 4-20 mA output
- C. Physical:
 - 1. Lining – Ebonite.
 - 2. Hastelloy electrode
 - 2. Process Connection – 150 # ANSI raised-face carbon steel flanges.
- D. Options/Accessories Required:
 - 1. Cable between sensor and transmitter.
 - 2. Wall mounting kit for remote transmitter.
 - 3. Potting kit for terminal box
 - 4. AISI 316 grounding flat ring for liner
 - 5. Active pulse output
- E. Manufacturer and Models:
 - 1. Siemens – MAG 5100W sensor
 - 2. Siemens – MAG 5000 transmitter

2.04 LEVEL TRANSMITTER

- A. Hydrostatic Level Transmitter:
 - 1 Suitable for raw wastewater applications.
 - 2. Construction: titanium body
 - 2. Wetted Materials: Titanium,
 - 3. Cable Jacket: PTFE
 - 3. Protection Rating: IP 68, NEMA 6P
 - 4. Output: 4-20mA
 - 5. Accessories:
 - i. Full Lightning Protection and Aneroid Bellows
 - ii. Stainless steel cable hanging and anchor kit
 - 6. Manufacturer & Model: KPSI Series 700.
- C. Installation - the submersible transmitter shall be installed in the wet well. Install the aneroid bellows in the Instrument Terminal Box (ITB).

2.05 CONTROL PANELS, ENCLOSURE AND CABINETS

- A. The following paragraphs describe general fabrication requirements of control panels, enclosures, consoles and cabinets.
- B. Wiring

SPECIFICATIONS

1. All interconnecting wiring, except for electronic circuits, shall have 600 Volt insulation and rated for not less than 90 degrees C.
2. Power distribution wiring on the line side of fuses shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 14 AWG minimum. Electronic analog circuits shall utilize 16 AWG shielded, twisted pair, cable insulated for not less than 300 Volts.
3. Power and low voltage dc wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 12-in. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.
4. All wiring shall terminate in a master terminal board, rigid type and numbered. The master terminal board shall have a minimum of 25 percent spares. Terminal blocks shall be separated into groups. (Power, AC control, DC signal, alarm, and graphic). Terminal blocks shall be barrier type with the appropriate voltage rating (600 Volts minimum). They shall be the raised channel mounted type. Wire connectors shall be the hook fork type with non-insulated barrel for crimp type compression connection to the wire. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers. Direct interlock wiring between equipment will not be allowed. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6-in of the side panel or adjacent terminal.
5. All wiring to hand switches and the like which are live circuits independent of the panel's circuit breaker protection shall be clearly identified as such.
6. All wiring shall be clearly tagged and color-coded. All tag numbers and color-coding shall correspond to the panel wiring diagrams and loop drawings. All power wiring, control wiring, grounding and DC wiring shall utilize different color insulation for each wiring system used.
7. Each control loop or system circuit shall be individually protected by a fuse or breaker. All protecting devices shall be clearly labeled and located for ease of maintenance.
8. Provide surge protectors on all incoming power supplies and 15A 125V duplex receptacle in each panel.
9. Control power to individual components requiring 120V power shall be wired with individual circuit breaker protection.
10. Intrinsically safe wiring shall be kept separate from all other control panel wiring.

C. Control Components

1. All components required for the monitoring and control functions specified and or required shall be provided. Control functions shall be performed by the pump controller as specified in Section 16920.

D. Equipment Mounting/Arrangement

1. All components shall be mounted in a manner that shall permit servicing, adjustment, testing and removal without disconnecting, moving or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Components mounting shall be oriented in accordance with the internal components shall be identified with suitable plastic or metal engraved tags attached with drive pins adjacent to (not on) each component identifying the component in accordance with the drawing, specifications and supplier's data.
2. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc, required to maintain the NEMA rating of the panel.

E. Nameplates

SPECIFICATIONS

1. All panels shall be supplied with suitable nameplates, which identify the panel and individual devices as required. Nameplates used to identify individual panels shall use the descriptive name, not the acronym/abbreviation.

F. Indoor Wall or Unistrut Mounted Cabinets

1. Unless noted other wise on the Contract Drawings, all indoor panels shall be minimum of NEMA 12 and fabricated of not less than USS 14-gauge steel.
2. All panels shall be by Hoffman or equal.

G. Outdoor Enclosures

1. Unless noted otherwise on the Contract Drawings, all outdoor panels shall have a NEMA 4X rating and shall be constructed of Type 316 stainless steel.
2. All panels shall be by Hoffman or equal.

H. SERIALIZED UL LABEL REQUIREMENT (508A) – all control panels provided under this section through section 16920 inclusive, shall be constructed in compliance with Underwriter's Laboratories Inc. Category 508A standards - Enclosed Industrial Control Panels listing and following-up. The control panel(s) shall bear the Underwriter's Laboratories serialized label for "Enclosed Industrial Control Panel".

1. While the use of U.L. listed components is encouraged, their use alone will not be considered an acceptable or satisfactory alternate to the "Enclosed Industrial Control Panel" serialized label specified above.
2. Upon request from the Engineer, the panel manufacturer shall supply documentation to the owner proving they are a U.L. recognized manufacturing facility for the type of equipment required.
3. Only the labeled products of U.L.508A/"Enclosed Industrial Control Panel" recognized panel manufacturer would be considered acceptable for use on this project.

2.06 LIGHTNING/SURGE PROTECTION

- A. Lightning/Surge protection shall be provided to protect the electronic instruments from induced surges propagating along the signal and power supply lines. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level and be maintenance free and self-restoring. Protectors on intrinsically safe circuits shall be suitable for such use. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure, control cabinet or a separate NEMA 4 junction box coupled to the enclosure. The units shall be Phoenix Contact MCR Plugtrab Series protectors or the equal manufactured by Joslyn.
- B. Power Supply - Protection of all 120 VAC instrument power supply lines shall be provided. Cabinet(s)/panel(s) and groups of field instruments regardless of location (indoor or outdoor), shall be protected by isolation transformers and surge suppressors. An individual surge suppressor shall protect each field instrument.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Perform installation of all control and instrumentation components in accordance with manufacturer's instructions. Perform adjustments and programming as required to perform the intended function.

3.02 EQUIPMENT CONTROL WIRING

SPECIFICATIONS

- A. Provide all wiring, conduit, and final connections for the interlock and control wiring of all equipment.
- B. Verify functionality of Intrinsically Safe Interface circuits, as required for wet well float switches. Separate all intrinsically safe wiring from other wiring and clearly identify it as such.

END OF SECTION 16900

SPECIFICATIONS

SECTION 16920 – PLANT PUMP CONTROL

PART 1 – GENERAL

1.01 DESCRIPTION

- A. The Plant Pump Control utilizes the Pump Control Panel (PCP) and autodialer to monitor and control the pump station's operation. The PCP shall provide monitoring of the wastewater level in the wet well and control pumping to discharge the wastewater. Contractor shall submit IO List, wiring diagrams and panel layout diagrams for the PCP. The Contractor is responsible for any and all programming and configuration of the PCP and autodialer. The work includes all labor, materials, equipment and services necessary for, and incidental to, the complete and satisfactory installation.
- B. The Contractor shall be responsible for and shall provide for the design, supply, delivery, installation, certification, calibration and adjustment, testing and startup, for the creation of the PCP and cellular based autodialer system.
- C. The Owner and the Engineer will review system technical information as submitted by the Contractor for software, operating system, database, control logic and the graphical alarming, etc. for complete compliance with these specifications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Please refer to the following specification sections for additional information. The information included in these sections does not supersede any information included herein, but complements and supplements it.
- B. Related Electrical Specification Sections
 - 1. Section 16010 - General Provisions
 - 2. Section 16050 - Basic Materials and Methods
 - 3. Section 16483 - Variable Frequency Drives
 - 4. Section 16900 - Electrical Controls and Instrumentation

1.03 ABBREVIATIONS AND DEFINITIONS

OIT	Operator Interface Terminal
PLC	Programmable Logic Controller
UPS	Uninterruptible Power Supply
PCP	Pump Control Panel

1.04 DESCRIPTION OF WORK

The major items of work are generally comprised of, but not limited to, the following:

- A. Provide a PCP as described in this section. Equipment shall be provided for the functions specified herein. Configuring and Programming of the PCP's PLC described in this section shall be the responsibility of the Contractor's Systems Integrator.
- B. The PLC and associated hardware and operating software shall be, but not limited to, as specified in Section 16900.
- C. PLC shall be provided with main breaker, power supply(s), UPS, surge protection, etc., and all incidental equipment as required.
- D. Provide operation and maintenance manuals, training, spare parts, etc., as specified.
- E. Perform system factory testing and site acceptance testing.
- F. Provide finalized PLC program with full documentation in printed and electronic format.

1.05 SUBMITTALS

SPECIFICATIONS

Consult Sections 01330, and 16900 for submittal requirements on all materials specified in this section.

1.06 WARRANTY

The warranty shall provide (a) a minimum of next-day, on-site service for emergency failures, and (b) replacement of the defective component within one week, if repairs cannot be implemented within that time. A five-day response time, on-site service, is required for non-critical failures. The Systems Integrator responsible for the system installation shall provide service work under this warranty. This warranty shall cover a period of one year from the date of final acceptance of the project.

PART 2 – PRODUCTS

2.01.1 Refer to Section 16900 for requirements related to the PCP's controller hardware, OIT and software.

2.02 Refer to Section 16900 for requirements related to control panels, counsels, and cabinets.

PART 3 - EXECUTION

3.01 PRE-INSTALLATION TESTING (FACTORY ACCEPTANCE TESTING)

The PLC's and all other associated hardware shall be tested at the factory, prior to shipment, so as to demonstrate that each component is operational and meets the requirements of these specifications. The Contractor shall provide a written test plan to the Owner & Engineer two weeks prior to planned shipment of the system. The Owner & Engineer shall be given the opportunity to witness the testing. Complete simulated functional testing shall be used to demonstrate all control and monitoring (autodialer) functions. All deficiencies must be corrected prior to shipment. Test results shall be certified, with written documentation provided to the Owner upon test completion. .

3.02 INSTALLATION

- A. The Contractor shall install all communication/signal wires and conduits for the plant's PCP and autodialer. All wires are to be tested and labeled. Final terminations to the PCP and autodialer will be made by the Contractor. Contractor shall perform all required corrective measures in trouble shooting defective wiring and field installed devices.
- B. The work includes all labor, materials, equipment and services necessary for, and incidental to, the complete and satisfactory installation.
- C. Wet well level float switches shall be connected through intrinsically safe barriers (see 16900). Intrinsically safe components and wiring shall be kept separate from all other wiring and shall be clearly identified.
- D. Keep pump power wiring separate from control and instrument wiring. Separate this higher voltage wiring and associated terminals from the low voltage control and instrumentation wiring and terminals by suitable design and use of barriers / inner panels. An alternative to inner barriers would be the use of separately enclosed drives – mounted on the backplane of the station enclosure. These enclosures, if provided, may be installed on the power side of the station enclosure. If separate drives are not provided, equip the PCP with a GracePort model P-R2-K2RFO or equal for access to the internal devices without opening of the enclosure door.

3.03 FUNCTIONAL DESCRIPTION

SPECIFICATIONS

- A. The function of the PCP is to provide operational control and monitoring of the two (2) pumps as lead and lag pumps.
- B. The PCP shall monitor the water level in the wet well through a continuous level transmitter and two (2) float switches. Set the transmitter level thresholds and level switch positions at the heights indicated in the contract drawings to serve the following functions:

1. Level 6 - High High Level Alarm and Backup Pump Control (Float Switch)
2. Level 5 - High Level Alarm (Analog Transmitter Threshold)
3. Level 4 - Lag Pump On (Analog Transmitter Threshold)
4. Level 3 - Lead Pump On (Analog Transmitter Threshold)
5. Level 2 - Pumps Off (Analog Transmitter Threshold)
6. Level 1 - Low Level Alarm and Backup Pump Control (Float Switch)

The PLC is to provide loop control of the lead pump to adjust its speed to within its range of operation.

- C. The PCP shall perform the following basic functions:

1. Allow the operator to select any pump as a Lead pump.
2. Allow the operator to select automatic alternation of the Lead and Lag Pumps on each successive start cycle.
3. On rise to Level 3 (Lead On), the Lead Pump shall start its associated VFD and control its speed to maintain the Level 3 setpoint. The speed shall increase on rise in level to its full speed and decrease to its minimum speed on fall in level. The pump shall stop when level falls to Level 2.
4. On rise to Level 4 (Lag On), the Lag Pump shall start and run until it stops at Level 2.
5. On rise to Level 5 (High Level), energize an alarm circuit.
6. On rise to Level 6 (High-High Level), energize an alarm circuit and start the lead pump. In the event that the lead pump does not start, the lag pump shall start after an adjustable start delay. Only one pump shall start on rise to Level 6.
7. On fall to Level 2 (Pumps Off), stop all pumps.
8. On fall to Level 1 (Low Level), energize an alarm circuit and stop all pumps.
9. In the event of a pump malfunction (overload trip, motor high temperature, pump fail to run when called, pump fail while running), promote the next pump in line and run it in place of the failed pump (promote Lag to Lead).
10. If a pump has failed, the PCP should consider it unavailable and remove it from the alternation cycle. It shall remain unavailable until the alarm is reset at the PCP.
11. Allow selection of "Maintain Level" or "Constant Speed" through the HMI
12. Allow manual adjustment of the pump speed through the HMI.
13. The PCP shall monitor the status of the UPS for display on the OIT Screen and initiating a UPS Failure alarm, which automatically switches to incoming power.

- D. The PCP shall be equipped with the following devices.

1. Intrinsically safe barriers for connection to instruments and switches located in the wet well: level switches and submersible level transmitter.
2. A motor protective relay (Flygt MiniCAS II to be provided by the pump vendor) for each pump.

SPECIFICATIONS

3. A Hand-Off-Auto selector switch for each pump. Switches shall be heavy-duty, oil-tight and rated for the NEMA class of the enclosure (shall be provided in separate VFD enclosure).
 4. Alternation selector – selector switch(es) or other means (PLC with OIT – see 16900) of selecting pump alternation.
 5. SCADAPack controller and HMI (see 16900) with means of receiving and indicating the following conditions:
 - a. High Water Level (float switch to discrete input)
 - b. Low Water Level (float switch to discrete input)
 - c. Wet Well Level (4-20 mA transmitter to analog input)
 - d. Station Discharge Flow (4-20 mA transmitter to analog Input)
 - e. Power On
 - f. Pump A Run (from VFD)
 - g. Pump B Run (from VFD)
 - h. Pump A Seal Leak (dry contact from motor protective relay to discrete input)
 - i. Pump B Seal Leak (dry contact from motor protective relay to discrete input)
 - j. Pump A Motor Temperature High Alarm (dry contact from motor protective relay to discrete input)
 - k. Pump B Motor Temperature High Alarm (dry contact from motor protective relay to discrete input)
 - l. VFD-A Fault (from VFD)
 - m. VFD-B Fault (from VFD)
 - n. Building Door Switch (Intrusion Alarm unless password into HMI < 30 seconds (shall be time-adjustable))
 - o. Alarm Output Contacts to OmniSite as listed below.
 6. A backup level control circuit, based on relays to start both pumps (with a time delay between each start) when the High Level switch is activated and stop both pumps when the low level switch is activated.
 7. Field terminals as discussed in section 16900.
- E. Graphic Screens - graphics screens shall be, but not limited to the following:
- i. Animate these screens to dynamically represent level in a graphic format. Provide numerical displays of all current analog inputs scaled to the appropriate engineering units with dynamic links to detail screens showing trends.
 - ii. Wet Well level in feet from bottom of wet well.
 - iii. Animate graphic device symbols for pumps to reflect current status of the device (Green = running, Red = stopped, Solid Yellow = failure alarm).
- F. This is an unattended facility. The associated and separately mounted cellular telephone based autodialer shall be an OmniSite Crystal Ball model in a NEMA 4X enclosure with optional remote mount high gain antenna and associated cables. Contractor shall furnish, install and test, complete and in place, the cellular autodialer system including antenna and cables. It shall have the following inputs:
1. Wet Well Water Level (Analog Input – repeated from SCADAPack controller)
 2. Stations Discharge Flow (Pulse – direct from flow transmitter)
 3. Pump A Running (repeated from SCADAPack controller)
 4. Pump B Running (repeated from SCADAPack controller)
 5. Pump A Failure (includes VFD Failure – from SCADAPack controller)
 6. Pump B Failure (includes VFD Failure - from SCADAPack controller)
 7. Generator Failure (direct from Generator)
 8. Wet Well Analog Low Level (repeated from SCADAPack controller)

SPECIFICATIONS

9. Wet Well Analog High Level (repeated from SCADAPack controller)
 10. Generator Low Fuel (direct from Generator)
 11. Backup Level Control Active (from Backup Level Control circuit, not SCADAPack controller)
 12. Intrusion Alarm (generated by SCADAPack Controller)
 13. AC Power Failure (direct from ATS)
- G. Other monitoring and control functions consist of the following:
1. Maintain elapsed running time record of the two (2) pumps through elapsed time counters or Programmable Logic Controller (PLC)/Operator Interface Terminal (OIT).
 2. Maintain flow record of effluent discharge via flow transmitter.

3.04 PUMP MONITOR RELAY

- A. A Pump Monitor Relay (PMR) is being provide with the pumps to provide Motor Over Temperature and Seal Leakage alarms. The PMR will be furnished by the pump vendor for installation in the PCP and wired to the pump controls for shutdown and alarming.
- B. The PMR has LED indicators for power and the status of the over temperature and seal leakage conditions for operator monitoring. These two PMRs are to be flush mounted on the door of the PCP.
- C. The PMR can be powered by either 120VAC, 24VAC or 24VDC and provide relay contacts rated for 8 Amps at 120VAC. The Seal Leakage alarm shall disable the respective pump and initiated an alarm on the OIT alarm screen and maintained until the alarm is reset. The Over Temperature shall disable the pump until the motor housing cools off. The Over Temperature condition shall initiate an alarm on the OIT alarm screen.

3.05 INSTALLATION

- A. The contractor shall install the PCP and all appurtenances in accordance with the manufacturer's recommendations.
- B. Routine preventative maintenance suggested or required by the manufacturer for the system components shall be performed by the contractor until the satisfactory completion of the final operational demonstration test has been completed.

3.06 FUNCTIONAL TESTING (SITE ACCEPTANCE TESTING)

The Contractor shall provide a written test plan to the Owner & Engineer two weeks prior to planned system tests, which shall be witnessed by the Owner. All system components shall be checked to verify that they have been installed properly and that all terminations have been made correctly. Witnessed field tests shall be performed on the complete system. Each function shall be demonstrated to the satisfaction of the Owner and Engineer on a paragraph-by-paragraph basis. Each test shall be witnessed and signed off by the Contractor and the Engineer upon satisfactory completion. Complete functional testing under utility and generator power is required, with demonstration of all control and monitoring (autodialer) functions.

3.07 TRAINING

The PCP supplier shall provide and/or arrange for training of personnel at the job site as detailed in the submitted training plan. The training program shall be not less than four (4) hours in duration, and the class size shall be limited to seven (7) persons. Training date shall be coordinated with the facility owner.

SPECIFICATIONS

END OF SECTION 16920

SPECIFICATIONS

SECTION 16950 - FIELD INSPECTION AND TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: The work specified in this Section consists of additional organizational requirements for Electrical Field Inspection and Testing.
- B. Related Sections include all Division 16 Sections and their Testing Requirements included elsewhere in this package.

1.02 SUBMITTALS

- A. Submit Electrical Field Inspection and Testing documentation as required by the Specifications to the Design Engineer in strict accordance with the provisions of Section 16010 "Basic Electrical Requirements."
- B. Submissions are to include the following:
 - 1. Field Inspection Report as required for each item of material and/or equipment outlined herein.
 - 2. Manufacturer's directions for use of ground megger with proposed method indicated.
 - 3. Field testing report as required for each item of material and equipment outlined herein.
- C. Test Reports:
 - 1. Each test report prepared by any respective testing firm(s) shall comply, where applicable, to all stipulations specified for Operation, Maintenance and Installation Manuals with reference to preparation, paper requirements, indexing and binders. Each test report shall include the following:
 - a. Summary of project.
 - b. Description of equipment tested.
 - c. Description of test, including applicable specification paragraph references.
 - d. Test results.
 - e. Conclusions and recommendations.
 - f. Appendix, including appropriate test forms.
 - g. Identification of test equipment used.
 - h. Signature of responsible test organization authority.
 - i. Furnish five copies of each completed report to the Electrical Design Engineer no later than 30 days after completion of each test. The testing firm shall assemble and certify each final test report which shall be submitted to the Design Engineer for review, comments and subsequent approval.

1.03 QUALITY ASSURANCE

- A. General: The following requirements are supplementary to tests specified for individual equipment or systems:
 - 1. Written notice of test dates shall be given at least two weeks in advance in order for the Field Engineer, the Design Engineer and the Owner to make arrangements to be present during the tests.
 - 2. However, if construction schedule requires, arrange for prior test on parts of the system.
 - 3. As soon as conditions permit, conduct preliminary test of equipment to ascertain compliance with specified requirements. Make needed changes, adjustments or replacements as preliminary tests may indicate, prior to acceptance test.
 - 4. Conduct performance and operating tests as specified or required for each system or equipment unit in presence of the Engineer, or his Representative, as well as representatives or agencies having jurisdiction.
 - 5. This Contractor shall furnish labor, material and instruments and shall bear all other costs

- in connection with tests, unless otherwise indicated.
6. Obtain certificates of approval and/or acceptance in compliance with regulations of agencies having jurisdiction. Work shall not be deemed complete until such certificates have been delivered to and reviewed by the Design Engineer.
 7. Testing shall prove conclusively that all electrical systems operate properly, efficiently, and quietly in accordance with the letter and the intent of the drawings and specifications.

B. Applicable Documents:

1. American National Standards Institute
 - a. ANSI C2 National Electrical Safety Code
2. National Electrical Manufacturer's Association (NEMA).
3. National Fire Protection Association (NFPA) 70 National Electrical Code.
4. American National Standards Institute (ANSI).
5. American Society for Testing and Materials (ASTM).
6. Institute of Electrical and Electronics Engineers (IEEE).
7. InterNational Electrical Testing Association (NETA).
 - a. Acceptance Testing Specifications (NETA ATS)
8. Insulated Cable Engineer's Association (ICEA).
9. State and Local Codes and Ordinances.
10. Local Utility Codes and Ordinances
11. Occupational Safety and Health Administration (OSHA).

1.04 GENERAL REQUIREMENTS

A. Field Inspection:

1. This Contractor shall be responsible for a complete inspection of all equipment, prior to testing and energization to ascertain that it is free from any damage, scratches, or missing components and that all power connections are correct, and that they are tight in conformance with recommended standard practice. The inspection shall also include a check of control wiring, terminal connections and all bolts and nuts.
2. Field inspection shall be performed by this Contractor during a time when the Field Engineer and the Design Engineer are present to witness each inspection and its performance.
3. Any deficiencies found during the inspection shall be corrected by this Contractor prior to the energization and testing of the equipment.

1.05 INSPECTION AND TESTING

A. General:

1. The Contractor shall engage the services of a recognized, InterNational Electrical Testing Association (NETA) certified independent testing firm to perform such work as stipulated by the respective sections of the Contract Specifications.
2. The testing firm used shall be approved by the Owner.

B. Testing Firm's Responsibility:

1. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.
2. It is the intent of these tests to assure that all electrical equipment, both contractor and owner supplied, is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
3. The tests and inspections shall determine suitability for energization.
4. The testing firm shall be a corporately independent testing organization which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installer of equipment or systems evaluated by the testing firm.
5. The testing firm shall be regularly engaged in the testing of electrical equipment devices,

installations, and systems.

6. The testing firm shall have been engaged in such practices for a minimum of five years.
7. The testing firm shall meet federal OSHA criteria for accreditation of testing laboratories, Title 29, Parts 1907, 1910 and 1936. Full membership in the InterNational Electrical Testing Association constitutes proof of such criteria.
8. The lead, on site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) in Electrical Power Distribution System Acceptance Testing.
9. The testing firm shall utilize only full time technicians who are regularly employed by the firm for testing services. Electrically unskilled employees are not permitted to perform testing or assistance of any kind. Electricians may assist, but may not perform testing and/or inspection services.
10. The testing firm shall submit proof of the above qualifications with bid documents when requested.
11. The testing firm shall be an independent organization as defined by OSHA Title 29, Part 1936 and the InterNational Electrical Testing Association.
12. All instruments used by the testing firm to evaluate electrical performances shall meet NETA's Specifications for Test Instruments.
13. The terms used here within such as Test Agency, Test Contractor, Testing Laboratory, or Contractor Test Company, shall be construed to mean testing firm.

- C. Division of Responsibility:
1. The Contractor shall perform routine insulation resistance, continuity and rotation tests for all distribution and utilization equipment prior to and in addition to tests performed by the testing firm specified herein.
 2. The Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the specific power requirements.
 3. The Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.
 4. The Contractor shall notify the Design Engineer prior to commencement of any testing by the testing firm.
 5. Any system, material or workmanship which is found defective on the basis of acceptance tests shall be reported to the Design Engineer.
 6. The testing firm shall maintain a written record of all tests and no later than thirty days after completion of the tests the testing firm shall assemble and certify the final test report which shall be submitted to the Design Engineer for review, comments and subsequent approval.
- D. Test Instrument Calibration:
1. The testing firm shall have a calibration program which assures that all applicable test instrumentation are maintained within rated accuracy.
 2. The accuracy shall be directly traceable to the National Bureau of Standards.
 3. Instruments shall be calibrated in accordance with the following frequency schedule.
 - a. Field Instruments:

Analog	- 6 months maximum
Digital	- 12 months maximum
 - b. Laboratory Instruments: 12 months
 - c. Leased specialty equipment: 12 months
(Where accuracy is guaranteed by lessor)
 4. Dated calibration labels shall be visible on all test equipment.
 5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
 6. An up-to-date instrument calibration instruction and procedure will be maintained for each test instrument.
 7. Calibrating standard shall be of higher accuracy than that of the instrument tested.
- E. Safety and Precautions:
1. Safety practices shall include, but are not limited to, the following requirements:
 - a. Occupational Safety and Health Act of 1970-OSHA.
 - b. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4.
 - c. Applicable State and Local safety operating procedures.
 - d. NETA Safety/Accident Prevention Program.
 - e. Owner's safety practices.
 - f. National Fire Protection Association - NFPA 70E.
 - g. ANSI Z244.1 American National Standards for Personnel Protection.
 2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
 3. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

1.06 ELECTRICAL EQUIPMENT TESTING

- A. When an item of electrical equipment furnished as work of these Division 16 Specifications, which is designated for testing in the Contract Documents, has been completely erected, including controls and instrumentation, the Contractor shall notify the Engineer who will designate the time to make the required tests. All testing shall be done in the presence of the Engineer and the item of equipment operated to the satisfaction of the Engineer.

1. "Completely erected" shall mean that the installation is erected, all necessary adjustments have been made, all required utility connections have been made, and that the following requirements have been met: O & M Manuals submitted and approved, electrical system tests completed, spare parts lists and manufacturer's installation certificate submittals received. The Contractor shall furnish labor, and all other materials, equipment and instruments necessary for all system's tests.
 2. The Contractor shall provide competent and experienced engineers or superintendents, who shall represent the manufacturer of equipment furnished and installed under this Contract, to assist the Contractor, in the installation, adjustment, and testing of equipment in conformity with the Contract Documents.
- B. After an item of equipment has satisfied all of the above conditions, the Contractor shall notify the Engineer and shall, at such time, as directed, conduct operational tests to demonstrate to the Engineer's satisfaction that the equipment is ready for operation. Specific operational testing requirements shall be as specified hereinafter and as contained in the individual sections of these Contract Documents.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Unless waived in writing by the Engineer, the Contractor shall be present during the tests.
- B. Miscellaneous:
 1. Initial Operation: Upon completion of structural work as well as installation and adjustment of equipment in a manner satisfactory to the Engineer, the Contractor with his own forces, including such equipment and other experts as may be necessary (hereinafter collectively referred to as Contractor's Personnel) shall place equipment in operation.
 - a. Give the Owner at least seven days written notice prior to placing equipment in operation.
 - b. Operating procedures during said period are subject to Engineer's approval.
 - c. Operation of equipment prior to satisfactory completion of Performance Tests is the Contractor's complete responsibility. Equipment shall be completely tested under both Utility and Emergency (generator) power supplies.
 - d. Designate a day approved by the Engineer for commencement of the Initial Mechanical Performance Test, utilizing water for the process flow.
 - e. Submit manufacturer's certificate regarding equipment installation.

3.02 INSPECTIONS AND TESTS

- A. This section of the specifications sets forth the testing procedures required for the acceptance of certain items of electrical equipment. The purpose of the specified tests and inspection is to determine that each piece of equipment is in satisfactory condition to successfully perform its intended function. It is the intent of these procedures to insure that all workmanship, material and the manner and method of erection and installation conform to manufacturer's instructions, and, except as modified herein, IEEE and ANSI standards and the National Electrical Code.
- B. The testing firm shall perform and supervise the electrical system tests on equipment provided under this Contract unless specifically noted otherwise herein. The testing firm shall furnish all

test equipment required for tests performed and shall be responsible for providing such safety measures as required for each test.

1. The Contractor shall schedule all testing with the Engineer and no testing of any kind shall be performed without the Engineer's approval.
2. The Contractor shall notify all involved parties, including the Engineer, prior to tests, advising them of the test to be performed and the schedule date and time.
3. The Contractor shall give manufacturer's sufficient notice to allow the necessary arrangements to be made and to have their engineer or representative present at tests where their presence is required. Where the manufacturer's responsibility includes both electrical and mechanical performance, the Contractor shall coordinate the tests with others involved.
4. The Engineer shall be allowed to examine the Contractor's test equipment and calibration log prior to use.
5. The Contractor shall notify the Engineer at least 48 hours prior to test, advising him of the test to be performed and to schedule the date and time of test. The Engineer shall be responsible for having his representative present at the designated time.
6. The Engineer shall ascertain that all tests specified are performed.

- C. The testing firm shall prepare all procedures and forms used in the test reports and shall submit them to the Engineer for approval prior to commencement of testing. The test reports shall contain as a minimum, the following information.
1. Job title.
 2. Date of test.
 3. Equipment, system or cable identification.
 4. Specific type of test.
 5. Description of test instrument and date of latest calibration.
 6. Section of specification defining test along with description of test and evaluations as reported by the testing company.
 7. Test results (correct all "Megger" reading at 20 degrees C).
 8. Signature of person supervising test.
 9. Signature of Contractor.
 10. Space for Engineer's signature.
 11. Refer to individual tests and inspections hereinafter specified for any additional or specified requirements.

3.03 TEST MEASUREMENTS

- A. Thermographic Inspection:
1. Perform thermographic inspection of the electrical equipment and installations listed herein in the presence of a duly authorized representative of the Engineer.
 2. The purpose of thermographic inspection is to locate, by comparisons of temperature levels, high resistive points in installations of electrical materials and equipment. Comparisons are made by referencing a known ambient temperature of the object being scanned to the hot spot detected.
 3. Detection Equipment: Equipment shall consist of an infrared camera that provides input to a display screen over a range of at least -20 degrees C to 0 degrees C with the infrared emissions of the object being displayed having an accuracy of 0.1 degrees C.
 - a. The camera shall have three lenses, one 7 degree telephoto lens, one 20 degree wide angle lens, and one 40 degree extra-wide angle lens.
 - b. The camera shall detect infrared wave lengths, converting them into video signals which are then projected onto a monitor screen in the form of a line thermal image which is then to be photographed to provide a record of the temperature variations. Two photographs required for the report.
 - c. In addition to above stated capabilities needed for the infrared scan, the scanner shall have capability to produce an image in both a gray step mode and color monitor. These capabilities allow distinct temperature levels to be shown in black and white and color on the thermogram.
 4. Contractor shall submit prospective bidders with their Bidder's Qualification statement, indicating experience in performing thermographic inspection and familiarity with equipment similar to that stated herein.
 5. Equipment Operator: Engage the service of a specialist who has at least one-year actual experience operating thermographic inspection equipment of the type stated herein, and who is familiar with the various electrical equipment and installations being scanned which are as follows: Cable terminators, Substation Transformers, 600 Volt Switchgear.
 6. Inspection Field Report: Prepare inspection field report in duplicate indicating in actual photographs and thermographs the defective equipment and installations. Also include in such report the probable cause, severity of defect and corrective measure recommendations. Submit both copies of the report to the Engineer who will make the determination of corrective measures. Based on the Engineer's decisions make such actual corrections and retest at no added increase in Contract Price.

END OF SECTION 16950



June 26, 2023

Mr. Mark Addison
Artesian Wastewater Management, Inc.
664 Churchmans Road
Newark, Delaware 19702

Re: Verdantas Project No. 15737
Geotechnical Evaluation
Chandler Street Lift Station Design Services
Milton, Delaware

Dear Mr. Addison:

Verdantas LLC (Verdantas) has completed our geotechnical evaluation for the proposed Chandler Street Lift Station project, located in Milton, Delaware. This evaluation is summarized in the appended report, which includes the data obtained in our field and laboratory programs, the subsurface conditions encountered, and recommendations related to the design and construction of the foundation systems for the proposed elevated platform. These services were performed in general accordance with our revised proposal, dated January 4, 2023.

We appreciate this opportunity to be of service to you and will remain available to assist you and your team as design progresses and into the construction phase of the building. Should you have any questions concerning this evaluation, we encourage you to contact us.

Sincerely,

VERDANTAS LLC

Christopher Franco, P.E.
Staff Engineer III

Ian Fairorth, P.E.
Geotechnical Engineer

CHANDLER STREET LIFT STATION

Geotechnical Evaluation | Milton, Delaware
Project No: 15737

June 26, 2023

Prepared for:

Artesian Wastewater Management, Inc.
664 Churchmans Road
Newark, Delaware 19702

Prepared by:

Verdantas LLC
5400 Limestone Road
Wilmington, Delaware 19808

Contents

Executive Summary	i
1.0 Project Summary	1
2.0 Field and Laboratory Testing.....	2
3.0 Subsurface Conditions.....	3
4.0 Design Analysis and Recommendations	5
5.0 Construction Recommendations	Error! Bookmark not defined.
6.0 Qualifications	10

Tables

1. Laboratory Testing Results
2. Generalized Stratigraphic Conditions
3. Generalized Soil Parameters

Appendices

- A. Figures
- B. Test Boring Logs
- C. General Notes

Executive Summary

The following report summarizes Verdantas' Geotechnical Evaluation for the proposed Chandler Street Lift Station project located in Milton, Delaware. The project is to consist of the demolition of existing discharge piping at the Chandler Street Lift Station, upgrading the existing pumps and electrical service, and installation of a new elevated platform for electrical cabinets. This report includes the data obtained in our field and laboratory programs, the subsurface conditions encountered, and recommendations related to the design and construction of the foundation systems for the proposed elevated platform. These services were performed in general accordance with our proposal dated January 4, 2023.

On March 30, 2023, two (2) Standard Penetration Test (SPT) borings were performed in the vicinity of the proposed elevated platform. Beneath a surficial asphalt cover and a granular fill layer, the natural subsurface conditions generally consist of an upper layer of very loose to loose silty sands overlying medium to dense silty gravelly sands to the extent of the test borings. Groundwater was encountered during the field program at consistent depths of approximately 2.0 to 4.0 feet below the existing ground surface.

Based on the observed subsurface conditions and information provided by the project team, Verdantas provides these comments and recommendations:

- The proposed foundations could be supported on a conventional shallow foundation and slab-on-grade system. Foundations should be designed for a maximum allowable bearing pressure of 3,000 pounds per square foot (psf) bearing on structural fill, placed and compacted as recommended herein, and/or on the natural, very loose to loose granular soils. The estimated total post-construction foundation settlement should be on the order of 1-inch or less, with a post-construction differential settlement on the order of ½-inch over a distance of 25 ft.
- The burial depth of the foundations for the proposed addition should be selected such that additional loads will not be imparted to the existing footings or walls. As such, the proposed foundations immediately adjacent to the existing structure should either be founded at an elevation equal to, or below, the existing foundations. As an alternative, the new foundation could be founded above the existing footing; however, it should be founded at a required distance away from the existing foundation to maintain a 1V:1H slope.
- If these recommendations cannot be achieved with the current shallow foundation design, alternatives to shallow foundations are also considered options. A deep foundation system, consisting of either driven or drilling concrete or steel shafts could be utilized.

Additional conclusions and recommendations are provided in the Design recommendations section herein.

1.0 Project Summary

The following report summarizes Verdantas' Geotechnical Evaluation for the proposed Chandler Street Lift Station project located in Milton, Delaware. This report includes the data obtained in our field and laboratory programs, the subsurface conditions encountered, and recommendations related to the design and construction of the foundation systems for the proposed elevated platform.

1.1 Proposed Site Construction

- Demolition of existing discharge piping; upgrades to the existing pumps and electrical service.
- Installation of a new 4-foot elevated platform for electrical cabinets.
- A new standby generator for the Chandler Street Lift Station will be located at the town's Water Treatment Plant.
- A new flow meter, valves, and appurtenances will be installed in an underground fault located in front of the lift station. Electrical enclosures and equipment will be installed on the elevated platform.
- Structural wall loading of 2 kips/ft for foundations has been assumed for bearing capacity analysis.

1.2 References Utilized

- A set of drawings entitled, "Artesian Wastewater Management – Chandler Street Pumping Station," prepared by Verdantas LLC, dated March 2023.

1.3 Existing Site Conditions

The proposed construction will be located adjacent to the existing Chandler Street Lift Station located on Chandler Street in Milton, Delaware. In general, the site location is relatively flat surrounding the existing lift station, with an existing ground surface elevations are approximately 3 feet. The Lift Station is bounded by residential developments to the North, East, and West. Located directly adjacent and south of the lift station is Milton Memorial Park and a body of water connecting to the Delaware Bay to the East and Wagamons Pond to the Southwest. Underground utilities, consisting of sewer, storm, telecommunications, electric, and water are present along Chandler Street. Overhead telecommunications and electric are present across the street from the lift station along Chandler Street. An approximate Site Vicinity Map is enclosed within Appendix A-1.

2.0 Field and Laboratory Testing

2.1 Standard Penetration Test Borings

On March 30, 2023, two (2) Standard Penetration Test (SPT) borings were performed in general accordance with ASTM D 1586, in the vicinity of the new elevated platform. The SPT borings within these areas were extended to depths of approximately 30 feet below the existing ground surface. Approximate test locations are enclosed as Appendix A-2. The test boring logs are enclosed as Appendix B.

The test borings were performed by CGC Geoservices, LLC, as a subcontractor to Verdantas, utilizing a track-mounted CME-55 drill rig with hollow stem augers. The upper 4ft of test boring TB-2 was hand-augured to confirm clearance of utilities. Upon completion, the test borings were backfilled with excavated soils and patched with cold-patch asphalt. Additional settlement and softening of the backfill may occur, resulting in a depression or hole in the ground surface. Consequently, future maintenance and restoration of the site may be required. The test borings were reviewed in the field by our representative, under supervision of a geotechnical engineer.

2.2 Laboratory Testing

Following completion of the field program, samples were returned to Verdantas' office, and laboratory testing was performed. The results of the laboratory testing are summarized below in Table No. 1.

Table No. 1 – Laboratory Test Results

Boring	Sample No.	Depth (feet)	Moisture Content (%) (ASTM D2216)	Percent Passing No. 200 Sieve (%) (ASTM D1140)
TB-1	S-3	4 – 6	19.1	9.3
	S-6	13 – 15	24.3	4.7
	S-8	23 – 25	12.5	3.1
	S-9	28 – 30	13.7	12.5
TB-2	S-2	6 – 8	20.8	11.0
	S-5	18 – 20	10.0	4.5
	S-7	28 – 30	19.9	5.8

3.0 Subsurface Conditions

3.1 Generalized Site Geology

Based on Delaware Geologic Survey (DGS) mapping, the site is located within the Atlantic Coastal Plain Province. Specifically, the site is within the Lynch Heights Formation, which is composed of light gray to brown to light yellowish brown, medium to fine sand with discontinuous beds of coarse sand, gravel, silt, fine to very fine sand, and organic-rich clayey silt to silty sand. Vertical sequences are variable, but generally consist of a lower medium to coarse sand, a middle interbedded clayey silt and fine to medium sand, and an upper medium sand fining upward to a fine sand to fine sandy silt. Sands are quartzose and slightly feldspathic (<2%), and typically micaceous where very fine to fine-grained. In the vicinity of the project site, the unit is approximately 20 feet thick, underlain by the Beaverdam Formation, which is composed of very coarse sand with pebbles to silty clay. Predominant lithologies at land surface are white to mottled light-gray and reddish-brown, silty to clayey, fine to coarse sand.

3.2 Stratigraphic Conditions

Beneath a surficial cover (i.e., asphalt) and fill layer, the natural subsurface conditions generally consist of an upper layer of very loose to loose silty sands overlying medium to dense silty gravelly sands to the extent of the test borings. Groundwater was encountered during the field program at consistent depths of approximately 2.0 to 4.0 feet below the existing ground surface.

For discussion purposes, the subsurface conditions can be further described as follows:

Table No. 2 – Generalized Stratigraphic Conditions

Subsurface Stratum	Approximate Stratum thickness (ft.)	Generalized Description ^[1]
A	0.4 – 0.5	SURFICIAL COVER (Asphalt)
B	3.5 – 4.0	FILL MATERIAL: Dark gray, black fine to medium sand, trace to little silt, trace debris (brick fragments, glass) (medium dense, moist)
C	19.0 – 24.0	Gray, light brown fine to coarse SAND, trace to little gravel, trace to little silt (loose to very loose density, moist to wet) USCS: SP, SP-SM
D	7.0 - -- [2]	Light gray, light brown fine to coarse SAND, little to some gravel, trace to little silt (medium dense to dense, wet); USCS: SP, SP-SM, SM

Notes:

- The soil descriptions utilized herein, and on the test boring logs, are defined in the enclosed General Notes.
- Stratum D not fully penetrated within test borings.

3.4 Groundwater Conditions

Groundwater conditions were observed at depths ranging between 2.0 and 4.0 feet below the existing ground surface, corresponding to approximate elevations of 0 and 1 feet. Regional groundwater mapping by the Delaware Geologic Survey indicates typical "Depth to Water" in "dry," "normal," and "wet" conditions is between 0 to 3 feet. Additionally, the water table elevation "dry," "normal," and "wet" conditions is between 0 to 10 feet.

Groundwater levels are likely to be affected by season and annual variations in precipitation, as well as by tidal fluctuations from the Delaware Bay. It is estimated that variations in groundwater levels several feet higher or lower than those observed in this evaluation could be experienced during extreme variations in precipitation.

4.0 Discussion and Design Recommendations

4.1 Shallow Foundation System

It is Verdantas' opinion that the loose to very loose granular soils (Stratum C) are generally considered suitable for supporting the proposed additions on a shallow foundation system, following subgrade preparation and review.

4.2 Allowable Foundation Bearing Capacity and Settlement

It is recommended that the proposed foundations for the building be designed for a maximum net allowable bearing pressure of 3,000 pounds per square foot. Based on the results of the analysis performed as part of this evaluation, and the loading information provided by the project structural engineer, it is estimated that maximum total foundation post-construction settlement for the addition should be on the order of 1-inch or less, with a post-construction differential settlement on the order of ½-inch over a distance of 25 feet.

4.3 Foundation Burial Depth and Size

The base of all exterior footings in areas exposed to frost should be placed at least 32 inches below final exterior grade. Foundations should be proportioned with a minimum dimension of 2 feet for continuous footings, regardless of bearing pressure. If a winter construction schedule is proposed for the foundations, provisions for the protection of shallow foundations from frost heave during construction should be included in the contract specifications.

4.4 Influence of Addition on Existing Building

It is understood that the new foundations for the addition will be independent of the existing foundations (i.e., the new addition will not be supported directly on the existing footings or foundation walls). The burial depth of the foundations for the proposed addition should be selected such that additional loads will not be imparted to the existing footings or walls. As such, the proposed foundations immediately adjacent to the existing structure should either be founded at an elevation equal to, or below, the existing foundations. As an alternative, the new foundation could be founded above the existing footing; however, it should be founded at a required distance away from the existing foundation to maintain a 1V:1H slope. If these recommendations cannot be achieved with the current shallow foundation design, alternatives to shallow foundations are also considered options. A deep foundation system, consisting of either driven or drilling concrete or steel shafts could be utilized.

4.5 Slab-On-Grade

Ground-supported floor slabs should be designed as free floating and should not be connected to the other structural elements (e.g., walls, framing, etc.) of the buildings. Isolation joints should be utilized at the interface of proposed ground-supported floor slabs and structural elements to accommodate potential differential settlement.

A minimum 10 mil polyethylene vapor barrier and free draining subbase, consisting of at least 4 inches of poorly graded crushed stone aggregate, such as AASHTO No.57 stone, should be provided beneath floor slabs. Subgrade conditions should be modeled for

design utilizing a subgrade modulus, K_s of 150 pci provided subgrade preparation is performed as recommended in this report.

4.6 Control Joints

Masonry walls should be provided with frequent control joints placed at architecturally convenient locations, such as windows and doorways, to provide a “preferred” location for the differential settlement to occur without cracking the walls.

4.7 Soil Parameters

The following soil parameters are recommended for lateral earth loads and braced excavation design:

Table No. 3 – Generalized Soil Parameters

Recommended Parameter	Stratum B Fills	Stratum C Loose to Very Loose Sands	Stratum D Medium to Dense Sands	Structural Fill (< 25% Passing No. 200 Sieve)
Moist Unit Weight (pcf)	120	115	120	125
Cohesion (psf)	0.0	0.0	0.0	0
Angle of Internal Friction	32	30	32	34
At Rest Earth Coefficient, K_o	0.47	0.50	0.47	0.44
Active Earth Pressure Coefficient, K_A	0.31	0.33	0.31	0.28
Passive Earth Pressure Coefficient, K_P	3.25	3.00	3.25	3.53
Coefficient of Sliding Friction	0.39	0.39	0.39	0.42

Backfill pressures on “unyielding” retaining walls restrained from rotation at the top should be analyzed using the “at rest” earth pressures coefficient, K_o . The “active” and “passive” earth pressure coefficients, K_A and K_P , respectively, should be utilized for the design of “yielding” retaining walls, such as cantilevered walls.

4.8 Seismic Design Parameters

Based on the subsurface conditions encountered during the field exploration at the site, and review of regional geologic maps, a “D” site classification is recommended for the analysis of seismic conditions, as defined by Section 1613.2.2 of the 2018 International Building Code and Chapter 20 of the American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7-16).

4.9 Existing Utilities

The site contains underground utilities including storm sewer, water, and electric. The presence of utilities beneath a structure could result in crushing and/or damaging of the pipes. Where existing site utilities may conflict with the proposed foundations, it is

recommended that foundations be relocated to accommodate the existing utilities, which will likely remain in current locations.

4.10 Site Grading

Site grading should be designed to provide positive drainage away from the proposed construction area. Positive site drainage should be maintained throughout the construction activities. Final site grading should provide drainage away from all structures.

4.11 Assumptions

The proposed grading and structural loading considered in this evaluation should be verified by the project team prior to the completion of their design. If the proposed loading conditions vary from those considered herein, Verdantas should be notified to possibly modify the recommendations provided herein as required.

4.12 Excavation Safety

All utility and foundation excavation should be performed in accordance with OSHA guidelines. The onsite soils can be characterized by OSHA CFR Part 1926 Excavation Standards as Type C soils. Should it be required, all temporary sheeting, shoring, benching, and sloping should be designed by a qualified engineer registered in the State of Delaware.

4.13 Protection of Subgrade Soils

If foundation excavations are left open, precipitation may result in the collection of water within the excavation. Provisions for removal of water by drainage or sumping are recommended. Subgrade soils disturbed by precipitation and construction traffic should be either scarified and re-compacted or undercut and replaced with structural fill as previously recommended in this report.

4.14 Groundwater Control

Groundwater and/or perched water conditions were observed at depths of approximately 2.0 to 4.0 feet, corresponding to elevations of 0.0 and 1.0 feet. Based on the foundation construction, groundwater is likely to be encountered during construction. It is recommended that groundwater be controlled during construction to maintain groundwater level a minimum of 2 feet below the base of the excavations. Typical groundwater methods may include a well point system or localized sumping. The actual method of groundwater control selected by the contractor should be established prior to excavation.

If groundwater is encountered during foundation construction, it is recommended that water be discharged away from the construction area and performed within general accordance with any and all regulatory requirements.

5.0 Construction Recommendations

5.1 Subgrade Preparation

The preparation of the foundations and site grading operations are anticipated to include removal of the existing surficial cover including topsoil, where identified on the test boring logs.

Unsuitable subgrade conditions encountered within the proposed structure area, should be undercut to firm subgrade conditions, and backfilled with compacted structural fill in accordance with the recommendations of this report. If acceptable to the project's engineer, granular soils may also be densified in place. A qualified soils technician working under the supervision of a geotechnical engineer should confirm the consistency and texture of the exposed soils with the conditions encountered by this evaluation, as described herein.

5.2 Foundation Subgrade Review

All shallow foundations should be placed on firm, dry, non-frozen subgrade consisting of medium dense or denser coarse-grained natural soil and compacted as recommended herein. Foundation excavations should be reviewed by a qualified technician working under the supervision of a geotechnical engineer who is familiar with the recommendations of this report.

Subgrade review should be performed prior to the placement of reinforcing steel or concrete and should verify the presence of suitable bearing soils, consisting of Stratum C and D soils, as described herein, that are free from debris or organics. If soft/loose or unsuitable subgrade conditions such including frozen soils, construction debris or waste, soils containing organics, or debris fill are encountered within the proposed structure area, additional excavation should be performed until they are uniformly encountered across the base of the foundation's excavation. If acceptable to the project geotechnical engineer, granular soils can be scarified, moisture conditioned and densified in place. Foundation undercut areas should be backfilled with structural fill as recommended herein.

5.3 Compaction Requirements

Structural fill should be placed in loose lifts with a maximum thickness of 8 inches. Each lift of fill placed within the proposed building construction areas (defined as the area extending at least 5 feet beyond the foundation element perimeters) should be compacted to at least 95.0 percent of the maximum dry density, at or slightly above optimum moisture as determined by the Modified Proctor test (ASTM D1557).

Structural fill for site pavements and for utility trenches located outside of the proposed building structure should be compacted to at least 90.0 percent of the Modified Proctor maximum dry density. The placement and compaction of structural fill should be monitored on a full-time basis by a qualified technician working under the supervision of a geotechnical engineer.

5.4 Excavation Safety

All utility and foundation excavations should be performed in accordance with OSHA guidelines. The very loose and denser sands (Stratum C and D) can be characterized by OSHA CFR Part 1926 Excavation Standards as Type C soils. Should it be required, all temporary sheeting, shoring, benching, and sloping should be designed by a qualified engineer registered in the State of Delaware.

5.5 Subsurface Data

All contractors interested in bidding on phases of this work, which involve subsurface conditions, should be given full access to this report so that they can develop their own interpretations of the available data.

5.6 Construction Review

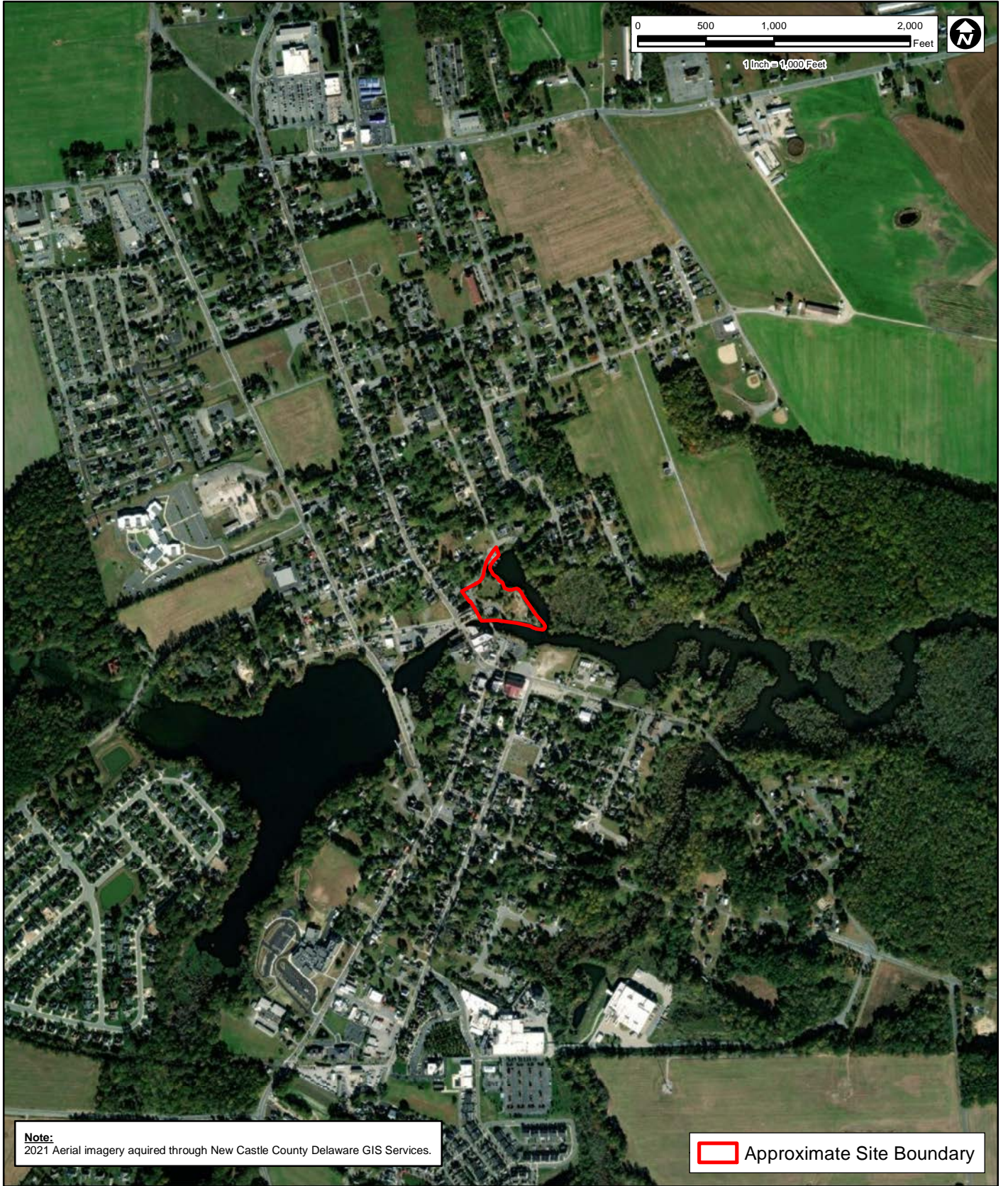
It is recommended that the project budget include provisions for the cost for independent construction monitoring of the earthwork and foundation construction by a qualified engineering firm retained by the Owner, to review conformance of construction with the recommendations of the project geotechnical evaluation, as well as the project plans and specifications.

6.0 Qualifications


The recommendations of this report have been prepared according to generally accepted soil and foundation engineering practice and are based on the conditions encountered by the test borings performed at the site. Although soil quality has been inferred from the interpolation of the sampling data, you should explicitly note that subsurface conditions beyond the test borings are, in fact, unknown. Should any conditions encountered during construction differ from those described in this report, this office should be notified immediately in order to review, and possibly modify these recommendations. This report applies solely to the size, type, and location of the structures described herein. In the event that changes are proposed, this report will not be considered valid unless the changes have been reviewed and the recommendations of this report modified and re-approved in writing by Verdantas LLC.

Appendix A

Figures



Note:
2021 Aerial imagery acquired through New Castle County Delaware GIS Services.

 Approximate Site Boundary



DISCLAIMER:
Verdantas LLC has furnished this map to the company identified in the title block (Client) for its sole and exclusive use as a preliminary planning and screening tool and field verification is necessary to confirm these data. This map is reproduced from geospatial information compiled from third-party sources which may change over time. Areas depicted by the map are approximate and may not be accurate to mapping, surveying or engineering standards. Verdantas LLC makes no representation or guarantee as to the content, accuracy, timeliness or completeness of any information or spatial location depicted on this map. This map is provided without warranty of any kind, including but not limited to, the implied warranties of merchantability or fitness for a particular purpose. In no event will Verdantas LLC, its owners, officers, employees or agents, be liable for damages of any kind arising out of the use of this map by Client or any other party.

April 2023
Geotechnical Evaluation
Chandler Street Lift Station
Milton, Delaware
Site Vicinity Map



Milton, Sussex County, Delaware

Figure

A-1



Note:
2021 Aerial imagery acquired through New Castle County Delaware GIS Services.

 Approx. Test Boring Locations
 Approx. Site Boundary



DISCLAIMER:
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April 2023
 Geotechnical Evaluation
 Chandler Street Lift Station
 Milton, Delaware
Site Exploration Map
 Milton, Sussex County, Delaware

Figure
A-2

Appendix B

Test Boring Logs

Geotechnical Evaluation
Chandler Street Lift Station
Milton, Delaware
Project No. 15737

Date Started : March 30, 2023
Date Completed : March 30, 2023
Logged by : DMS
Weather : Clear, High 30s
Driller/Agency : J. Truver/CGCG

Drilling Equipment : CME-55 Track-Mounted
Drilling Methods : HSA (SPT, ASTM D 1586)
Surface Elevation : 3.2 feet
Northing : 38.77936 feet
Easting : -75.31064 feet

Depth in feet	Surf. Elev. 3.2 ft	GRAPHIC	USCS	Sample Condition	Water Levels	SAMPLES	Sample Number	Blows per 6 inches	Recovery (ft)	Moisture Content (%)	Percent Passing 200 Sieve	WATER LEVEL
				Auger Cuttings Remolded	During Drilling							
				DESCRIPTION								
0				ASPHALT (± 5 inches)								
				FILL: Dark gray, black fine to medium SAND, little silt, trace gravel, trace debris (brick) (moist)			S-1	3-5-6	1.0			
	0			FILL: Dark gray, black fine SAND, some to little silt, trace shell fragments, trace organics, trace debris (glass) (wet)			S-2	2-3-3-2	0.8			
5			SP-SM	Gray fine to medium SAND, trace gravel, trace silt (wet)			S-3	2-2-3-2	1.0	19.1	9.3	
				Gray fine to medium SAND, trace silt, trace gravel (wet)			S-4	4-7-5-3	1.5			
-5				Gray, light brown fine to medium SAND, trace silt (wet)			S-5	1-3-1-2	2.0			
10			SP	Gray fine to medium SAND, trace silt (wet)			S-6	WOH-2-3-2	2.0	24.3	4.7	
-10				Light brown medium to coarse SAND, little gravel, trace silt, trace fine sand (wet)			S-7	3-3-3-4	0.5			
15				Light brown fine to coarse SAND, some gravel, trace fine sand, trace silt (wet)			S-8	8-6-7-11	2.0	12.5	3.1	
20			SM	Gray fine to medium SAND, little silt (wet)			S-9	16-16-22-21	2.0	13.7	12.5	
-20												
25												
-25												
30												

- NOTES:
- Test boring terminated at ± 30.0 feet below existing ground surface (b.e.g.s.).
 - Groundwater conditions observed at ± 2.0 feet b.e.g.s. with augers at ± 18.0 feet b.e.g.s.
 - Test boring caved at ± 9.9 feet b.e.g.s.
 - Soil descriptions performed in general accordance with ASTM D 2488, the Practice for Description and Identification of Soils (Visual-Manual Procedure).
 - Borehole backfilled with auger cuttings and cold-patch asphalt upon completion.

Geotechnical Evaluation
Chandler Street Lift Station
Milton, Delaware
Project No. 15737

Date Started : March 30, 2023
Date Completed : March 30, 2023
Logged by : DMS
Weather : Clear, High 30s
Driller/Agency : J. Truver/CGCG

Drilling Equipment : CME-55 Track-Mounted
Drilling Methods : HSA (SPT, ASTM D 1586)
Surface Elevation : 3.2 feet
Northing : 38.77943 feet
Easting : -75.3106 feet

Depth in feet	Surf. Elev. 3.2 ft	GRAPHIC	USCS	Sample Condition	Water Levels	SAMPLES	Sample Number	Blows per 6 inches	Recovery (ft)	Moisture Content (%)	Percent Passing 200 Sieve	WATER LEVEL	
				Auger Cuttings Remolded	During Drilling								
				DESCRIPTION									
0				ASPHALT (± 5 inches)									
0				HAND AUGERED									
5			SP-SM	Gray fine to medium SAND, little silt (wet)				S-1	2-3-3-2	1.0			
-5				Light brown fine to medium SAND, little silt, trace gravel (wet)				S-2	WOH-1-1-1	2.0	20.8	11.0	
-10				Light brown, gray fine to medium SAND, little silt, trace gravel (wet)				S-3	1-2-2-1	2.0			
-15			SP	Light gray fine to medium SAND, little silt, trace gravel (wet)				S-4	1-2-2-1	2.0			
-20				Light gray fine to medium SAND, trace silt, trace gravel (wet)				S-5	6-2-4-5	0.8	10.0	4.5	
-25			SP	Light gray and brown fine to coarse SAND, some gravel, trace fine sand, trace silt (wet)				S-6	4-8-11-17	1.0			
-30			SP-SM	Light gray fine to medium SAND, trace silt (wet)				S-7	8-6-8-10	1.1	19.9	5.8	

- NOTES:
- Test boring terminated at ± 30.0 feet below existing ground surface (b.e.g.s.).
 - The top ± 4 feet of test boring hand augered prior to drilling.
 - Groundwater conditions observed at ± 4.0 feet b.e.g.s. with augers at ± 18.0 feet b.e.g.s.
 - Test boring caved at ± 9.2 feet b.e.g.s
 - Soil descriptions performed in general accordance with ASTM D 2488, the Practice for Description and Identification of Soils (Visual-Manual Procedure).
 - Borehole backfilled with auger cuttings and cold-patch asphalt upon completion.

Appendix C

General Notes

GENERAL NOTES

VERDANTAS LLC uses the following definitions and terminology to classify and correlate the field and laboratory samples.

VISUAL UNIFIED CLASSIFICATIONS: The soil samples are described by color, major constituent, modifiers (by percentage), and density (or consistency). Coarse Grained or Granular Soils have more than 50% of their dry weight retained on a No. 200 sieve; they are described as: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a No. 200 sieve; they are described as: clays or clayey silts if they are cohesive and silts if they are noncohesive. In addition to gradation, granular soils are defined on the basis of their relative in-place density and fine grained soils on the basis of their strength or consistency and their plasticity.

The Unified Soil Classification symbols are:

COARSE GRAINED SOILS

GW - Well graded gravels
 GP - Poorly graded gravels
 GM - Silty gravels
 GC - Clayey gravels
 SW - Well graded sands
 SP - Poorly graded sands
 SM - Silty sands
 SC - Clayey sands

FINE GRAINED SOILS

ML - Silts of low plasticity
 CL - Clays of low to medium plasticity
 OL - Organic silt clays of low plasticity
 MH - Silts of high plasticity
 CH - Clays of high plasticity
 OH - Organic silt clays of high plasticity
 PT - Peat and highly organic soils

SIZE DESCRIPTION

F - Fine
 M - Medium
 C - Coarse
 G - Gravel

MODIFIERS (PERCENTAGE)

Tr - Trace 1 - 10%
 Ltl - Little 11 - 20%
 Some 21 - 35%
 & - And 36 - 50%

COLOR

Or - Orange	Blk - Black	Vc - Varicolored
Yel - Yellow	Gr - Gray	Dk - Dark
Br - Brown	R - Red	Lt - Light

DENSITY: COARSE GRAINED SOILS

Very loose	4 blows/ft or less
Loose	5 to 10 blows/ft
Medium	11 to 30 blows/ft
Dense	31 to 50 blows/ft
Very Dense	51 blows/ft or more

CONSISTENCY: FINE GRAINED SOILS

Very soft	2 blows/ft or less
Soft	3 to 4 blows/ft
Medium	5 to 8 blows/ft
Stiff	9 to 15 blows/ft
Very stiff	16 to 30 blows/ft
Hard	31 blows/ft or more

NOTE: The Standard Penetration Test "N" value is the number of blows per foot of a 140 pound hammer falling 30 inches on a 2 inch O.D. split spoon sampler, except where otherwise noted.